Board of Education

5 Minortown Road ~ Woodbury, CT 06798

www.ctreg14.org

Mission: The mission of Connecticut Region 14 Schools is to educate all students to their highest level of academic potential and to teach them the skills and knowledge to become capable, creative, collaborative lifelong learners and responsible members of the world community.

Board of Education Goals:
Academic Performance - The district will strive to improve academic performance for all students on multiple assessment indicators and the staff will be committed to continuous improvement.
Communication - Region 14 will develop partnerships with all stakeholders in the school community to highlight the exemplary programs the district offers
Safety - Region 14 will provide safe and secure facilities equipped with technology, enabling a 21st century learning environment that supports the values of the district
Budget - Region 14 will prepare a budget that meets the needs of every student and communicates the needs and priorities of Region 14 in a clear and concise manner.

A G E N D A

Special Meeting

Curriculum Committee Meeting
Thursday, September 5, 2024; 2:30 p.m.
Central Office Conference Room

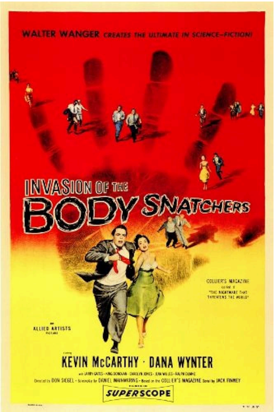
I. Call to order

II. Curriculum Documents for Approval
   A. History through Film
   B. AP Chemistry
   C. Chemistry
   D. Psychology
   E. ECE Contemporary Issues in Sports (This is a slight edit of the Sports and Society curriculum approved by the Board on 8/15/22 to align with UConn's requirements for those students taking the course for UConn credit)

III. Textbook Proposal for Approval
   A. Textbook for ECE Contemporary Issues in Sports - "Social Issues in Sports" by Ronald B. Woods and B. Nalani Butler (this textbook is required by UConn for the ECE course)

IV. Adjourn

HISTORY THROUGH FILM CURRICULUM

	
Grade Level(s): 10-12	**Curriculum Author(s):** Scott Parkhouse

In History Through Film, students will examine the relationship between film and history. Historians rely on a variety of primary and secondary sources and artifacts to interpret the events and forces that shape societies. Beginning in the twentieth century, the motion picture industry has provided historians with another tool to critically interpret the past. Similar to other types of resources, films present an interpretation of history that should be investigated and critically analyzed and evaluated by the viewer for bias, integrity, and accuracy. The films that the class studies will provide a vehicle for learners to engage in rigorous inquiry to evaluate the values, ideas and larger historical issues of specific eras in American history. Students will be required to watch the assigned films in class and at home and write essays that evaluate points of view, and support claims with specific evidence from the films.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner Attribute and Indicator**
Introduction To Film	*How do films communicate with their audience?*	Primary and Secondary source films communicate with their audience using a variety of elements.	TCC2(9-12), TCC3(9-12), TI2(9-12), P2(9-12), AA1(9-12)
History Through Secondary Source Films (1775-1945)	*How do secondary source war films teach history?*	Secondary source films often include inaccuracies that must be considered, but can still teach us history.	TCC2(9-12), CCE1(9-12), DE1(9-12), TI2(9-12)
History Through Primary Source Films (1941-present)	*How can we learn from films that were "made in the moment"?*	Films of the 20th century often represent "where people are at" socially, economically and politically.	TCC2(9-12), CCE1(9-12), DE1(9-12), TI2 (9-12)

(adapted from Wiggins, G. & McTighe, J. (2005). Understanding by Design (2nd Edition). ASCD.)

Unit 1 - Introduction to Film

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

US.Inq.1.c. Determine the kinds of sources that will be helpful in answering compelling and supporting questions, taking into consideration multiple points of view represented in the sources, the types of sources available, and the potential uses of the sources.

US.Inq.3.a. Gather relevant information from multiple sources representing a wide range of views and mediums while using the origin, authority, structure, context, and corroborative value to guide the selection of credible sources.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

- I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2**
- I can integrate relevant information to produce multiple valid solutions. **TCC3**
- I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge. **TI2**
- I can strengthen weaknesses through purposeful strategies, practice, and effort. **P2**
- I can evaluate different approaches and justify the best pathway to success. **AA1**

Understandings: Students will understand that...

- Film has been used over the years to entertain and inform people.
- People react to films in different ways.
- Films communicate with their audience using a variety of elements.
- We can learn history from both primary and secondary source films.
- We can learn history from various genres of film.
- Film can be used as text, similar to written forms.

Essential Questions:

- What is the purpose of film?
- How do films communicate with their audience?
- What makes a film effective/successful?
- Are primary source films reliable sources?
- Are secondary source films reliable sources?

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<td>Students will know...

A brief history of how film was invented.
How films have changed over the years to include high tech advances, but also use the same elements that early films used.
different elements of film such as music, sound, motion, cinematography and color usage.
the difference between primary and secondary sources when studying history.
Films can be viewed as “text”, similar to written stories
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<td>Students will be able to...

Analyze a movie scene from a silent film.
Analyze movie scenes from various genres of film (with a focus on five elements of film)
Evaluate the effectiveness of different kinds of films.
Compare/contrast the techniques used in silent films with those that are used in modern day “high tech” films.
Evaluate the credibility of both primary and secondary source films.
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<td colspan="2">Key Vocabulary: motion picture, movie, silent film, Charlie Chaplin, primary source, secondary source, genre, color, sound, music, cinematography, motion. This vocabulary is introduced in Unit 1, but will be applied in all units of study.</td>
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<th colspan="2">Assessment Evidence</th>
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<td>Performance Tasks:

Summative: Students will view various scenes from a variety of movies (a silent film, a “primary source” film, a “secondary source” film) and write a response that explains how the film communicated with the audience through the use of sound, color, motion, cinematography and music. TI2, TCC3</td>
<td>Other Evidence:

Classwork: Students will work in groups, and will be given a number of films in DVD jackets. After reading the information on the jacket of the DVD, students will discuss if the film would be viewed as a primary source or secondary source, along with a brief explanation of how we could learn history from the movie. .TCC3, P2

Interim: Students will view various scenes from movies, and answer SAT style questions on a multiple choice “quiz”. Reinforcing the idea that films will be used as the text for this class.TI2, P2, AA1</td>
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<th colspan="2">Learning Plan</th>
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Teach students the brief history of film using visuals, as the students take notes: How it began, and developed through the years.TCC3
Use an inquiry lesson for students to learn about how films communicate with their audience by playing scenes from silent films, and also various popular movies they might be familiar with.P2, TI2
Review/teach the difference between primary and secondary sources as seen in “Other Evidence” section above.TCC3
Lesson on the credibility of sources, and factors to consider when researching/learning from different sources. TCC2, AA1
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<td colspan="2">Teacher Resources: Clips from various films for this unit to include (but not limited to): The Circus, Nosferatu, Jaws, Braveheart, Star Wars. Various DVDs to be found in the NHS History Department collection.</td>
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<table>
<tr><th colspan="2">Unit 2 - History Through Secondary Source Films</th></tr>
<tr><th colspan="2">Desired Results - Goals, Transfer, Meaning, Acquisition</th></tr>
<tr><td colspan="2">Established Goals:

US.Inq.1.c. Determine the kinds of sources that will be helpful in answering compelling and supporting questions, taking into consideration multiple points of view represented in the sources, the types of sources available, and the potential uses of the sources.

US.Inq.4.c. Critique historical arguments and explanations while acknowledging the strengths and weaknesses given the purpose and audience.</td></tr>
<tr><td colspan="2">Vision of A Learner Attributes: Students will be able to independently use their learning to...
I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. TCC2
I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. CCE1
I can seek, listen to, and understand multiple perspectives. DE1
I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge. TI2</td></tr>
<tr><td>Understandings: Students will understand that…
The American Revolution and Civil War had multiple causes and was fought by people who had various motivations for fighting.
Films do include biases that need to be considered when viewing.
Secondary source films often include inaccuracies, but can still teach us about historical events.
It is the role of the viewer to consider biases when learning history from a film.
Secondary source films often give a specific perspective of historical events, and sometimes exclude other points of view.
Certain genres of film often include common themes or ideas.
Secondary source war films can inspire a renewed sense of interest in events from the past.</td><td>Essential Questions:
Is film a legitimate historical source?
How do American films teach history?
Is this film biased?
How do films communicate the importance of a significant historical event?</td></tr>
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Students will know... ● The basic causes of the American Revolution. ● The role that the militia played in the United States gaining its independence. ● Factors to consider when viewing a secondary source film. ● How to evaluate the credibility of a secondary source film. ● The basic causes and purpose of the Civil War. ● The contributions of African Americans in the Civil War. ● The various perspectives and motivations of the Union and Confederate side of the Civil War. ● The significance of the D-Day invasion during WW2 and its impact on the nation and on individual families.	**Students will be able to...** ● Understand key moments or turning points in a film by focusing on the five elements learned in the first unit. ● Evaluate the credibility of a secondary source film. ● Research important characters and events in U.S. History. ● Critique the appropriateness of fictional scenes and characters in secondary source films. ● Analyze important primary source documents to include the Emancipation Proclamation and Eisenhower's D-Day message. ● Observe common themes in secondary source war films. ● Apply evidence from documents and films to back up a claim in writing.
Key Vocabulary: *Declaration of Independence,* militia, loyalist, *Emancipation Proclamation,* 54th Massachusetts, Union, Confederate, Little Round Top, Pickett's charge, Normandy, D-Day, Dwight D. Eiesenhower, Omaha Beach, Allies, Axis	
Assessment Evidence	
Performance Tasks: **Summatives:** 1. Students will research the main characters and events in the secondary source film and compare with the real life characters of the time period to answer the essential question, *Is film a legitimate historical source?***TCC2** 2. After viewing four secondary source war films, students will reflect on the common themes of the films using evidence from both the films and history, and have an opportunity to give feedback to other students.**CCE1, TI2**	**Other Evidence:** **Classwork:** ● Students will complete a viewing chart while watching the film *The Patriot.* The chart will include personal reactions/questions as well as analysis using the 5 elements of film. **TCC2** ● Students will work independently and in groups to analyze parts of the Emancipation Proclamation prior to viewing the movie *Glory*, and will analyze General Eisenhower's D-Day message prior to viewing *Saving Private Ryan.* **DE1, TI2** ● Students will study a map of the United States and Gettysburg prior to viewing the film *Gettysburg.* Maps of Europe will be studied prior to viewing *Saving Private Ryan*. **TI2** **Interim:** ● Students will have short quizzes to check for understanding of the historical content presented in the selected movies.**TI2**

	• Discussion questions after various scenes in the films. **DE1, CCE1**

Learning Plan
• Work with timelines and other visuals to review major wars/events in U.S. History. **TI2** • Review the causes of the American Revolution with the class using various documents prior to viewing *The Patriot.***TCC2** • Review/teach strategies to analyze films with an emphasis on the five elements of film. **TI2** • Work on/teach research skills for finding accurate information about important historical events prior to the summative. **DE1** • Work on skills for primary source analysis and analyze essential documents prior to viewing the various films. (for example, use the "SOAPS" method to analyze Eisenhower's D-Day message)**TCC2** • An emphasis on reading primary documents prior to viewing the various films (letters, photos, cartoons, maps, journals). **TCC2** • Work on map skills prior to viewing the various films.**TI2** • An emphasis on observing/analyzing character development for the movie *Glory*.**TI2** • Classroom discussions are best used at different critical moments in the movie *Saving Private Ryan.***CCE1**
Teacher Resources: Emancipation Proclamation, Eisenhower's D-Day message, maps for American Revolution, Civil War, Gettysburg battlefield, World War 2, D-Day, The Declaration of Independence, Paul Revere's engraving of the Boston Massacre. Films to include but not limited to: *The Patriot, Gettysburg* (NOTE: due to the length of the movie, the teacher will select certain scenes to be viewed in class)*, Glory, Saving Private Ryan* *students should have a signed permission form to watch rated "R" films.

Unit 3 - History Through Primary Source Films

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

US.Inq.1.c. Determine the kinds of sources that will be helpful in answering compelling and supporting questions, taking into consideration multiple points of view represented in the sources, the types of sources available, and the potential uses of the sources.
US.Inq.3.a. Gather relevant information from multiple sources representing a wide range of views and mediums while using the origin, authority, structure, context, and corroborative value to guide the selection of credible sources.
US.His.5.b. Analyze the role of popular culture, subculture, and counterculture in shaping public perception of national identity during the post-World War II era
US.His.1.h. Evaluate how popular culture in the 1970s and 1980s promoted and reflected hyper-consumerism, racial tension, women's empowerment, and the Cold War

Vision of A Learner Attributes: Students will be able to independently use their learning to...

