

HS - CP Chemistry 2

Huntingdon Area School District

UNITS (8/8 SELECTED)

SUGGESTED DURATION

 Unit 4: Module 11 - States of Matter	<i>9 lessons</i>
 Unit 4: Module 12 - Gases	<i>18 lessons</i>
 Unit 4: Module 13 - Mixtures and Solutions	<i>25 lessons</i>
 Unit 4: Module 14 - Energy and Chemical Change	<i>16 lessons</i>
 Unit 4: Module 15 - Reaction Rates	<i>18 lessons</i>
 Unit 4: Module 16 - Chemical Equilibrium	<i>25 lessons</i>
 Unit 4: Module 17 - Acids and Bases	<i>18 lessons</i>
 Unit 5: Module 23 - Nuclear Chemistry	<i>25 lessons</i>

Unit 4: Module 11 - States of Matter

HS - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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 - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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 - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

unsaturated, saturated or supersaturated.

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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	
STEM Project	Summative	assesses group problem-solving skills

Unit 4: Module 14 - Energy and Chemical Change

HS - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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 - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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 - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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	
STEM Project	Summative	assesses group problem-solving skills

Unit 4: Module 17 - Acids and Bases

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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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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 - CP Chemistry 2

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 - CP Chemistry 2

LEARNING TARGETS: KNOWLEDGE & SKILLS

Knowledge	Skills
Students will know (Acquired Knowledge)	Students can do (Acquired Skill)
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	
STEM Project	Summative	assesses group problem-solving skills