

# HS - Honors Chemistry - 10-12

## Huntingdon Area School District

UNITS (18/18 SELECTED)

SUGGESTED DURATION

 Unit 1: Module 1 - The Central Science	<i>5 lessons</i>
 Unit 2: Module 2 - Matter, Properties and Changes	<i>6 lessons</i>
 Unit 2: Module 3 - The Structure of the Atom	<i>10 lessons</i>
 Unit 2: Module 4 - Electrons in Atoms	<i>10 lessons</i>
 Unit 2: Module 5 - The Periodic Table and Periodic Law	<i>11 lessons</i>
 Unit 3: Module 6 - Ionic Compounds and Metals	<i>9 lessons</i>
 Unit 3: Module 7 - Covalent Bonding	<i>10 lessons</i>
 Unit 3: Module 8 - Chemical Reactions	<i>11 lessons</i>
 Unit 3: Module 9 - The Mole	<i>10 lessons</i>
 Unit 3: Module 10 - Stoichiometry	<i>10 lessons</i>
 Unit 4: Module 11 - States of Matter	<i>5 lessons</i>
 Unit 4: Module 12 - Gases	<i>10 lessons</i>
 Unit 4: Module 13 - Mixtures and Solutions	<i>10 lessons</i>
 Unit 4: Module 14 - Energy and Chemical Change	<i>9 lessons</i>
 Unit 4: Module 15 - Reaction Rates	<i>10 lessons</i>
 Unit 4: Module 16 - Chemical Equilibrium	<i>10 lessons</i>
 Unit 4: Module 17 - Acids and Bases	<i>10 lessons</i>
 Unit 5: Module 23 - Nuclear Chemistry	<i>10 lessons</i>

# Unit 1: Module 1 - The Central Science

HS - Honors Chemistry - 10-12

## UNIT OVERVIEW

Students will seek to answer the question, "What do plants and buildings have in common?".

## STANDARDS/EXPECTATIONS

Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)

3.2.9-12.L

3.2.9-12.V

## BIG IDEAS

### Big Ideas

- **Students will define chemistry as a discipline, helping them understand the role of chemistry as a science central to a wide variety of questions.**
- **Students will learn about the base units for scientific measurement, as well as some basic operations with these measurements, building the foundation for quantifying their investigations.**
- **Students will learn about accuracy and precision and how significant figures reflect the precision of a measurement, further developing their ability to analyze data.**
- **Students will analyze graphs, which supports their ability to communicate the results of their investigations.**

## ESSENTIAL QUESTIONS

### Essential Questions

- How can chemistry help you understand the world?
- Why do scientists use standardized units?
- Why are significant figures important?
- How can displaying data help you interpret it?

# Unit 1: Module 1 - The Central Science

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
the base SI units of measurement.	identify an observation as quantitative or qualitative.
the difference between accuracy and precision.	convert numbers into/from scientific notation and conduct basic mathematical operations with scientific notation without a calculator
how to identify a digit as significant.	read measurements off of instrumentation with the appropriate accuracy and precision.
which graph type is appropriate for a given data set; line, pie, histogram, bar.	Calculate the percent error given experimental data.
the difference between dependent and independent variables.	Interpret graphical data.
	Create graphical representations of experimental data.

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
Lab reports	project based	
Module 1 Test	summative	
Assorted worksheets	diagnostic and formative	

## Unit 2: Module 2 - Matter, Properties and Changes

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions, "How are the colors of the fireworks connected to the structure of the atom?" and "Why is this volcano spewing bright blue flames?"

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.A

3.2.9-12.C

3.2.9-12.G

### BIG IDEAS

#### Big Ideas

- **Students will learn that everything is made of matter, and this matter can undergo physical and chemical changes.**
- **Students explore the basic properties of matter, including physical and chemical changes.**
- **Students extend their understanding of the properties of matter to an understanding of the different changes matter undergoes, including physical and chemical changes.**
- **Students further their understanding of how volcanos transform matter.**
- **Students are introduced to homogeneous and heterogeneous mixtures and how they can be separated.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- What are the differences between physical and chemical properties?
- How does a substance change when it burns?
- What are elements and compounds?
- Would the substance still burn blue if it were mixed with another substance?

## Unit 2: Module 2 - Matter, Properties and Changes

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
how to differentiate between solutions, suspensions and colloids	Use the Tyndall Effect to determine if a mixture is a colloid or solution.
define, explain and give examples of physical and chemical properties and changes.	identify whether a chemical reaction has occurred and determine the products.
The difference between elements and compounds.	