- I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2**
- I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. **CCE1**
- I can seek, listen to, and understand multiple perspectives. **DE1**
- I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge. **TI2**

Understandings: Students will understand that…

- We can learn history from films that were "made in the moment" of different historical time periods.
- Films often communicate the fears of a given time period, sometimes in an indirect way.
- Films, like other forms of text, can be interpreted differently depending on the viewer.
- Popular films of the 20th century often represent "where people are at" socially, economically and politically.

Essential Questions:

- Is propaganda still used in films and other forms of media today?
- Is the movie Invasion of the Body Snatchers an allegory?
- How do the music and cinematography of a film teach us about the time period in which a film was made?
- What is the overall meaning of the story in the film Easy Rider?
- Did the counterculture of the 1960's have a positive or negative overall impact on American culture?

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- High-Tech films of today continue to use the same basic techniques of early silent films to communicate with the viewer.

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- Why did/do so many Americans connect with the various characters in the 1976 film Rocky?
- What makes a film popular at a given point in time?
- How was the mutual hostility of the Cold War communicated through popular films of the 1980's?
- How do the films of the 1990's communicate America's role in the post-Cold War world?
- How do modern day films communicate the fears and trends of today's world?

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Students will know...

- The role of the film industry during World War 2 and its impact on the WW2 Homefront.
- About the different phases of the Cold War and its impact on Americans at home.
- About the prosperity and paranoia of the 1950's and how it is shown through a science fiction film.
- About how the turbulence of 1960's America was communicated through music and film.
- The aftermath of the 1960's and how it changed the attitude of Americans in the 1970s in a variety of ways.
- About the environment in America in the final years of the Cold War.
- How Americans viewed their role in the world in the years following the Cold War.
- About the expanding role of technology in today's world along with its positive and negative consequences.

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Students will be able to...

- Observe and analyze primary source films by focusing on the five elements of film learned in the first unit.
- Research important characters and events in U.S. History.
- Apply evidence from primary source films to back up a claim about a given time period.
- Observe and analyze how various propaganda techniques are used in film.
- Understand how the 5 elements of film can teach about the time period in which the film was made (for example, the music in *Easy Rider*, the cinematography in *Rocky*)
- Create their own modern day version of a science fiction film (re-writing a scene, creating a poster, etc.)
- Discuss the meaning of various films.
- Observe and analyze the changing roles of characters in films.
- Evaluate the lasting impacts of various social movements in the United States.

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Key Vocabulary: propaganda, Cold War, communism, capitalism, arms race, containment, McCarthyism, science fiction, counterculture, communes, Vietnam War, Civil Rights movement, Clean Air Act, Watergate, stagflation, malaise, bicentennial,

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Assessment Evidence

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Performance Tasks:

Summatives:

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Other Evidence:

Classwork:

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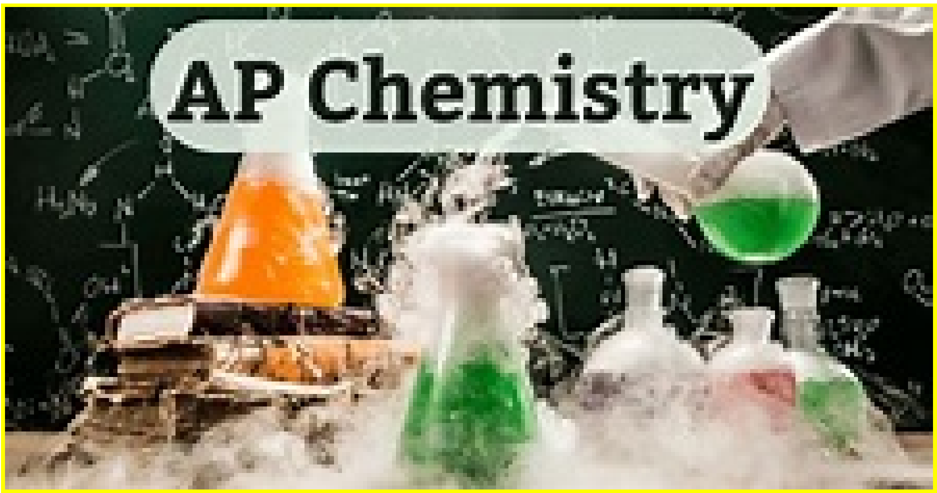
1. After viewing *Invasion of the Body Snatchers* (both versions if time allows), students will work both independently and in groups to create a modern version of the film to reflect the fears and social changes of today. The project is not an actual film but rather a rewrite of certain aspects of the movie to include a poster, script of a scene, character roles, etc.**TCC2, DE1** 2. Students will write an essay about how a film's music and cinematography teach us about a time in history. This essay works best if given after *Easy Rider* or *Rocky.***TCC2**	● Students will complete a viewing chart while watching various WW2 propaganda films. **TCC2** **Interim:** ● Students will have short quizzes to check for understanding of the historical content presented in the selected movies.**TI2** ● A socratic seminar after a film can be used to review/discuss some of the essential questions of the unit. **CCE1**

Learning Plan
● This unit will begin with a review of what primary source films are, along with how we can learn from them, along with factors to consider.**TCC2** ● Define propaganda and hold a class discussion about how it is often used in film past and present.**CCE1** ● Inquiry style lesson to be used when analyzing WW2 propaganda films. **DE1** ● Follow up discussions (socratic seminar, Google classroom) after the various films that are viewed. **DE1, CCE1** ● An emphasis on using primary documents prior to viewing the various films (maps, photos, journals, speeches) to place students in that time period. **TCC2** ● Relevant vocabulary words will be taught and reviewed prior to the various films. **TI2** ● Teach comparative film analysis prior to viewing different versions of *Invasion of the Body Snatchers.***TCC2** ● Continue to work on film analysis (using 5 elements) throughout the various films.**TCC2** ● Work on basic essay writing skills, with an emphasis on how to use evidence from films to back up a claim.**TI2**
Teacher Resources: Various WW2 propaganda short films and cartoons (Examples: *Daffy Duck Commando, Superman Secret Agent, Bing Crosby sings Buy a Bond, Andrews Sisters sing Johnny Get Your Gun and We've Got a Job to Do, Humphrey Bogart News From the Front), Invasion of the Body Snatchers (1956 and 1978 versions), It's a Wonderful Life, White Christmas* (fall semester)*, Easy Rider, Dr. Strangelove, Rocky, Rocky 4, Red Dawn (1984 version), The Hunt For Red October, Independence Day, Wall-E*

AP CHEMISTRY CURRICULUM



Grade Level(s): 11-12	**Curriculum Author(s):** Melissa Hodges
Course Description: Students will practice reasoning skills by using chemical models to analyze, explain, and predict phenomena, and by supporting claims with scientific evidence from data, models, and theories. Students will develop inquiry and reasoning skills by designing and conducting inquiry based laboratory investigations to answer scientific questions through observations, data collection, data analysis and interpretation, troubleshooting and procedural refinement,and error analysis. This course follows the CollegeBoard® AP Chemistry Curriculum.	

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Atomic Structure and Properties (3 weeks)	How do we describe atoms and how do their properties relate to their position on the periodic table?	Although atoms represent the foundational level of chemistry, observations of chemical properties are made on collections of atoms.	TCC2(9-12)
Compound Structure and Properties (2.5 weeks)	How do atoms arrange themselves when forming compounds and how does that arrangement affect the properties of compounds?	Both the chemical and physical properties of materials can be explained by the structure and arrangement of atoms, ions, or molecules and the forces between them.	TCC3(9-12); CCE2(9-12)
Properties of Substances and Mixtures (4 weeks)	How are the properties of substances related to the arrangement of the atoms in those compounds?	The properties of solids, liquids, and gasses reflect the relative orderliness of the arrangement of particles in those states,their relative freedom of motion, and the nature and strength of the interactions between them.	TCC2(9-12); CCE3(9-12); DE1(9-12)
Chemical Reactions (3 weeks)	How can we predict both the amount and structure of products of a chemical reaction?	Chemical changes involve the making and breaking of chemical bonds while conserving the amount of atoms involved.	CCE3(9-12); DE4(9-12)
Kinetics (3.5 weeks)	How can we affect the rate of a reaction?	Reactions occur as a series of collisions and the frequency and effectiveness of those collisions are affected by temperature, surface area and concentration of reactants.	TCC2(9-12)
Thermochemistry (3 weeks)	How is energy transferred during both chemical and physical processes and	Energy is conserved during all chemical and physical processes; it only changes form.	AA1(9-12); AA2(9-12); P4(9-12)

	why do substances absorb/release heat at different rates?		
Equilibrium (3.5 weeks)	How can we describe and affect the ratio of products to reactants during chemical and physical processes?	Chemical equilibrium is a dynamic state in which opposing processes occur at the same rate, so concentration of products and reactants remain constant.	TCC1(9-12); TCC2(9-12); CCE3(9-12)
Acids and Bases (3 weeks)	How can we describe the strength and concentration of acids and bases?	The strength of acids and bases are explained using equilibrium expressions.	TI1(9-12); P1(9-12); P4(9-12):
Thermodynamics and Electrochemistry (3 weeks)	How can we predict if a reaction occurs in the forward or reverse direction?	The thermodynamics of a chemical reaction is connected to both the structural aspects of the reaction and the macroscopic outcomes of the reaction.	P2(9-12); P3(9-12); AA3(9-12)

2 Weeks are allotted for review for the AP Exam in May (Online Review Book)

Unit 1 - Atomic Structure and Properties

Desired Results - Students will describe the basic structure and properties of atoms relative to their position on the periodic table.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

NGSS Standards:
HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

AP Chemistry Curricula Unit 1

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that...	**Essential Questions:**
• Macroscopic systems involve such large numbers of particles that they require the units of moles to translate between this and	• How can large quantities of objects be counted by weighing? • If atoms are too small to be observed directly, how do we know

the particulate scale. ● The organization of the periodic table reflects the periodicity of element properties as a function of atomic number. ● The electronic structure of an atom can be described by an electron configuration that provides a method for describing the distribution of electrons in an atom or ion.	how they're structured? ● Why does the periodic table have the shape that it does?
Students will know... ● Avogadro's number (N = 6.022 × 1023 mol−1) provides the connection between the number of moles in a pure sample of a substance and the number of constituent particles (or formula units) of that substance. ● There is a quantitative connection between the mass of a substance and the number of particles that the substance contains. ● The mass spectrum of a sample containing a single element can be used to determine the identity of the isotopes of that element and the relative abundance of each isotope in nature. ● The average atomic mass of an element can be estimated from the weighted average of the isotopic masses ● Some pure substances are composed of individual molecules, while others consist of atoms or ions held together in fixed proportions as described by a formula unit.using the mass of each isotope and its relative abundance. ● According To The Law Of Definite Proportions, the ratio of the masses of the constituent elements in any pure sample of that compound is always the same. ● The chemical formula that lists the lowest whole number ratio of atoms of the elements in a compound is the empirical formula. ● Pure substances contain atoms, molecules, or formula units of a single type. Mixtures contain atoms, molecules, or formula units of two or more types, whose relative proportions can vary. ● Elemental analysis can be used to determine the relative numbers of atoms in a substance and to determine its purity. ● The atom is composed of negatively charged electrons and a positively charged nucleus that is made of protons and neutrons. ● Coulomb's law is used to calculate the force between two	**Students will be able to...** ● Calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept. ● Explain the quantitative relationship between the mass spectrum of an element and the masses of the element's isotopes. ● Explain the quantitative relationship between the elemental composition by mass and the empirical formula of a pure substance. ● Explain the quantitative relationship between the elemental composition by mass and the composition of substances in a mixture. ● Represent/write the ground-state electron configuration of an atom or its ions. ● Explain the relationship between the photoelectron spectrum of an atom or ion and: ○ The ground-state electron configuration of the species. ○ The interactions between the electrons and the nucleus. ● Explain the relationship between trends in atomic properties of elements and electronic structure and periodicity. ● Explain the relationship between trends in the reactivity of elements and periodicity.

charged particles. ● In atoms and ions, the electrons can be thought of as being in “shells (energy levels)” and “subshells (sublevels),” as described by the ground-state electron configuration. ● The relative energy required to remove an electron from different subshells of an atom or ion or from the same subshell in different atoms or ions (ionization energy) can be estimated through a qualitative application of Coulomb’s law. This energy is related to the distance from the nucleus and the effective (shield) charge of the nucleus. ● The energies of the electrons in a given shell can be measured experimentally with photoelectron spectroscopy (PES). The position of each peak in the PES spectrum is related to the energy required to remove an electron from the corresponding subshell, and the relative height of each peak is (ideally) proportional to the number of electrons in that subshell. ● The organization of the periodic table is based on patterns of recurring properties of the elements, which are explained by patterns of ground-state electron configurations and the presence of completely or partially filled shells (and subshells) of electrons in atoms. ● Trends in atomic properties within the periodic table (periodicity) can be predicted by the position of the element on the periodic table and qualitatively understood using Coulomb’s law, the shell model, and the concepts of shielding and effective nuclear charge. ● The periodicity is useful to predict/estimate values of properties in the absence of data. ● The likelihood that two elements will form a chemical bond is determined by the interactions between the valence electrons and nuclei of elements. ● Elements in the same column of the periodic table tend to form analogous compounds. ● Typical charges of atoms in ionic compounds are governed by the number of valence electrons and predicted by their location on the periodic table.	
Key Vocabulary: Avogadro’s number, mole, mass spectrum, isotope, relative abundance, atomic number, ion, formula unit, molecule, empirical	

formula, Law of Definite Proportions, pure substance, mixture, proton, neutron, electron, electron configuration, Coulomb's law, core electron, valence electron, PES diagram, photoelectron spectroscopy, ionization energy, electronegativity, atomic radius, electron affinity, effective nuclear charge, shielding effect, periodicity

Assessment Evidence	
Performance Tasks: ● Empirical Formula Lab ○ Students will experimentally determine the formula of a hydrate. This will also serve as a review for correct laboratory techniques.	**Other Evidence:** ● Moles/Molar Mass Notes/Worksheet ● Mass Spectra of Elements Notes/Worksheet ● Elemental Composition of Pure Substances Notes/Worksheet ● Combustion Analysis Worksheet ● Composition of Mixtures Notes/Worksheet ● Atomic Spectra and Electron Configuration Notes/Worksheet ● Photoelectron Spectroscopy Notes/Worksheet ● Periodic Trends Notes/Worksheet ● Periodic Trends POGIL ● Valence Electrons and Ionic Compounds Notes/Worksheet ● Unit Test

Learning Plan
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Translate visual representations of elements, compounds and mixtures into words and translate words into visual representations of elements, compounds and mixtures RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Explain how to measure and calculate the empirical formula of a compound HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays ● Convert between moles and mass of elements and compounds ● Use percent composition to determine the empirical formula of a compound ● Interpret a PES diagram ● Interpret a Mass Spectrum diagram HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure mass to determine the empirical formula of a compound 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

- Predict the properties of elements based on their position on the periodic table
- Write the electron configuration for elements

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.

- Use the periodic table to

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

- Explain why heating a hydrate allows us to determine its chemical formula and composition

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

- Use Coulomb's law to explain the properties of Ionic Compounds
- Use Coulomb's law to explain periodic trends

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

- Explain the properties of ionic compounds

VOL Common Assessment
THINK CRITICALLY AND CREATIVELY
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Empirical Formula Lab

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 1 1-Pager, Topic Specific Videos

Unit 2 - Compound Structure and Properties	
Desired Results - Students will predict the properties and structure of compounds.	
Established Goals: [Common Core State Standards:] RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities [NGSS Standards:] HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials [AP Chemistry Curricula Unit 2]	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● TCC3(9-12): I can integrate relevant information to produce multiple valid solutions. ● CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.	
Understandings: Students will understand that… ● Both the chemical and physical properties of materials can be explained by the structure and arrangement of atoms, ions, or molecules and the forces between them. ● Chemical bonds are distinct from typical intermolecular interactions. ● Electronegativity can be used to make predictions about the type of bonding present between two atoms	**Essential Questions:** ● How are the atoms in molecular compounds arranged? ● Why are some bonds easier to break than others? ● In what ways does a diagram drawn on paper accurately reflect the structure of a molecule? In what ways does it not accurately reflect the structure?

Students will know...	Students will be able to…

● Electronegativity values for the representative elements increase going from left to right across a period and decrease going down a group. These trends can be understood qualitatively through the electronic structure of the atoms, the shell model, and Coulomb's law.
● Valence electrons shared between atoms of similar electronegativity constitute a nonpolar covalent bond.
● Valence electrons shared between atoms of unequal electronegativity constitute a polar covalent bond
    ○ The atom with a higher electronegativity will develop a partial negative charge relative to the other atom in the bond.
    ○ In single bonds,greater differences in electronegativity lead to greater bond dipoles.
    ○ All polar bonds have some ionic character, and the differences between ionic and covalent compounds is not distinct but rather a continuum.
● Generally, bonds between a metal and nonmetal are ionic, and bonds between two nonmetals are covalent.
● In a metallic solid, the valence electrons from the metal atoms are considered to be delocalized and not associated with any individual atom.
● Interstitial alloys form between atoms of significantly different radii, where the smaller atoms fill the interstitial spaces between the larger atoms.
● Substitutional alloys form between atoms of comparable radius, where one atom substitutes for the other in the lattice.
● A graph of potential energy versus the distance between atoms (internuclear distance) is a useful representation for describing the interactions between atoms. Such graphs illustrate both the equilibrium bond length (the separation between atoms at which the potential energy is lowest) and the bond energy (the energy required to separate the atoms).
● In a covalent bond, the bond length is influenced by both the size of the atom's core and the bond order (i.e., single, double, triple). Bonds with a higher order are shorter and have larger bond energies.
	● Explain the relationship between the type of bonding and the properties of the elements participating in the bond.
	● Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength.
	● Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions.
	● Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.
	● Represent a molecule with a Lewis diagram.
	● Represent a molecule with a Lewis diagram that accounts for resonance between equivalent structures or that uses formal charge to select between nonequivalent structures.
	● Explain structural properties of molecules.
	● Explain electron properties of molecules.

• Coulomb's law can be used to understand the strength of interactions between cations and anions • The cations and anions in an ionic crystal are arranged in a systematic,periodic 3-D array that maximizes the attractive forces among cations and anions while minimizing the repulsive forces. • Lewis diagrams can be constructed according to an established set of principles. • In cases where more than one equivalent Lewis structure can be constructed, resonance must be included as a refinement to the Lewis structure. In many such cases,this refinement is needed to provide qualitatively accurate predictions of molecular structure and properties. • The octet rule and formal charge can be used as criteria for determining which of several possible valid Lewis diagrams provides the best model for predicting molecular structure and properties. • VSEPR theory uses the Coulombic repulsion between electrons as a basis for predicting the arrangement of electron pairs around a central atom. • Both Lewis diagrams and VSEPR theory must be used for predicting electronic and structural properties of many covalently bonded molecules and polyatomic ions. • The terms "hybridization" and "hybrid atomic orbital" are used to describe the arrangement of electrons around a central atom. When the central atom is sp hybridized, its ideal bond angles are 180°; for sp2 hybridized atoms the bond angles are 120°; and for sp3 hybridized atoms the bond angles are 109.5°. • Bond formation is associated with overlap between atomic orbitals. In multiple bonds, such overlap leads to the formation of both sigma and pi bonds. The overlap is stronger in sigma than pi bonds,which is reflected in sigma bonds having greater bond energy than pi bonds. The presence of a pi bond also prevents the rotation of the bond and leads to geometric isomers.	
Key Vocabulary: ionic, covalent, metallic, Lewis dot structure, intermolecular force, potential energy, alloy, resonance, formal charge, VSEPR, hybridization, hybrid atomic orbital, internuclear distance, interstitial alloy, substitutional alloy, octet rule, Molecular geometry (linear, trigonal	

planar, tetrahedral, trigonal pyramidal, bent, trigonal bipyramidal, seesaw, T-shaped, octahedral, square pyramidal, square planar), bond angle, dipole moment, bond energy, polar, nonpolar, electronegativity, geometric isomer, sigma bonding, pi bonding, single bond, double bond, triple bond	
Assessment Evidence	

Performance Tasks:
● Properties of Ionic, Metallic and Molecular Substances lab
    ○ Students will use laboratory data to determine the type of bonding present in several given substances.
● Put it all together Lewis Dot Structure Practice
    ○ Students will correctly draw lewis dot structure, indicate their shape and bond angles, indicate which molecules demonstrate resonance, determine the hybridization of the central atom and calculate the formal change of each structure.
	Other Evidence:
	● Types of Chemical Bonds Notes/Worksheet
	● Intermolecular Force and Potential Energy Notes/Worksheet
	● Structure of Ionic Solids Notes/Worksheet
	● Structure of Metals and Alloys Notes/Worksheet
	● Lewis Diagrams Notes/Worksheet
	● Resonance and Formal Charge Notes/Worksheet
	● VSEPR and Hybridization Notes/Worksheet
	● Unit Test

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Draw particulate level diagrams of compounds RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Explain how to determine the type of bonding present using lab data HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure mass and temperature of compounds 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 ● Use the periodic table to predict the type of bonding present in a compound ● Use the periodic table to predict the number of valence electrons available for bonding 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 ● Use laboratory data to determine the type of bonding present in a compound HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. ● Use Coulomb's law to explain the properties of ionic compounds ● Use Coulomb's law to explain the properties and type of alloy present in a metallic compound HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed	

materials ● Use the type of bonding present to explain physical and chemical properties of compounds VOL Common Assessments: THINK CRITICALLY AND CREATIVELY TCC3(9-12): I can integrate relevant information to produce multiple valid solutions. ● Properties of Ionic, Metallic and Molecular Substances Lab COLLABORATE AND COMMUNICATE EFFECTIVELY CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success. ● Putting it All Together Lewis Structure Practice
Teacher Resources Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 2 1 pager, Topic Specific Videos

Unit 3 - Properties of Substances and Mixtures
Desired Results - Students will understand the relationship between the arrangement of atoms in a compound and the properties of the resulting compound or mixtures.
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS4-1 - Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media HS-PS4-3 - Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other HS-PS-4-4 - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials **AP Chemistry Curricula Unit 3**
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
- DE1(9-12): I can acknowledge, process, and respond appropriately to others' comments and perspectives.

Understandings: Students will understand that…
- Transformations of matter can be observed in ways that are generally categorized as either a chemical or physical change.
- The shapes of the particles involved and the space between them are key factors in determining the nature of physical changes.
- The properties of solids, liquids, and gasses reflect the relative orderliness of the arrangement of particles in those states,their relative freedom of motion, and the nature and strength of the interactions between them.
- There is a relationship between the macroscopic properties of solids, liquids, and gasses, as well as the structure of the constituent particles of those materials on the molecular and atomic scale.

Essential Questions:
- How do interactions between particles influence the properties of pure substances and mixtures?
- How does the spacing and motion of particles relate to a substance's state of matter and the properties of gasses?
- How can you determine the structure and concentration of a chemical species in a mixture?