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 2 Test	summative	

## Unit 2: Module 3 - The Structure of the Atom

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions, "How are the colors of the fireworks connected to the structure of the atom?" and "What is matter made of?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.A

3.2.9-12.B

3.2.9-12.C

3.2.9-12.H

3.2.9-12.G

3.2.9-12.S

### BIG IDEAS

#### Big Ideas

- **Students will learn that the atom is the fundamental building block of matter.**
- **A summary of early theories about the nature of matter builds to the introduction of modern atomic theory and its relationship to conservation of mass.**
- **Students see the atom defined, from the discovery of the electron through the modern electron cloud model.**
- **Students enhance their understanding of the composition of matter as they study atomic number, mass number and isotopes.**
- **Students are introduced to the basic types of radiation, furthering their understanding of matter and how it can change.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How has our understanding of matter changed over time?
- What does an atom look like?
- Are all atoms identical?
- How can atoms change?

## Unit 2: Module 3 - The Structure of the Atom

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
the history of the development of the atomic theory	write balanced nuclear reactions for alpha, beta and gamma decay.
The difference between isotopes	Calculate the atomic mass of an element given the isotopic information (mass and abundance)
subatomic particles of the atom	Using atomic and mass numbers, describe the makeup of the atom.
Rutherford's gold foil experiment, Thomson's cathode ray experiment and Milliken's oil drop experiment	

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 3 Test	summative	

## Unit 2: Module 4 - Electrons in Atoms

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the question, "How are the colors of the fireworks connected to the structure of the atom?", and "How do we know what stars are made of?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.A

3.2.9-12.C

3.2.9-12.W

3.2.9-12.T

3.2.9-12.V

### BIG IDEAS

#### Big Ideas

- **Students will learn that the atoms of each element have a unique arrangement of electrons, and the valence electrons primarily contribute to the chemical properties of the elements.**
- **Students study the dual nature of light, leading to atomic emission spectra, the foundation for analyzing the light from stars.**
- **Students apply the idea of quantized energy to the atom, helping them understand how different colors of light can signal different elements in the stars.**
- **Students learn to model the arrangement of electrons in atoms.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- What is light made of?
- Why does every element produce a unique atomic emission spectrum?
- How are electrons arranged in atoms?

## Unit 2: Module 4 - Electrons in Atoms

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
Bohr model of the atom	write electron configurations for any element
Failures of the Bohr model and develop the Modern Atomic Theory	write Noble Gas electron configuration shortcut for any element
Pauli Exclusion Principle, Hund's Rule, Aufbau Principle, and the Diagonal Rule	Write dot diagrams for the elements.

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 4 test	summative	

## Unit 2: Module 5 - The Periodic Table and Periodic Law

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the question, "How are the colors of the fireworks connected to the structure of the atom?", and "What can we learn from the Periodic Table?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.C

3.2.9-12.A

3.2.9-12.B

3.2.9-12.D

### BIG IDEAS

#### Big Ideas

- **Students will learn how periodic trends in the properties of atoms allows us to predict physical and chemical properties.**
- **A brief introduction to the history of the Periodic Table helps students understand why elements are so arranged and how to begin extracting information from the table.**
- **Students connect the organization of the periodic table to the organization of electrons in atoms, solidifying their understanding of the table's construction and preparing them to analyze trends on the table.**
- **Students study the basic trends on the periodic table and the reasons for these trends.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How are elements organized on the periodic table?
- Why do elements in the same group have similar properties?
- How can you use the periodic table to predict an elements properties?

## Unit 2: Module 5 - The Periodic Table and Periodic Law

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
the organization of the periodic table	predict behaviors of the elements based on periodic trends
the concept of the effective nuclear charge	<div style="border: 1px solid black; padding: 5px;">                     explain the periodic trends and how the effective nuclear charge is responsible for the behavior.                 </div>
	rank various elements for properties such as Ionization Energy, Electronegativity, and Atomic Size.
	Explain how the Octet rule contributes to the reactivity of elements

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 5 Test	summative	

## Unit 3: Module 6 - Ionic Compounds and Metals

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "How can understanding chemical bonding and reactions support fire safety?", and "Why do some crystals form cubes?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.C

3.2.9-12.B

3.2.9-12.D

3.2.9-12.N

3.2.9-12.L

3.2.9-12.S

### BIG IDEAS

#### Big Ideas

- **Students study the formation of ions, the foundation for the crystalline structure of ionic compounds.**
- **Students learn how ionic bonds are formed and the properties, including crystal structure, that emerge from those bonds.**
- **Students learn how to name ionic compounds and how to write their formulas.**
- **Students learn about bonding in metals and how that bonding affects the properties of metals.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- Why do elements form compounds?
- How are the ions in ionic compounds arranged?
- What are the names and formulas of ionic compounds?
- How do metals and ionic compounds compare and contrast?