Students will know...
- London dispersion forces are a result of the Coulombic interactions between temporary, fluctuating dipoles. London dispersion forces are often the strongest net intermolecular force between large molecules.
    - Dispersion forces increase with increasing contact area between molecules and with increasing polarizability of the molecules.
    - The polarizability of a molecule increases with an increasing number of electrons in the molecule and the size of the electron cloud. It is enhanced by the presence of pi bonding.
    - The term "London dispersion forces" should not be used synonymously with the term "van der Waals forces".
- The dipole moment of a polar molecule leads to additional interactions with other chemical species.
    - Dipole-induced dipole interactions are present between a

Students will be able to…
- Explain the relationship between the chemical structures of molecules and the relative strength of their intermolecular forces when:
    - i. The molecules are of the same chemical species.
    - ii. The molecules are of two different chemical species
- Explain the relationship among the macroscopic properties of a substance, the particulate-level structure of the substance, and the interactions between these particles.
- Represent the differences between solid, liquid, and gas phases using a particulate level model.
- Explain the relationship between the macroscopic properties of a sample of gas or mixture of gasses using the ideal gas law.
- Explain the relationship between the motion of particles and the macroscopic properties of gasses with:
    - The kinetic molecular theory (KMT).
    - A particulate model.

polar and nonpolar molecule. These forces are always attractive. The strength of these forces increases with the magnitude of the dipole of the polar molecule and with the polarizability of the nonpolar molecule. ○ Dipole-dipole interactions are present between polar molecules. The interaction strength depends on the magnitude of the dipoles and their relative orientations. Interactions between polar molecules are typically greater than those between nonpolar molecules of comparable size because these interactions act in addition to London dispersion forces. ● The relative strength and orientation dependence of dipole-dipole and ion-dipole forces can be understood qualitatively by considering the sign of the partial charges responsible for the molecular dipole moment, and how these partial charges interact with an ion or with an adjacent dipole. ● Hydrogen bonding is a strong type of intermolecular interaction that exists when hydrogen atoms covalently bonded to the highly electronegative atoms (N, O, and F) are attracted to the negative end of a dipole formed by the electronegative atom (N, O, and F) indifferent molecule, or a different part of the same molecule. ● In large biomolecules, noncovalent interactions may occur between different molecules or between different regions of the same large biomolecule. ● Many properties of liquids and solids are determined by the strengths and types of intermolecular forces present. Because intermolecular interactions are overcome completely when a substance vaporizes, the vapor pressure and boiling point are directly related to the strength of those interactions. Melting points also tend to correlate with interaction strength, but because the interactions are only rearranged, in melting, the relations can be more subtle. ● Particulate-level representations,showing multiple interacting chemical species, are a useful means to communicate or understand how intermolecular interactions help to establish macroscopic properties. ● Due to strong interactions between ions, ionic solids tend to	○ A graphical representation. ● Explain the relationship among non-ideal behavior of gasses, interparticle forces, and/or volumes. ● Calculate the number of solute particles, volume, or molarity of solutions. ● Use particulate models for mixtures: ○ Represent interactions between components. ○ Represent concentrations of components ● Explain the results of a separation experiment based on intermolecular interactions. ● Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles. ● Differences in absorption or emission of photons in different spectral regions are related to the different types of molecular motion or electronic transition: ○ Microwave radiation is associated with transitions in molecular rotational levels. ○ Infrared radiation is associated with transitions in molecular vibrational levels. ○ Ultraviolet/visible radiation is associated with transitions in electronic energy levels. ● Explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule. ● Explain the amount of light absorbed by a solution of molecules or ions in relationship to the concentration, path length, and molar absorptivity.

have low vapor pressures, high melting points, and high boiling points. They tend to be brittle due to the repulsion of like charges caused when one layer slides across another layer. They conduct electricity only when the ions are mobile, as when the ionic solid is melted (i.e., in a molten state) or dissolved in water or another solvent. ● In covalent network solids, the atoms are covalently bonded together into a three dimensional network or layers of two-dimensional networks. These are only formed from nonmetals and metalloids: elemental or binary compounds. Due to the strong covalent interactions, covalent solids have high melting points. Three-dimensional network solids are also rigid and hard, because the covalent bond angles are fixed. ● Molecular solids are composed of distinct, individual units of covalently-bonded molecules attracted to each other through relatively weak intermolecular forces. Molecular solids generally have a low melting point because of the relatively weak intermolecular forces present between the molecules. They do not conduct electricity because their valence electrons are tightly held within the covalent bonds and the lone pairs of each constituent molecule. Molecular solids are sometimes composed of very large molecules or polymers. ● Metallic solids are good conductors of electricity and heat, due to the presence of free valence electrons. They also tend to be malleable and ductile, due to the ease with which the metal cores can rearrange their structure. In an interstitial alloy, interstitial atoms tend to make the lattice more rigid, decreasing malleability and ductility. Alloys typically retain a sea of mobile electrons and so remain conducting. ● In large biomolecules or polymers, noncovalent interactions may occur between different molecules or between different regions of the same large biomolecule. The functionality and properties of such molecules depend strongly on the shape of the molecule, which is largely dictated by noncovalent interactions. ● Solids can be crystalline, where the particles are arranged in regular three-dimensional structure, or they can be amorphous, where the particles do not have a regular, orderly arrangement. In both cases, the motion of the individual particles is limited,	

and the particles do not undergo overall translation with respect to each other. The structure of the solid is influenced by interparticle interaction and the ability of the particles to pack together.

- The constituent particles in liquids are in close contact with each other, and they are continually moving and colliding. The arrangement and movement of particles are influenced by the nature and strength of the forces (e.g., polarity, hydrogen bonding, and temperature) between the particles.
- The solid and liquid phases for a particular substance typically have similar molar volume because, in both phases, the constituent particles are in close contact at all times.
- In the gas phase, the particles are in constant motion. Their frequencies of collision and the average spacing between them are dependent on temperature, pressure, and volume. Because of this constant motion,and minimal effects of forces between particles, a gas has neither a definite volume nor definite shape.
- The macroscopic properties of ideal gasses are related through the ideal gas law: $PV = nRT$.
- In a sample containing a mixture of ideal gasses, the pressure exerted by each component (the partial pressure) is independent of the other components. Therefore, the partial pressure of a gas within the mixture is proportional to its mole fraction (X), and the total pressure of the sample is the sum of the partial pressures.
- Graphical representations of the relationships between P, V, T, and n are useful to describe gas behavior.
- The kinetic molecular theory (KMT) relates the macroscopic properties of gasses to motions of the particles in the gas. The Maxwell-Boltzmann Distribution describes The distribution of the kinetic energies of particles at a given temperature.
- All the particles in a sample of matter are in continuous, random motion. The average kinetic energy of a particle is related to its average velocity by the equation: $KE = \frac{1}{2} mv^2$
- The Kelvin temperature of a sample of matter is proportional to the average kinetic energy of the particles in the sample.
- The Maxwell-Boltzmann Distribution provides a graphical representation of the energies/ velocities of particles at a given

temperature. ● The ideal gas law does not explain the actual behavior of real gasses. Deviations from the ideal gas law may result from interparticle attractions among gas molecules, particularly at conditions that are close to those resulting in condensation. Deviations may also arise from particle volumes, particularly at extremely high pressures. ● Solutions, also sometimes called homogeneous mixtures, can be solids, liquids, or gasses. In a solution, the macroscopic properties do not vary throughout the sample. In a heterogeneous mixture, the macroscopic properties depend on location in the mixture. ● Solution composition can be expressed in a variety of ways; molarity is the most common method used in the laboratory. ○ $M = n_{solute} / L_{solution}$ ● Particulate representations of solutions communicate the structure and properties of solutions, by illustration of the relative concentrations of the components in the solution and/or drawings that show interactions among the components. ● The components of a liquid solution cannot be separated by filtration. They Can,however, be separated using processes that take advantage of differences in intermolecular interactions of the components. ○ Chromatography (paper,thin-layer,and column) separates chemical species by taking advantage of the differential strength of intermolecular interactions between and among the components of the solution (the mobile phase) and with the surface components of the stationary phase. The resulting chromatogram can be used to infer the relative polarities of components in a mixture. ○ Distillation separates chemical species by taking advantage of the differential strength of intermolecular interactions between and among the components and the effects these interactions have on the vapor pressures of the components in the mixture. ● Substances with similar intermolecular interactions tend to be miscible or soluble in one another.	

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Explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region.
When a photon is absorbed (or emitted) by an atom or molecule, the energy of the species is increased (or decreased) by an amount equal to the energy of the photon.
The wavelength of the electromagnetic wave is related to its frequency and the speed of light by the equation: $c = \lambda v$.
The energy of a photon is related to the frequency of the electromagnetic wave through Planck’s equation: $E = \hbar v$.
The Beer-Lambert law relates the absorption of light by a solution to three variables according to the equation: $A = \varepsilon bc$. The molar absorptivity, ε, describes how intensely a chemical species absorbs light of a specific wavelength. The Pathlength,b, and concentration, c, are proportional to the number light-absorbing particles in the light path.
In most experiments the path length and wavelength of light are held constant. In such cases,the absorbance is proportional only to the concentration of absorbing molecules or ions. The Spectrophotometer Is typically set to the wavelength of maximum absorbance (optimum wavelength) for the species being analyzed to ensure the maximum sensitivity of measurement.

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<td colspan="2">Key Vocabulary: intermolecular forces, London dispersion forces, polarizability, dipole-dipole forces, dipole-induced dipole forces, Hydrogen bonding, polar, nonpolar, vapor, vapor pressure, boiling point, melting point, network solid, polymer, amorphous solid, real gas, ideal gas, kinetic molecular theory of gasses, kinetic energy, partial pressure, vapor pressure, Kelvin temperature, Maxwell-Boltzmann Distribution, solution, homogeneous mixture, solute, solvent, chromatography, mobile phase, stationary phase, chromatograph, distillation, miscible, soluble, electron transition, electromagnetic spectrum, photon, frequency, wavelength, Plank’s constant, microwave radiation, ultraviolet radiation, infrared radiation, Beer-Lambert’s Law, absorbance, spectrophotometer, colorimeter</td>
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<th colspan="2">Assessment Evidence</th>
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Performance Tasks:

What Volume do you Want Lab

Students will be asked to experimentally produce a fixed amount of gaseous product given the correct reactants.

Chromatography Lab

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Other Evidence:

Intermolecular and Interparticle Forces Notes/Worksheet
Properties of Solids Notes/Worksheet
Solids, Liquids, and Gases Notes/Worksheet
Ideal Gas Law Notes/Worksheet

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○ Students will separate the contents of a liquid mixture using paper chromatography and compare that to known chromatographs to determine the contents of the mixture. ● AP Investigation 2: % Cu in Brass Lab ○ Students will use Beer's Law to determine the percent of copper in brass.	● Kinetic Molecular Theory Notes/Worksheet ● Deviations From Ideal Gas Law Notes/Worksheet ● Solutions and Mixtures Notes/Worksheet ● Representations of Solutions Notes/Worksheet ● Separation of Solutions and Mixtures Notes/Worksheet ● Solubility Worksheet ● Spectroscopy and the Electromagnetic Spectrum Notes/Worksheet ● Properties of Photons Notes/Worksheet ● Beer-Lambert Law Notes/Worksheet ● Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
- Visually represent solids, liquids and gasses as it relates to the spacing between particles
- Visually represent temperature of particles relative to the speed of particles

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Explain how to determine a known quantity of gas
- Explain how to determine the composition of a liquid mixture

HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
- Calculate the moles, pressure, volume or temperature of a gas
- Calculate the wavelength or frequency of light
- Calculate the energy of light
- Calculate the molarity of a solution
- Calculate the concentration of a solution given absorbance data

HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
- Accurately measure mass of solids
- Accurately measure the volume of a gas
- Accurately measure the distance of movement of a solvent front vs dye movement

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
- Predict the properties of compounds based on how the atoms are bonded

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.

- Use the periodic table to explain the difference between ionic and covalent compounds

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

- Use chromatography to separate components of a mixture

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

- Calculate wavelength, frequency and energy of photons
- Predict the wavelength of light that ensures maximum absorbance data

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

- Describe the wave nature of light
- Describe the particle nature of light
- Use wavelength to determine the type of electromagnetic radiation

HS-PS-4-4 - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter

- Explain how and why atoms produce light

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

- Use Coulomb's law to explain the strength of interactions between molecules
- Use Coulomb's law to explain solubility
- Use Coulomb's law to explain the properties of ionic compounds

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

- Describe the particle interacts that results in a substance's state of matter

VOL Common Assessments:

THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- % Cu in Brass Lab

COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

- What Volume do You Want Lab
- Chromatography Lab

DEMONSTRATE EMPATHY

DE1(9-12): I can acknowledge, process, and respond appropriately to others' comments and perspectives.

- Chromatography Lab

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 3 1 pager, AP Chemistry Lab Manual, Topic Specific Videos

Unit 4 - Chemical Reactions	
Desired Results - Students will predict the amount of structure of products during a chemical reaction.	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction **AP Chemistry Curricula Unit 4**	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products. ● DE4(9-12): I can work respectfully with all members of my community and support the needs of others.	
Understandings: Students will understand that…	**Essential Questions:**

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Chemical changes involve the making and breaking of chemical bonds.
Many properties of a chemical system can be understood using the concepts of varying strengths of chemical bonds and weaker intermolecular interactions.
When chemical changes occur, the new substances formed have properties that are distinguishable from the initial substance or substances.
Chemical reactions are the primary means by which transformations in matter occur.
Chemical equations are a representation of the rearrangement of atoms that occur during a chemical reaction

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In what ways can a chemical change be described and documented?
How can you predict that a chemical reaction will generate enough product?
How can you predict the amount of product produced during a chemical reaction?