# Unit 3: Module 6 - Ionic Compounds and Metals

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
nomenclature rules of ionic solids	write chemical formulas for ionic compounds
the common cations and anions	name ionic compounds

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 6 Test	summative	

## Unit 3: Module 7 - Covalent Bonding

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "How can understanding chemical bonding and reactions support fire safety?", and "Why does water expand when it freezes?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.C

3.2.9-12.L

3.2.9-12.N

3.2.9-12.S

### BIG IDEAS

#### Big Ideas

- **Students explore how atoms gain stability from sharing electrons, foundational to the understanding of bonding in water.**
- **Students study the formal system for naming molecules, as well as how to write formulas from the formal names.**
- **Students write structural formulas for molecules, including molecules that are exceptions to the octet rule.**
- **Students move from molecular structures to molecular shapes, including the shapes of molecules such as water that have lone pairs of electrons.**
- **Students study bond character and how bond character affects the properties of compounds, tying together the information necessary to analyze the bonds in water and how they affect water's properties.**

## Unit 3: Module 7 - Covalent Bonding

HS - Honors Chemistry - 10-12

### ESSENTIAL QUESTIONS

#### Essential Questions

- How do atoms bond in covalent molecules?
- How do you name molecules?
- How are electrons shared in covalent molecules?
- What shapes do molecules form?
- How does molecular shape affect the way that covalent compounds are held together?

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . . (Acquired Skill)</b>
nomenclature rules for covalent compounds	write formulas for covalent compounds
VSEPR Theory of molecular geometry	Draw 3 dimensional depictions of simple covalent compounds
polar vs nonpolar bonding	predict physical properties of covalent compounds based on the type of IMF's present.
relative strengths of Intermolecular Forces of Attraction in covalent compounds	Use VSEPR Theory, and bonding polarity to determine the molecular polarity of covalent compounds

# Unit 3: Module 7 - Covalent Bonding

HS - Honors Chemistry - 10-12

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
module 7 test	summative	

## Unit 3: Module 8 - Chemical Reactions

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "How can understanding chemical bonding and reactions support fire safety?", and "What happens to food when you cook it?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.F

3.2.9-12.G

3.2.9-12.C

### BIG IDEAS

#### Big Ideas

- **Students learn to describe chemical reactions with balanced chemical equations.**
- **Students learn to classify chemical reactions and how those classifications can help them predict the outcomes of chemical reactions.**
- **Students learn about reactions between substances dissolved in water and learn to write ionic equations, as well as to combine two reactions into an overall equation.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How are chemical reactions modeled?
- What are the different types of chemical reactions?
- What is unique about reactions that take place in water?

# Unit 3: Module 8 - Chemical Reactions

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
5 basic types of reactions: synthesis, decomposition, single replacement, double displacement, and combustion	Utilize the law of conservation of matter to balance chemical reactions.
how to read the activity series and solubility charts	Based on the type of reaction, predict the products of a given reaction
	Utilize the activity series and solubility rules to predict products, and write net ionic equations for reactions in solutions.

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
module 8 Test	summative	
lab reports	project based	

## Unit 3: Module 9 - The Mole

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "How can understanding chemical bonding and reactions support fire safety?", and "How is counting pennies like counting atoms?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.G

### BIG IDEAS

#### Big Ideas

- **Students will learn about the mole and how to convert between moles and molecules.**
- **Students will convert between the mass of a substance and the moles of the representative particles.**
- **Students apply their understanding of the mole to compounds, determining the molar mass and converting between moles of a compound and mass.**
- **Students apply mass and the mole to determine empirical and molecular formulas from percent composition.**
- **Students analyze hydrates to determine the moles of water associated with each mole of the compound.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- Why is it useful to group large numbers of things?
- What is the mass of a mole?
- What do chemical formulas say about mole relationships?
- Can different molecules have the same ratio of elements?
- How can you determine the amount of water in a hydrate?

## Unit 3: Module 9 - The Mole

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . . (Acquired Skill)</b>
Avogadro's number.	convert from atoms/molecules to moles and back
the concept of the mole as a chemical quantity.	convert from grams of a substance to moles and back, using the formula mass
formula mass/molar mass/molecular weight	Determine the percent composition, empirical formula and molecular formula of a compound given various pieces of experimental data.

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 9 Test	summative	

## Unit 3: Module 10 - Stoichiometry

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "How can understanding chemical bonding and reactions support fire safety?", and "How much carbon dioxide did this field of corn need to grow?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.G

### BIG IDEAS

#### Big Ideas

- **Students define the relationships in a balanced chemical equation and write mole ratios given the balanced equation.**
- **Students apply molar mass and mole ratios to convert between masses of reactants and products.**
- **Students continue to develop their understanding of stoichiometry by identifying limiting reactants and determining the masses of products formed and excess reactant remaining.**
- **Students compare the actual yield of a reaction to the theoretical yield to determine the percent yield.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- What can you learn from balanced chemical equations?
- How do you determine the amounts of products and reactants involved in chemical reactions?
- How do you know if you have enough of a reactant?
- Do you always get the calculated amount of product out of a reaction?

## Unit 3: Module 10 - Stoichiometry

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
stoichiometry	perform stoichiometric calculations; mass-mass, mass-volume for a chemical reaction.
theoretical yield	Determine the theoretical yield of a chemical reaction
limiting reactant vs excess reactant	Compare the experimental (actual) yield of the reaction and the theoretical yield by calculating percent yield of a chemical reaction.
	propose ways to increase the yield of a reaction.
	Determine the limiting reactant of a chemical reaction and identify any excess reactants.

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
Lab reports	project based	
Module 10 Test	summative	

## Unit 4: Module 11 - States of Matter

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "Why does water naturally exist as a solid, liquid, and gas on Earth?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.B

3.2.9-12.N

### BIG IDEAS

#### Big Ideas

- **Students develop the kinetic molecular theory to explain the behavior of gases.**
- **Students develop a deeper understanding of intermolecular forces.**
- **Students examine how the properties of liquids and solids relate to the arrangements and interactions of the particles that compose them.**
- **Students study phase changes that require energy and phase changes that release energy, rounding out their understanding of the module question.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- Do all gases behave the same way?
- What forces exist between molecules?
- What are the properties of liquids and solids?
- What causes a substance to change phases?

# Unit 4: Module 11 - States of Matter

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
kinetic molecular theory of matter	interpret phase diagrams to identify the state of matter at a given pressure and temperature.
atmospheric pressure and gas pressure	Calculate the pressure exerted by individual gases in a mixture.
Dalton's Law of Partial Pressures	explain the intermolecular forces in depth including Hydrogen Bonding.
surface tension, density, compressibility as well as adhesive and cohesive forces	Identify the conditions under which a substance will undergo any of the 6 phase changes; freezing, melting, vaporization, condensation, sublimation and deposition.
heating and cooling curves	Explain the concepts of effusion and diffusion and Graham's Law
phase diagrams and the effect of pressure and temperature on the state of matter	

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 11 Test	summative	

## Unit 4: Module 12 - Gases

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "How do hot air balloons fly?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.F

### BIG IDEAS

#### Big Ideas

- **Students learn the laws that can be used to predict the behavior of a sample of gas when pressure, temperature, and volume change.**
- **Students learn how the ideal gas law can account for changes in the amount of gas, in addition to changes in pressure, temperature, and volume, and reexamine ideal vs. nonideal behavior.**
- **Students learn that Avogadro's principle means that the molar relationships between gases in balanced chemical equations also represent volume relationships.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How are a gas's temperature, pressure, and volume related?
- What happens when you change the amount of gas present?
- How are the amounts of gaseous reactants and products in a chemical reaction calculated?

# Unit 4: Module 12 - Gases

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
The gas laws - Charles, Boyle's, Avogadro's, and combined	predict the behavior of a gas based on the variables being changed.
The ideal gas law	Calculate the volume of a gas produced in a reaction using the Ideal gas law and stoichiometry.
real gas vs ideal gas.	