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Students will know…

A physical change occurs when a substance undergoes a change in properties but not a change in composition. Changes in the phase of a substance (solid, liquid, gas) or formation/ separation of mixtures of substances are common physical changes.
A chemical change occurs when substances are transformed into new substances, typically with different compositions. Production of heat or light, formation of a gas, formation of a precipitate, and/or color change provide possible evidence that a chemical change has occurred.
All physical and chemical processes can be represented symbolically by balanced equations.
Chemical equations represent chemical changes. These changes are the result of a rearrangement of atoms into new combinations; thus, any representation of a chemical change must contain equal numbers of atoms of every element before and after the change occurred. Equations thus demonstrate that mass and charge are conserved in chemical reactions.
Balanced molecular, complete ionic, and net ionic equations are differing symbolic forms used to represent a chemical reaction. The form used to represent the reaction depends on the context in which it is to be used.
Balanced chemical equations in their various forms can be translated into symbolic particulate representations.

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Students will be able to...

Identify evidence of chemical and physical changes in matter.
Represent changes in matter with a balanced chemical or net ionic equation:

For physical changes.
For given information about the identity of the reactants and/or product.
For ions in a given chemical reaction.

Represent a given chemical reaction or physical process with a consistent particulate model.
Explain the relationship between macroscopic characteristics and bond interactions for:

Chemical processes.
Physical processes

Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.
Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.
Identify a reaction as acid base,oxidation-reduction,or precipitation.
Identify species as Brønsted Lowry acids, bases, and/or conjugate acid-base pairs, based on proton-transfer involving those species.

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- Processes that involve the breaking and/or formation of chemical bonds are typically classified as chemical processes. Processes that involve only changes in intermolecular interactions, such as phase changes, are typically classified as physical processes. - Sometimes physical processes involve the breaking of chemical bonds. - Because atoms must be conserved during a chemical process, it is possible to calculate product amounts by using known reactant amounts, or to calculate reactant amounts given known product amounts. - Coefficients of balanced chemical equations contain information regarding the proportionality of the amounts of substances involved in the reaction. These values can be used in chemical calculations involving the mole concept. - Stoichiometric calculations can be combined with the ideal gas law and calculations involving molarity to quantitatively study gasses and solutions. - Titrations may be used to determine the amount of an analyte in solution. The titrant has a known concentration of a species that reacts specificallyandquantitativelywiththeanalyte. The equivalence point of the titration occurs when the analyte is totally consumed by the reacting species in the titrant. The equivalence point is often indicated by a change in a property (such as color) that occurs when the equivalence point is reached. This observable event is called the endpoint of the titration. - Acid-base reactions involve transfer of one or more protons (H^+ ions) between chemical species. - Oxidation-reduction (redox) reactions involve transfer of one or more electrons between chemical species, as indicated by changes in oxidation numbers of the involved species. Combustion is an important subclass of oxidation-reduction reactions,in which a species reacts with oxygen gas. In the case of hydrocarbons, carbon dioxide and water are products of complete combustion. - In a redox reaction, electrons are transferred from the species that is oxidized to the species that is reduced.	Represent a balanced redox reaction equation using half-reactions.

• Oxidation numbers may be assigned to each of the atoms in the reactants and products; this is often an effective way to identify the oxidized and reduced species in a redox reaction. • Precipitation reactions frequently involve mixing ions in aqueous solution to produce an insoluble or sparingly soluble ionic compound. All sodium, potassium, ammonium, and nitrate salts are soluble in water. • By definition,a Brønsted-Lowry acid is a proton donor and a Brønsted-Lowry base is a proton acceptor. • Only in aqueous solutions, water plays an important role in many acid-base reactions, as its molecular structure allows it to accept protons from and donate protons to dissolved species. • When an acid or base ionizes in water,the conjugate acid-base pairs can be identified and their relative strengths compared. • Balanced chemical equations for redox reactions can be constructed from half-reactions.	
Key Vocabulary: reaction, net ionic equation, physical change, chemical change, stoichiometry, titration, end point, equivalence point, synthesis, decomposition, double replacement, single replacement, combustion acid, base, redox, reduction, oxidation, oxidation number, precipitate, aqueous, coefficient, Bronsted-Lowry acid/base, conjugate acid/base pair, half reaction	
Assessment Evidence	
Performance Tasks: • Decomposition of Baking Soda 　○ Students will use laboratory data to determine the correct balanced chemical equation for the decomposition of baking soda. • Titration Lab 　○ Students will use titration data to standardize an unknown concentration of sodium hydroxide.	**Other Evidence:** • Introduction to Reactions Notes/Worksheet • Net Ionic Equations Notes/Worksheet • Representations of Reactions Notes/Worksheet • Physical and Chemical Changes Notes/Worksheet • Stoichiometry Notes/Worksheet • Introduction to Titrations Notes/Worksheet • Types of Chemical Reactions Notes/Worksheet • Introduction to Acid-Base Reactions Notes/Worksheet • Redox Reactions Notes/Worksheet • Unit Test
Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words	

- Create visual representations of chemical reactions and physical changes
- Create visual representations of proton transfer between acids and bases

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain how to predict the products and amount of product during a chemical reaction
- Explain how to differentiate between chemical and physical changes

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

- Calculate the predicted amount of products
- Calculate Percent Yield
- Calculate necessary amount of reactants

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

- Accurately measure volume and mass of components of a chemical reaction
- Accurately perform a titration

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.

- Use the periodic table to predict products of chemical reactions

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.

- Use the periodic table to predict products of chemical reactions

HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

- Calculate the predicted amount of products
- Calculate Percent Yield
- Calculate necessary amount of reactants

VOL Common Assessments:
COLLABORATE AND COMMUNICATE EFFECTIVELY
CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

- Titration Lab

DEMONSTRATE EMPATHY
DE4(9-12): I can work respectfully with all members of my community and support the needs of others.

- Decomposition of Baking Soda Lab

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 4 1 Pager, Topic Specific Videos

Unit 5 - Kinetics	
Desired Results - Goals, Transfer, Meaning, Acquisition	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-8 - 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 **AP Chemistry Curricula Unit 5**	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.	
Understandings: Students will understand that... ● The rate at which chemical reactions occur is affected by e the concentration of reactants, temperature, catalysts, and other environmental factors. ● Chemical changes are represented by chemical reactions, and the rates of chemical reactions are determined by the details of the molecular collisions. ● Rates of change in chemical reactions are observable and measurable. ● When measuring rates of change,we are measuring the concentration of reactant or product species as a function of	**Essential Questions:** ● Why are some reactions faster than other reactions? ● How can the speed of a reaction be controlled by understanding the collisions that occur on the particle level?

time. ● Chemical processes may be observed in a variety of ways and often involve changes in energy as well.	
Students will know… ● The kinetics of a chemical reaction is defined as the rate at which an amount of reactants is converted to products per unit of time. ● The rates of change of reactant and product concentrations are determined by the stoichiometry in the balanced chemical equation. ● The rate of a reaction is influenced by reactant concentrations, temperature, surface area, catalysts, and other environmental factors. ● Experimental methods can be used to monitor the amounts of reactants and/or products of a reaction over time and to determine the rate of the reaction. ● The rate law expresses the rate of a reaction as proportional to the concentration of each reactant raised to a power. ● The power of each reactant in the rate law is the order of the reaction with respect to that reactant. The sum of the powers of the reactant concentrations in the rate law is the overall order of the reaction. ● The proportionality constant in the rate law is called the rate constant. The value of this constant is temperature dependent and the units reflect the overall reaction order. ● Comparing initial rates of a reaction is a method to determine the order with respect to each reactant. ● The order of a reaction can be inferred from a graph of concentration of reactant versus time. ● If a reaction is first order with respect to a reactant being monitored, a plot of the natural log (ln) of the reactant concentration as a function of time will be linear. ● If a reaction is second order with respect to a reactant being monitored, a plot of the reciprocal of the concentration of that reactant versus time will be linear. ● The slopes of the concentration versus time data for zeroth, first, and second order reactions can be used to determine the rate	**Students will be able to…** ● Explain the relationship between the rate of a chemical reaction and experimental parameters. ● Represent experimental data with a consistent rate law expression. ● Identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time. ● Represent an elementary reaction as a rate law expression using stoichiometry. ● Explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of particle collisions. ● Represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile. ● Identify the components of a reaction mechanism. ● Identify the rate law for a reaction from a mechanism in which the first step is rate limiting. ● Identify the rate law for a reaction from a mechanism in which the first step is not rate limiting. ● Represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile. ● Explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism.

constant for the reaction.
    - Zeroth order: $[A]t - [A]0 = -kt$
    - First order: $\ln[A]t - \ln[A]0 = -kt$
    - Second order: $1/[A]t - 1/[A]0 = kt$
- Half-life is a critical parameter for first order reactions because the half-life is constant and related to the rate constant for the reaction by the equation: $t_{1/2} = 0.693/k$.
- Radioactive decay processes provide an important illustration of first order kinetics.
- The rate law of an elementary reaction can be inferred from the stoichiometry of the particles participating in a collision.
- Elementary reactions involving the simultaneous collision of three or more particles are rare.
- For an elementary reaction to successfully produce products, reactants must successfully collide to initiate bond-breaking and bond making events.
- In most reactions, only a small fraction of the collisions leads to a reaction. Successful collisions have both sufficient energy to overcome the activation energy requirements and orientations that allow the bonds to rearrange in the required manner.
- The Maxwell-Boltzmann distribution curve describes the distribution of particle energies; this distribution can be used to gain a qualitative estimate of the fraction of collisions with sufficient energy to lead to a reaction,and also how that fraction depends on temperature.
- Elementary reactions typically involve the breaking of some bonds and the forming of new ones.
- The reaction coordinate is the axis along which the complex set of motions involved in rearranging reactants to form products can be plotted.
- The energy profile gives the energy along the reaction coordinate, which typically proceeds from reactants, through a transition state, to products. The energy difference between the reactants and the transition state is the activation energy for the forward reaction.
- The rate of an elementary reaction is temperature dependent because the proportion of particle collisions that are energetic enough to reach the transition state varies with temperature.

The Arrhenius equation relates the temperature dependence of the rate of an elementary reaction to the activation energy needed by molecular collisions to reach the transition state. ● A reaction mechanism consists of a series of elementary reactions, or steps, that occur in sequence. The components may include reactants, intermediates, products, and catalysts. ● The elementary steps when combined should align with the overall balanced equation of a chemical reaction. ● A reaction intermediate is produced by some elementary steps and consumed by others, such that it is present only while a reaction is occurring. ● Experimental detection of a reaction intermediate is a common way to build evidence in support of one reaction mechanism over an alternative mechanism. ● For reaction mechanisms in which each elementary step is irreversible, or in which the first step is rate limiting, the rate law of the reaction is set by the molecularity of the slowest elementary step (i.e.,the rate-limiting step). ● If the first elementary reaction is not rate limiting, approximations (such as pre-equilibrium) must be made to determine a rate law expression. ● Knowledge of the energetics of each elementary reaction in a mechanism allows for the construction of an energy profile for a multistep reaction. ● In order for a catalyst to increase the rate of a reaction, the addition of the catalyst must increase the number of effective collisions and/or provide a reaction path with a lower activation energy relative to the original reaction coordinate. ● In a reaction mechanism containing a catalyst, the net concentration of the catalyst is constant. However, the catalyst will frequently be consumed in the rate-determining step of the reaction, only to be regenerated in a subsequent step in the mechanism. ● Some catalysts accelerate a reaction by binding to the reactant(s). The reactants are either oriented more favorably or react with lower activation energy. There is often a new reaction intermediate in which the catalyst is bound to the reactant(s). Many enzymes function in this manner.	

● Some catalysts involve covalent bonding between the catalyst and the reactant(s). This introduces a new reaction intermediate and new elementary reactions involving that intermediate. ● In surface catalysis, a reactant or intermediate binds to, or forms a covalent bond with, the surface. This introduces elementary reactions involving these new bound reaction intermediate(s).	