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 12 Test	summative	

## Unit 4: Module 13 - Mixtures and Solutions

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "How is it possible for a liquid to hold this shape?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.M

3.2.9-12.N

### BIG IDEAS

#### Big Ideas

- **Students revisit heterogeneous and homogeneous mixtures, expanding their understanding of these classifications.**
- **Students describe and quantify the concentrations of solutions.**
- **Students study the solvation process, including factors such as agitation, surface area, and temperature that affect solvation.**
- **Students study the properties of solutions that depend on the concentration of solute particles, such as boiling point elevation and freezing point depression.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- Do all mixtures have a uniform composition?
- How can you describe the concentration of a solution?
- Why do some substances dissolve in water while others don't?
- Why do we salt the roads when it is cold outside?

## Unit 4: Module 13 - Mixtures and Solutions

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

unsaturated, saturated or supersaturated.

Knowledge	Skills
<b>Students will know . . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . . (Acquired Skill)</b>
solution concentration; molarity, percent by mass, percent by volume, molality, mole fraction	calculate the concentration of a solution.
dilution equation	dilute a solution to achieve the desired concentration.
Solvation, and the factors that affect it	Explain why some substances dissolve while others don't
solubility curves	Explain how to speed up the rate at which solvation occurs.
unsaturated, saturated and supersaturated solutions	Read a solubility chart and determine if a solution is saturated, unsaturated, or supersaturated.
colligative properties.	Make a supersaturated solution.

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 13 Test	summative	

## Unit 4: Module 14 - Energy and Chemical Change

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "How much heat is released during a rocket launch?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.D

3.2.9-12.O

3.2.9-12.P

3.2.9-12.R

### BIG IDEAS

#### Big Ideas

- **Students examine the nature of energy in chemical reactions, establishing the foundation for analyzing heat released by a reaction.**
- **Students learn about heat in chemical processes and how thermochemistry defines heat changes in terms of systems and surroundings.**
- **Students learn to write thermochemical equations and to use them to calculate energy released in a chemical reaction.**
- **Students apply Hess's Law and the summation equation to determine enthalpy changes in chemical processes.**
- **Students learn about entropy and how to use enthalpy and entropy to determine Gibb's free energy to assess the spontaneity of a reaction.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- What is energy?
- How are heat and temperature related?
- Why do you include energy changes in chemical equations?
- How much energy is released when rocket fuel reacts?
- Are all reactions that release energy spontaneous?

# Unit 4: Module 14 - Energy and Chemical Change

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
specific heat and heat	calculate the amount of heat required to increase the temperature of a substance and/or change the physical state of the substance.
calorimetry	Determine the specific heat of a metal using a calorimeter.
enthalpy of reaction, exothermic and endothermic	Calculate the enthalpy changes for chemical reactions using enthalpies of formation.
Hess's Law	Calculate the enthalpy change for a reaction using Hess's Law
Entropy and Spontaneity	Explain the concepts of entropy, spontaneity and free energy for a chemical reaction.
Gibb's Free Energy	Determine if a reaction will occur spontaneously and if not, what conditions would need to be changed so that it does occur spontaneously.

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 14 Test	summative	

## Unit 4: Module 15 - Reaction Rates

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "How is this frog frozen but still alive?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.E

3.2.9-12.D

### BIG IDEAS

#### Big Ideas

- **Students learn to calculate an average reaction rate and use collision theory to explain how substances react.**
- **Students apply activation energy and collision theory to explain factors that affect reaction rates, including the nature of the reactants, concentration, surface area, temperature, and catalysts and inhibitors.**
- **Students write rate laws for reactions and determine reaction order.**
- **Students calculate instantaneous reaction rates and study reaction mechanisms for complex reactions.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How do you determine how fast a reaction is going?
- Can chemical reactions speed up or slow down?
- What is the relationship between reaction rate and concentration?
- How are reaction rates related to reaction mechanisms?

# Unit 4: Module 15 - Reaction Rates

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
collision theory	explain the function and effect of catalysts and inhibitors.
factors that affect the rate of a reaction	write rate laws for reactions and determine the order of the reaction.
zero, first and second order rate laws.	Calculate the instantaneous rate of reaction.
	Determine rate limiting step for a complex reaction that occurs in elementary steps.

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 15 Test	summative	

## Unit 4: Module 16 - Chemical Equilibrium

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "Why does photochemical smog appear on some days but not others?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.F

### BIG IDEAS

#### Big Ideas

- **Students will be introduced to reversible reactions, and the concept of dynamic equilibrium and will write equilibrium constants.**
- **Students will apply LeChatelier's Principle to analyze factors that affect equilibrium, including concentration, temperature and volume and pressure.**
- **Students will use equilibrium constants, including the solubility product constant, to calculate concentrations and predict precipitates.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How do you describe chemical equilibrium?
- What happens when the equilibrium conditions change?
- How do you calculate equilibrium concentrations?

## Unit 4: Module 16 - Chemical Equilibrium

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
Reversible reactions and dynamic versus static equilibria	Write equilibrium expressions for reversible reactions
LeChatelier's Principle	Calculate the equilibrium concentrations and constants for a given reaction.
equilibrium expressions	Utilize LeChatelier's Principle to predict the effect on the concentrations of reactants and products when a change is made to the system.
Keq versus Ksp	Utilize solubility product constants and equilibrium constants to predict the concentrations of products and reactants and/or the solution concentrations.
Common Ion Effect	

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab reports	project based	
Module 16 Test	summative	

## Unit 4: Module 17 - Acids and Bases

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the questions; "What changes in ocean chemistry might leave corals vulnerable to bleaching and other harm?", and "Why would the acidic water erupting from this geyser burn your skin?".

### STANDARDS/EXPECTATIONS

**Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)**

3.2.9-12.C

### BIG IDEAS

#### Big Ideas

- **Students will be introduced to the basic acid-base definitions.**
- **Students will compare strong and weak acids and bases in terms of ionization and be introduced to ionization constants.**
- **Students will apply the ion product for water and the formulas for pH and pOH of solutions.**
- **Students will learn that neutralization reactions produce salt and water and will calculate molarity from titration data. Students will also be introduced to salt hydrolysis and buffer solutions.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- What are acids and bases?
- What makes an acid or base strong or weak?
- What are pH and pOH?
- What happens when an acid and a base react?

## Unit 4: Module 17 - Acids and Bases

HS - Honors Chemistry - 10-12

### LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
Definition of Acids and Bases according to Arrhenius, Bronsted-Lowry, and Lewis	Identify the acid, base and their conjugates in a neutralization reaction.
Conjugate acids and conjugate bases	explain the relative strength of an acid or base based on the $K_a$ , or $K_b$ .
Acid dissociation constants, $K_a$ Base Dissociation Constants, $K_b$	Utilize $K_w$ to determine the pH, and pOH for a given solution.
autoionization of water	Titrate an unknown with a standard to determine the concentration of the unknown.
pH	Pick an appropriate indicator for usage in a titration.
Titration of a neutralization reaction, and indicators.	

### EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
lab report	project based	
Module 17 Test	summative	

## Unit 5: Module 23 - Nuclear Chemistry

HS - Honors Chemistry - 10-12

### UNIT OVERVIEW

Students will seek to answer the question, "Where does the Sun get all of its energy?".

### STANDARDS/EXPECTATIONS

Pennsylvania - Grade 9-12 - Science, Technology & Engineering, And Environmental Literacy & Sustainability Standards (STEELS) (2023)

3.2.9-12.H

3.2.9-12.W

3.2.9-12.R

### BIG IDEAS

#### Big Ideas

- **Students will identify and describe the basic types of radiation, alpha, beta and gamma.**
- **Students will describe the importance of the neutron to proton ratio, write balanced nuclear reactions for the basic types of decay, and calculate the remaining amount of an isotope after a given time interval.**
- **Students will write balanced equations for the transmutations, calculate the energy equivalent of mass, and describe fission and fusion.**
- **Students will describe some uses of radiation, as well as the biological effects of exposure to radiation.**

### ESSENTIAL QUESTIONS

#### Essential Questions

- How was radioactivity discovered?
- Why are some nuclei radioactive?
- What is the relationship between mass and energy and why is it important?
- What are some applications of nuclear reactions?

# Unit 5: Module 23 - Nuclear Chemistry

HS - Honors Chemistry - 10-12

## LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
<b>Students will know . . . . (Acquired Knowledge)</b>	<b>Students can do . . . . (Acquired Skill)</b>
Radioactive decay, alpha, beta, and gamma	Explain nuclear stability and the "band" of stability.
half life	Explain positron emission and electron capture.
Einstein's equation $E=mc^2$	Write and Balance nuclear reactions and radioactive series.
fission and fusion	Calculate the concentration of a radioactive isotope after some time has elapsed.
	Explain differences between fission and fusion.
	Explain how a nuclear power plant works and controls the nuclear reactions

## EVIDENCE OF LEARNING & ASSESSMENT

Name of Assessment	Type (formative, summative, project-based, diagnostic)	Description
Module 23 Test	summative	