Key Vocabulary: reaction rate, rate law, elementary step, collision model, energy profile, reaction mechanism, steady state approximation, catalysis, rate constant, integrated rate law, reactant order, overall order, half life, Maxwell-Boltzmann distribution curve, activation energy, transition state, forward reaction, reverse reaction, Arrhenius equation, intermediate, rate limiting or rate determining step, enzyme, kinetics

Assessment Evidence

Performance Tasks:	**Other Evidence:**
● Kinetics of Dye Fading lab ○ Students will collect concentration data over a fixed period of time. They will then graphically analyze that data to determine if the reaction is 0th, 1st or 2nd order kinetics.	● Reaction Rates Notes/Worksheet ● Introduction to Rate Laws Notes/Worksheet ● Concentration Changes Over Time Notes/Worksheet ● Elementary Reactions Notes/Worksheet ● Collision Model Notes/Worksheet ● Reaction Energy Profile Notes/Worksheet ● Introduction to Reaction Mechanisms Notes/Worksheet ● Reaction Mechanism and Rate Law Notes/Worksheet ● Steady-State Approximation Notes/Worksheet ● Multistep Reaction Energy Profile Notes/Worksheet ● Catalysis Notes/Worksheet ● Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
- Use particle representations to describe successful and unsuccessful collisions

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Explain how to use numeric data to determine the rate law of a substance
- Explain how to use graphical data to determine the rate law of a substance

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

- Calculate the rate law of a substance
- Calculate the initial concentration of a substance
- Calculate the remaining concentration of a substance
- Calculate the half life of a substance
- Calculate the rate constant of a substance

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

- Accurately measure mass, absorbance and concentration to determine the kinetics of dye fading

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.

- Explain how concentration, surface area and temperature affect the amount and efficacy of collisions

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

- Use data to determine the half life of a substance
- Use half life to determine the amount of remaining radioactive substance

VOL Common Assessments:
THINK CRITICALLY AND CREATIVELY
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Kinetics of Dye Fading Lab

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 5 1 pager, Topic Specific Videos

Unit 6 - Thermochemistry	
Desired Results - Students will explain and quantify enthalpy and entropy exchange during chemical and physical processes.	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-4 - Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). **AP Chemistry Curricula Unit 6**	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● AA1(9-12): I can evaluate different approaches and justify the best pathway to success. ● AA2(9-12): I can assess my past successes and mistakes to change my approach. ● P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.	
Understandings: Students will understand that… ● The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in	**Essential Questions:** ● How does a thermal energy transfer affect temperature, states of matter, and chemical bonds?

matter. ● The availability or disposition of energy plays a role in virtually all observed chemical processes. ● Thermochemistry provides tools for understanding this key role, particularly the conservation of energy, including energy transfer in the forms of heat and work. ● The breaking of a chemical bond inherently requires an energy input, and because bond formation is the reverse process, it will release energy.	● How can energy changes be tracked and measured when energy can’t be seen? ● Why do combustion reactions that form carbon dioxide release energy?
Students will know… ● Temperature changes in a system indicate energy changes. ● Energy changes in a system can be described as endothermic and exothermic processes such as the heating or cooling of a substance, phase changes, or chemical transformations. ● When a chemical reaction occurs, the energy of the system either decreases (exothermic reaction), increases (endothermic reaction), or remains the same. ● The formation of a solution may be an exothermic or endothermic process, depending on the relative strengths of intermolecular/interparticle interactions before and after the dissolution process. ● A physical or chemical process can be described with an energy diagram that shows the endothermic or exothermic nature of that process. ● The particles in a warmer body have a greater average kinetic energy than those in a cooler body. ● Collisions between particles in thermal contact can result in the transfer of energy. This process is called “heat transfer,” “heat exchange,” or “transfer of energy as heat.” ● Eventually, thermal equilibrium is reached as the particles continue to collide. At thermal equilibrium, the average kinetic energy of both bodies is the same, and hence, their temperatures are the same. ● The amount of heat transferred between two bodies may be quantified by the heat transfer equation: $q = mc\Delta T$. ● Calorimetry experiments are used to measure the transfer of heat.	**Students will be able to…** ● Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation. ● Represent a chemical or physical transformation with an energy diagram. ● Explain the relationship between the transfer of thermal energy and molecular collisions. ● Calculate the heat q absorbed or released by a system undergoing heating/cooling based on the amount of the substance, the heat capacity, and the change in temperature. ● Explain changes in the heat q absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition. ● Calculate the heat absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction. ● Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction. ● Calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation. ● Represent a chemical or physical process as a sequence of steps. ● Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual

- The first law of thermodynamics states that energy is conserved in chemical and physical processes. - The transfer of a given amount of thermal energy will not produce the same temperature change in equal masses of matter with differing specific heat capacities. - Heating a system increases the energy of the system, while cooling a system decreases the energy of the system. - The specific heat capacity of a substance and the molar heat capacity are both used in energy calculations. - Chemical systems change their energy through three main processes: heating/cooling, phase transitions, and chemical reactions. - In calorimetry experiments involving dissolution, temperature changes of the mixture within the calorimeter can be used to determine the direction of energy flow. If the temperature of the mixture increases, thermal energy is released by the dissolution process (exothermic). If the temperature of the mixture decreases, thermal energy is absorbed by the dissolution process (endothermic). - Energy must be transferred to a system to cause a substance to melt (or boil). The energy of the system therefore increases as the system undergoes a solid-to-liquid (or liquid to-gas) phase transition. Likewise, a system releases energy when it freezes (or condenses). - The temperature of a pure substance remains constant during a phase change. - The energy absorbed during a phase change is equal to the energy released during a complementary phase change in the opposite direction. - The enthalpy change of a reaction gives the amount of heat energy released (for negative values) or absorbed (for positive values) by a chemical reaction at constant pressure. - When the products of a reaction are at a different temperature than their surroundings, they exchange energy with the surroundings to reach thermal equilibrium. - Thermal energy is transferred to the surroundings as the reactants convert to products in an exothermic reaction. Thermal energy is transferred from the surroundings as the	steps.

reactants convert to products in an endothermic reaction. ● The chemical potential energy of the products of a reaction is different from that of the reactants because of the breaking and forming of bonds. The energy difference results in a change in the kinetic energy of the particles, which manifests as a temperature change. ● During a chemical reaction, bonds are broken and/or formed, and these events change the potential energy of the system. ● The average energy required to break all of the bonds in the reactant molecules can be estimated by adding up the average bond energies of all the bonds in the reactant molecules. Likewise, the average energy released in forming the bonds in the product molecules can be estimated. If the energy released is greater than the energy required, the reaction is exothermic. If the energy required is greater than the energy released, the reaction is endothermic. ● Tables of standard enthalpies of formation can be used to calculate the standard enthalpies of reactions: ○ $\Delta H°_{reaction} = \Sigma\Delta H_f°_{products} - \Sigma\Delta H_f°_{reactants}$ ● Many processes can be broken down into a series of steps. Each step in the series has its own energy change. ● Because total energy is conserved (first law of thermodynamics), and each individual reaction in a sequence transfers thermal energy to or from the surroundings, the net thermal energy transferred in the sequence will be equal to the sum of the thermal energy transfers in each of the steps. ● The following are essential principles of Hess's law: ○ When a reaction is reversed, the enthalpy change stays constant in magnitude but becomes reversed in mathematical sign. ○ When a reaction is multiplied by a factor c, the enthalpy change is multiplied by the same factor c. ○ When two (or more) reactions are added to obtain an overall reaction, the individual enthalpy changes of each reaction are added to obtain the net enthalpy change of the overall reaction.	

Key Vocabulary: thermodynamics, enthalpy, work, endothermic, exothermic, Hess's Law, thermal equilibrium, heat capacity, calorimetry, bond

enthalpy, enthalpy of formation, energy diagram, kinetic energy, first law of thermodynamics, molar heat capacity, kinetic energy, potential energy	
Assessment Evidence	
Performance Tasks: ● Introduction to Calorimetry Lab ○ Students will use calorimetry data to determine effective contents of hot/cold packs. ● It's time for a change Lab ○ Students will be asked to dissolve 2 solids in water so that the resulting temperature change is 0. The dissolution of 1 solid is exothermic, while the other is endothermic. They must calculate the amount of each solid to use so that the resulting temperature change when mixed is negligible.	**Other Evidence:** ● Endothermic and Exothermic Processes Notes/Worksheet ● Energy Diagrams Notes/Worksheet ● Heat Transfer and Thermal Equilibrium Notes/Worksheet ● Heat Capacity and Calorimetry Notes/Worksheet ● Energy of Phase Changes Notes/Worksheet ● Introduction to Enthalpy of Reactions Notes/Worksheet ● Bond Enthalpies Notes/Worksheet ● Enthalpy of Formation Notes/Worksheet ● Hess's Law Notes/Worksheet ● Mixed Heat Review Worksheet ● Unit Test
Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Calculate the enthalpy change during chemical and physical processes ● Use potential energy diagrams to explain heat exchange RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Explain how to calculate and measure enthalpy changes during chemical reactions, heat transfer between 2 substances and the dissolution of solids HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays ● Use potential energy diagrams to describe enthalpy changes ● Calculate enthalpy changes for chemical and physical processes HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure temperature, volume and mass to calculate heat exchange 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. ● Calculate enthalpy changes during a chemical reaction through stoichiometry ● Use potential energy diagrams to determine if a reaction is endothermic or exothermic ● Use potential energy diagrams to compare the stored energy of reactants vs. stored energy of products ● Use bond enthalpies to calculate the enthalpy change of a reaction	

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

- Use specific heat and calorimetry as an explanation for why substances do not change temperature at the same rate

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.

- Use calorimetry to calculate heat exchange

HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

- Use calorimetry to calculate the heat exchange of dissolving solids and determine if that heat exchange is exothermic or endothermic

HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

- Discuss the flaws in assuming energy is conserved during all heat exchanges as it relates to accurate experimental data.
- Use experimental data to calculate heat exchange, assuming energy is conserved in a calorimeter

VOL Common Assessments:
ADAPT AND ADJUST:
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

- Calorimetry Lab

AA2(9-12): I can assess my past successes and mistakes to change my approach.

- It's Time for a Change Lab

PERSEVERE:
P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.

- Unit Test

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 6 1 pager, Topic Specific Videos

Unit 7 - Equilibrium	
Desired Results - Students will calculate and predict the amounts of products and reactants present once a reaction reaches equilibrium	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 - Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. **AP Chemistry Curricula Unit 7**	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) • TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions. • TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. • CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.	
Understandings: Students will understand that… • Chemical equilibrium is a dynamic state in which opposing processes occur at the same rate. • Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations. • A change in conditions, such as addition of a chemical species,	**Essential Questions:** • How are the rates of forward and reverse reactions related to the direction that a reversible reaction proceeds? • How can the composition of a mixture at equilibrium be predicted? • How can an equilibrium system be manipulated to maximize product yield?

change in temperature, or change in volume, can cause the rate of the forward and reverse reactions to fall out of balance. ● Le Châtelier's principle provides a means to reason qualitatively about the direction of the shift in an equilibrium system resulting from various possible stresses ● The expression for the equilibrium constant, K, is a mathematical expression that describes the equilibrium state associated with a chemical change. ● Q, describes a chemical reaction at any point, enabling a comparison to the equilibrium state. ● The dissolution of a solid in a solvent can also be understood by applying the principles of chemical equilibrium because it is a reversible reaction.	● What factors influence the degree to which a salt will dissolve?
Students will know... ● Many observable processes are reversible. ● When equilibrium is reached, no observable changes occur in the system. Reactants and products are simultaneously present, and the concentrations or partial pressures of all species remain constant. ● The equilibrium state is dynamic. The forward and reverse processes continue to occur at equal rates, resulting in no net observable change. ● Graphs of concentration, partial pressure, or rate of reaction versus time for simple chemical reactions can be used to understand the establishment of chemical equilibrium. ● If the rate of the forward reaction is greater than the reverse reaction, then there is a net conversion of reactants to products. If the rate of the reverse reaction is greater than that of the forward reaction, then there is a net conversion of products to reactants. An equilibrium state is reached when these rates are equal. ● The reaction quotient Q_c describes the relative concentrations of reaction species at any time. For gas phase reactions, the reaction quotient may instead be written in terms of partial pressures as Q_p . The reaction quotient tends toward the equilibrium constant such that at equilibrium $K_c = Q_c$ and $K_p = Q_p$.	**Students will be able to…** ● Explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations. ● Explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions. ● Represent the reaction quotient Q_c or Q_p, for a reversible reaction, and the corresponding equilibrium expressions $K_c = Q_c$ or $K_p = Q_p$. ● Calculate K_c or K_p based on experimental observations of concentrations or pressures at equilibrium. ● Explain the relationship between very large or very small values of K and the relative concentrations of chemical species at equilibrium. ● Represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction. ● Identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant. ● Represent a system undergoing a reversible reaction with a particulate model. ● Identify the response of a system at equilibrium to an external

- Equilibrium constants and reaction quotients are calculated for a generic reaction (aA + bB ⟷ cC + dD) using: K_c or $Q_c = \frac{[C]^c[D]^b}{[A]^a[B]^b}$ K_p or $Q_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$ - The reaction quotient and equilibrium constant does not include substances whose concentrations (or partial pressures) are independent of the amount, such as for solids and pure liquids. - Equilibrium constants can be determined from experimental measurements of the concentrations or partial pressures of the reactants and products at equilibrium. - Some equilibrium reactions have very large K values and proceed essentially to completion. Others have very small K values and barely proceed at all. - When a reaction is reversed, K is inverted. - When the stoichiometric coefficients of a reaction are multiplied by a factor c, K is raised to the power c. - When reactions are added together, the K of the resulting overall reaction is the product of the K's for the reactions that were summed. - Since the expressions for K and Q have identical mathematical forms, all valid algebraic manipulations of K also apply to Q. - The concentrations or partial pressures of species at equilibrium can be predicted given the balanced reaction, initial concentrations, and the appropriate K. - When Q < K, the reaction will proceed with a net consumption of reactants and generation of products. When Q > K, the reaction will proceed with a net consumption of products and generation of reactants. When Q = K, the system is at dynamic equilibrium; both forward and reverse reactions proceed at the same rate, and the proportion of reactants and products remains constant.	stress, using Le Châtelier's principle. - Explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium. - Calculate the solubility of a salt based on the value of K_{sp} for the salt. - Identify the solubility of a salt, and/or the value of K_{sp} for the salt, based on the concentration of a common ion already present in solution.

• Particulate representations can be used to describe the relative numbers of reactant and product particles present prior to and at equilibrium, and the value of the equilibrium constant. • Le Châtelier's principle can be used to predict the response of a system to stresses such as addition or removal of a chemical species, change in temperature, change in volume/ pressure of a gas-phase system, or dilution of a reaction system. • Le Châtelier's principle can be used to predict the effect that a stress will have on experimentally measurable properties such as pH, temperature, and color of a solution. • A disturbance to a system at equilibrium causes Q to differ from K, thereby taking the system out of equilibrium. The system responds by bringing Q back into agreement with K, thereby establishing a new equilibrium state. • Some stresses, such as changes in concentration, cause a change in Q only. A change in temperature causes a change in K. In either case, the concentrations or partial pressures of species redistribute to bring Q and K back into equality. • The dissolution of a salt is a reversible process whose extent can be described by K_{sp}, the solubility-product constant. • The solubility of a substance can be calculated from the K_{sp} for the dissolution process. This relationship can also be used to predict the relative solubility of different substances. • The solubility rules can be quantitatively related to K_{sp}, in which K_{sp} values >1 correspond to soluble salts. • The molar solubility of one or more species in a saturated solution can be used to calculate the K_{sp} of a substance. • The solubility of a salt is reduced when it is dissolved into a solution that already contains one of the ions present in the salt. The impact of this "common-ion effect" on solubility can be understood qualitatively using Le Châtelier's	

principle or calculated from the K_{sp} for the dissolution process.

Key Vocabulary: dynamic equilibrium, Le Châtelier’s principle, equilibrium expression, reaction quotient, solubility product, molar solubility, reversible reaction, common ion effect, ICE table

Assessment Evidence

Performance Tasks:
- Determining an Equilibrium Constant Lab
    - Students will experimentally determine the equilibrium constant for a reaction and compare it to the known value.
- Calculating Q Dry Lab
- Understanding Le Chatelier's Principle Lab
    - Students will apply several stresses to reactions and will explain their observations using Le Chatelier’s Principle.

Other Evidence:
- Introduction to Equilibrium Notes/Worksheet
- Equilibrium Snowball Fight
- Direction of Reversible Reactions Notes/Worksheet
- Reaction Quotient and Equilibrium Constant Notes/Worksheet
- Calculating the Equilibrium Constant Notes/Worksheet
- Magnitude of the Equilibrium Constant Notes/Worksheet
- Properties of the Equilibrium Constant Notes/Worksheet
- Calculating Equilibrium Concentrations Notes/Worksheet
- Representations of Equilibrium Notes/Worksheet
- Le Chatelier Activity
- Introduction to Le Châtelier’s Principle Notes/Worksheet
- Reaction Quotient and Le Châtelier’s Principle Notes/Worksheet
- Introduction to Solubility Equilibria Notes/Worksheet
- Common Ion Effect Notes/Worksheet
- Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
- Use particle diagrams to describe equilibrium mixtures
- Calculate reaction quotients using particle diagrams
- Calculate equilibrium constants using particle diagrams

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Predict how a reaction will respond to an added stress

HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
- Use concentration vs. time graphs to explain how rates of reactions changed with added or removed products and reactants
- Calculate equilibrium constants

- Calculate reaction quotients
- Calculate concentrations at equilibrium
- Calculate K_{sp} values
- Calculate molar solubility

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

- Accurately measure mass and volume to calculate concentration

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.

- Predict how added or removed reactants affect the rate of the forward and reverse reactions
- Predict how added or removed products affect the rate of the forward and reverse reactions

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.

- Use Le Chatelier's principle to explain how any stress affects an equilibrium system

VOL Common Assessments:
THINK CRITICALLY AND CREATIVELY
TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

- Reaction Quotient Dry Lab

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Understanding Le Chatelier's Principle Lab

COLLABORATE AND COMMUNICATE EFFECTIVELY
CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

- Determining an Equilibrium Constant Lab

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 7 1 pager, Topic Specific Videos

Unit 8 - Acids and Bases

Desired Results - Students will describe and calculate the strength and concentration of acids and bases using equilibrium expressions.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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.

AP Chemistry Curricula Unit 8

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.
- P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.

Understandings: Students will understand that… • The proton-exchange reactions of acid-base chemistry are reversible reactions that reach equilibrium quickly, and much of acid-base chemistry can be understood by applying the principles of chemical equilibrium. • Most acid-base reactions have either large or small values of K, which means qualitative conclusions regarding equilibrium state can often be drawn without extensive computations.	**Essential Questions:** • How is pH related to the concentration and strength of an acid, a base, or a mixture of them? • How does acid or base strength relate to the concentrations of reactants and products when a system reaches equilibrium? • Why are some acids stronger than others?

Students will know…

- The concentrations of hydronium ion and hydroxide ion are often reported as pH and pOH, respectively.
  - $pH = -\log[H_3O^+]$
  - $pOH = -\log[OH^-]$
- Water autoionizes with an equilibrium constant Kw.
  - $Kw = [H_3O^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C
- In pure water, pH = pOH is called a neutral solution.
  - At 25°C, $pK_w = 14.0$
  - pH = pOH = 7.0.
  - $pK_w = 14 = pH + pOH$ at 25°C
- The value of K_w is temperature dependent, so the pH of pure, neutral water will deviate from 7.0 at temperatures other than 25°C.
- Molecules of a strong acid (HCl, HBr, HI, $HClO_4$, H_2SO_4, and HNO_3) will completely ionize in aqueous solution to produce hydronium ions and the conjugate base of the acid. As such, the concentration of H_3O^+ in a strong acid solution is equal to the initial concentration of the strong acid, and thus the pH of the strong acid solution is easily calculated.
- When dissolved in solution, strong bases (group I and II hydroxides) completely dissociate to produce hydroxide ions. As such, the concentration of OH^- in a strong base solution is equal to the initial concentration of a group I hydroxide and double the initial concentration of a group II hydroxide, and thus the pOH (and pH) of the strong base solution is easily calculated.
- Weak acids react with water to produce hydronium ions. However, only a small percentage of molecules of a weak acid will ionize in this way. Thus, the concentration of H_3O^+ is much less than the initial concentration of the molecular acid, and the vast majority of the acid molecules remain un-ionized.
- A solution of a weak acid involves equilibrium between an un-ionized acid and its conjugate base. The equilibrium constant for this reaction is K_a, often reported as pK_a . The pH of a weak acid solution can be determined from the initial acid concentration and the pK_a.
  - $K_a = \frac{[H_3O^+][A^-]}{[HA]}$

Students will be able to…

- Calculate the values of pH and pOH, based on Kw and the concentration of all species present in a neutral solution of water.
- Calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base.
- Explain the relationship among pH, pOH, and concentrations of all species in a solution of a monoprotic weak acid or weak base.
- Explain the relationship among the concentrations of major species in a mixture of weak and strong acids and bases.
- Explain results from the titration of a mono-or polyprotic acid or base solution, in relation to the properties of the solution and its components.
- Explain the relationship between the strength of an acid or base and the structure of the molecule or ion.
- Explain the relationship between the predominant form of a weak acid or base in solution at a given pH and the pK_a of the conjugate acid or the pK_b of the conjugate base.
- Explain the relationship between the ability of a buffer to stabilize pH and the reactions that occur when an acid or a base is added to a buffered solution.
- Identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid-base pair used to create the buffer.
- Explain the relationship between buffer capacity of a solution and the relative concentrations of the conjugate acid and conjugate base components of the solution.
- Identify the qualitative effect of changes in pH on the solubility of a salt.

    - $pK_a = -\log K_a$
- Weak bases react with water to produce hydroxide ions in solution. However, ordinarily just a small percentage of the molecules of a weak base in solution will ionize in this way. Thus, the concentration of OH^- in the solution does not equal the initial concentration of the base, and the vast majority of the base molecules remain un-ionized.
- A solution of a weak base involves equilibrium between an un-ionized base and its conjugate acid. The equilibrium constant for this reaction is K_b , often reported as pK_b. The pH of a weak base solution can be determined from the initial base concentration and the pK_b.
    - $K_a = \frac{[HB^+]\,[OH^-]}{[B]}$
    - $pK_b = -\log K_b$
- The percent ionization of a weak acid (or base) can be calculated from its pK_a (pK_b) and the initial concentration of the acid (base). The percent ionization can also be calculated from the initial concentration of the acid (base) and the equilibrium concentration of any of the species in the equilibrium expression.
- For any conjugate acid-base pair, the acid ionization constant and base ionization constant are related by:
    - $K_w = K_a \times K_b$
    - $pK_w = pK_a + pK_b$
- When a strong acid and a strong base are mixed, they react quantitatively in a reaction represented by the equation: $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$. The pH of the resulting solution may be determined from the concentration of excess reagent.
- When a weak acid and a strong base are mixed, they react quantitatively in a reaction represented by the equation: $HA_{(aq)} + OH^-_{(aq)} \rightarrow A^-_{(aq)} + H_2O_{(l)}$. If the weak acid is in excess, then a buffer solution is formed, and the pH can be determined from the Henderson-Hasselbalch equation. If the strong base is in excess, then the pH can be determined from the moles of excess hydroxide ion and the total volume of solution. If they are equimolar, then the (slightly basic) pH can be determined from the equilibrium represented by the equation: $A^-_{(aq)} + H_2O_{(l)} \rightarrow$

$HA_{(aq)} + OH^{-}_{(aq)}$.

- When a weak base and a strong acid are mixed, they will react quantitatively in a reaction represented by the equation: $B_{(aq)} + H_3O^{+}_{(aq)} \rightarrow HB^{+}_{(aq)} + H_2O_{(l)}$. If the weak base is in excess, then a buffer solution is formed, and the pH can be determined from the Henderson-Hasselbalch equation. If the strong acid is in excess, then the pH can be determined from the moles of excess hydronium ion and the total volume of solution. If they are equimolar, then the (slightly acidic) pH can be determined from the equilibrium represented by the equation: $HB^{+}_{(aq)} + H_2O_{(l)} \rightarrow B_{(aq)} + H_3O^{+}_{(aq)}$.
- When a weak acid and a weak base are mixed, they will react to an equilibrium state whose reaction may be represented by the equation: $HA_{(aq)} + B_{(aq)} \rightarrow A^{-}_{(aq)} + HB^{+}_{(aq)}$.
- An acid-base reaction can be carried out under controlled conditions in a titration. A titration curve, plotting pH against the volume of titrant added, is useful for summarizing results from a titration.
- At the equivalence point for titrations of monoprotic acids or bases, the number of moles of titrant added is equal to the number of moles of analyte originally present. This relationship can be used to obtain the concentration of the analyte. This is the case for titrations of strong acids/bases and weak acids/bases.
- For titrations of weak acids/bases, it is useful to consider the point halfway to the equivalence point, that is, the half-equivalence point. At this point, there are equal concentrations of each species in the conjugate acid-base pair, for example, for a weak acid [HA] = [A−]. Because pH = pK_a when the conjugate acid and base have equal concentrations, the pK_a can be determined from the pH at the half equivalence point in a titration.
- At the equivalence point, pH is determined by the major species in solution. Strong acid and strong base titrations result in neutral pH at the equivalence point. However, in titrations of weak acids (weak bases), the conjugate base of the weak acid (conjugate acid of the weak base) is present at the equivalence point and can undergo proton-transfer reactions with the

surrounding water, producing basic (acidic) solutions. ● For polyprotic acids, titration curves can be used to determine the number of acidic protons. In doing so, the major species present at any point along the curve can be identified, along with the pK_a associated with each proton in a weak polyprotic acid. ● The protons on a molecule that will participate in acid-base reactions, and the relative strength of these protons, can be inferred from the molecular structure. ○ Strong acids have very weak conjugate bases that are stabilized by electronegativity, inductive effects, resonance, or some combination thereof. ○ Carboxylic acids are one common class of weak acid. ○ Strong bases (such as group I and II hydroxides) have very weak conjugate acids. ○ Common weak bases include nitrogenous bases such as ammonia as well as carboxylate ions. ○ Electronegative elements tend to stabilize the conjugate base relative to the conjugate acid, and so increase acid strength. ● The protonation state of an acid or base can be predicted by comparing the pH of a solution to the pK_a of the acid in that solution. When solution pH < acid pK_a, the acid form has a higher concentration than the base form. When solution pH > acid pK_a, the base form has a higher concentration than the acid form. ● Acid-base indicators are substances that exhibit different properties (such as color) in their protonated versus deprotonated state, making that property respond to the pH of a solution. ● To ensure accurate results in a titration experiment,acid-base indicators should be selected that have a pK_a close to the pH at the equivalence point. ● A buffer solution contains a large concentration of both members in a conjugate acid-base pair. The conjugate acid reacts with added base and the conjugate base reacts with added acid. These reactions are responsible for the ability of a buffer to stabilize pH. ● The pH of the buffer is related to the pKa of the acid and the	

concentration ratio of the conjugate acid-base pair. This relation is a consequence of the equilibrium expression associated with the dissociation of a weak acid, and is described by the Henderson-Hasselbalch equation. Adding small amounts of acid or base to a buffered solution does not significantly change the ratio of $[A^{-1}]/[HA]$ and thus does not significantly change the solution pH. The change in pH on addition of acid or base to a buffered solution is therefore much less than it would have been in the absence of the buffer. 　○ $pH = pK_a + [A^-]/[HA]$ ● Increasing the concentration of the buffer components (while keeping the ratio of these concentrations constant) keeps the pH of the buffer the same but increases the capacity of the buffer to neutralize added acid or base. ● When a buffer has more conjugate acid than base, it has a greater buffer capacity for addition of added base than acid. When a buffer has more conjugate base than acid, it has a greater buffer capacity for addition of added acid than base. ● The solubility of a salt is pH sensitive when one of the constituent ions is a weak acid, a weak base, or the hydroxide ion. These effects can be understood qualitatively using Le Châtelier's principle.	

Key Vocabulary: acid, base, strong acid/base, weak acid/base, equivalence point, half equivalence point, buffer, buffer capacity, pK_a, pK_b, pH, pOH, monoprotic, diprotic, polyprotic, conjugate acid, conjugate base, percent ionization, excess reagent, ICE table, indicator

Assessment Evidence

Performance Tasks:	Other Evidence:
● Ksp Lab 　○ Students will experimentally determine the Ksp of a solid and will compare it to the known value. ● Lab 52 The Great Buffer Challenge 　○ Students will design and create an effective buffer. They will then test their buffer against added acid and base.	● Introduction to Acids and Bases Notes/Worksheet ● pH and pOH of Strong Acids and Strong Bases Notes/Worksheet ● Weak Acid and Base Equilibria Notes/Worksheet ● Acid Base Reactions and Buffers Notes/Worksheet ● Acid Base Titrations ● Molecular Structure of Acids and Bases Notes/Worksheet ● pH and pK_a Notes/Worksheet ● Properties of Buffers Notes/Worksheet

	• Henderson-Hasselbalch Equation Notes/Worksheet • Buffer Capacity Notes/Worksheet • pH and Solubility Notes/Worksheet • Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
• Interpret the strength of an acid or base based on pictorial representations of ionization
• Calculate the pH of various solutions
• Interpret a titration curve
    ○ To calculate pH
    ○ To determine the strength of an acid or base
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
• Explain how to perform a titration
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
• Calculate pH of various solutions
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
• Accurately measure mass and volumes as they relate to titrations
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.
• Calculate and explain how the concentrations of acids and bases change with added acid or base
• Calculate and decrease how to solubility of solids is affected by the pH of a solution
 	
VOL Common Assessments:
TAKE INITIATIVE
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
• Ksp Lab
PERSEVERE
P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.
• The Great Buffer Challenge
P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.
• Unit Test

Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 8 1 Pager, Topic Specific Videos

Unit 9 - Thermodynamics and Electrochemistry

Desired Results - Students will calculate and predict the favorability of reactions.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

HS-PS1-4 - Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-6 - Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

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

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

HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

AP Chemistry Curricula Unit 9

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.

- P3(9-12): I can accept constructive feedback and use setbacks to adjust my learning journey in order to reach my goals.
- AA3(9-12): I can adjust my expectations and behaviors to succeed in a changing and unpredictable environment.

Understandings: Students will understand that…

- All changes in matter involve some form of energy change.
- One key determinant of chemical transformations is the change in potential energy that results from changes in electrostatic forces.
- Chemical systems undergo three main processes that change their energy: heating/cooling, phase transitions, and chemical reactions.
- Applying the laws of thermodynamics will allow students to describe the essential role of energy and explain and predict the direction of changes in matter.

Essential Questions:

- Why do some chemical reactions occur without intervention, but others require the input of energy?
- How can we determine the conditions under which a chemical or physical transformation is likely to occur?
- How is electrical energy generated using chemical reactions?

Students will know…

- Entropy increases when matter becomes more dispersed.
- Entropy increases when energy is dispersed. According to kinetic molecular theory (KMT), the distribution of kinetic energy among the particles of a gas broadens as the temperature increases. As a result, the entropy of the system increases with an increase in temperature.
- The entropy change for a process can be calculated from the absolute entropies of the species involved before and after the process occurs.
  - $\Delta S^o_{reaction} = \Sigma S^o_{products} - \Sigma S^o_{reactants}$
- The Gibbs free energy change for a chemical process in which all the reactants and products are present in a standard state (as pure substances, as solutions of 1.0 M concentration, or as gasses at a pressure of 1.0 atm) is given the symbol ΔG^o.
- The standard Gibbs free energy change for a chemical or physical process is a measure of thermodynamic favorability.
- The standard Gibbs free energy change for a physical or chemical process may also be determined from the standard Gibbs free energy of formation of the reactants and products.
  - $\Delta G^\circ_{reaction} = \Sigma \Delta G^\circ_{f(products)} - \Sigma \Delta G^\circ_{f(reactants)}$
- In some cases, it is necessary to consider both enthalpy and entropy to determine if a process will be thermodynamically favored.

Students will be able to…

- Identify the sign and relative magnitude of the entropy change associated with chemical or physical processes.
- Calculate the standard entropy change for a chemical or physical process based on the absolute entropies (standard molar entropies) of the species involved in the process.
- Explain whether a physical or chemical process is thermodynamically favored based on an evaluation of ΔG^o.
- Explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate.
- Explain whether a process is thermodynamically favored using the relationships between K, ΔG^o, and T.
- Explain the relationship between the solubility of a salt and changes in the enthalpy and entropy that occur in the dissolution process.
- Explain the relationship between external sources of energy or coupled reactions and their ability to drive thermodynamically unfavorable processes.
- Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell.
- Explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half reactions with the cell.

• Knowing the values of $\Delta H°$ and $\Delta S°$ for a process at a given temperature allows $\Delta G°$ to be calculated directly.
  ○ $\Delta G° = \Delta H° - T\Delta S°$
• In general, the temperature conditions for a process to be thermodynamically favored ($\Delta G° < 0$) can be predicted from the signs of $\Delta H°$ and $\Delta S°$.
• In cases where $\Delta H° < 0$ and $\Delta S° >$, no 0 calculation of $\Delta G°$ is necessary to determine that the process is thermodynamically favored ($\Delta G° < 0$). In cases where $\Delta H° > 0$ and $\Delta S° < 0$, no calculation of $\Delta G°$ is necessary to determine that the process is thermodynamically unfavored ($\Delta G° > 0$).
• Many processes that are thermodynamically favored do not occur to any measurable extent, or they occur at extremely slow rates.
• Processes that are thermodynamically favored, but do not proceed at a measurable rate, are under “kinetic control.” High activation energy is a common reason for a process to be under kinetic control. The fact that a process does not proceed at a noticeable rate does not mean that the chemical system is at equilibrium. If a process is known to be thermodynamically favored, and yet does not occur at a measurable rate, it is reasonable to conclude that the process is under kinetic control.
• $\Delta G°$ < 0) means that the products are favored at equilibrium ($K > 1$) under standard conditions.
• The equilibrium constant is related to free energy by the equations:
  ○ $K = e^{-\Delta G°/RT}$
  ○ $\Delta G° = -RT \ln K$
• Connections between K and $\Delta G°$ can be made qualitatively through estimation. When $\Delta G°$ is near zero, the equilibrium constant will be close to 1. When $\Delta G°$ is much larger or much smaller than RT, the value of K deviates strongly from 1.
• Processes with $\Delta G° < 0$ favor products (i.e., $K > 1$) and those with $\Delta G° > 0$ favor reactants (i.e., $K < 1$).
• The free energy change ($\Delta G°$) for dissolution of a substance reflects a number of factors: the breaking of the intermolecular interactions that hold the solid together, the reorganization of the solvent around the dissolved species, and the interaction of the dissolved species with the solvent. It is possible to estimate the
	• Explain the relationship between deviations from standard cell conditions and changes in the cell potential.
	• Calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell.

sign and relative magnitude of the enthalpic and entropic contributions to each of these factors. However, making predictions for the total change in free energy of dissolution can be challenging due to the cancellations among the free energies associated with the three factors cited. ● An external source of energy can be used to make a thermodynamically unfavorable process occur. ● A desired product can be formed by coupling a thermodynamically unfavorable reaction that produces that product to a favorable reaction. In the coupled system, the individual reactions share one or more common intermediates. The sum of the individual reactions produces an overall reaction that achieves the desired outcome and $\Delta G° < 0$. ● Each component of an electrochemical cell (electrodes, solutions in the half-cells,salt bridge, voltage/current measuring device) plays a specific role in the overall functioning of the cell. The operational characteristics of the cell (galvanic vs. electrolytic, direction of electron flow, reactions occurring in each half-cell, change in electrode mass, evolution of a gas at an electrode, ion flow through the salt bridge) can be described at both the macroscopic and particulate levels. ● Galvanic, sometimes called voltaic, cells involve a thermodynamically favored reaction, whereas electrolytic cells involve a thermodynamically unfavored reaction. Visual representations of galvanic and electrolytic cells are tools of analysis to identify where half-reactions occur and in what direction current flows. ● For all electrochemical cells, oxidation occurs at the anode and reduction occurs at the cathode. ● Electrochemistry encompasses the study of redox reactions that occur within electrochemical cells. The reactions are either thermodynamically favored (resulting in a positive voltage) or thermodynamically unfavored (resulting in a negative voltage and requiring an externally applied potential for the reaction to proceed). ● The standard cell potential of electrochemical cells can be calculated by identifying the oxidation and reduction half-reactions and their respective standard reduction potentials.	

- ΔG° (standard Gibbs free energy change) is proportional to the negative of the cell potential for the redox reaction from which it is constructed. Thus, a cell with a positive E° involves a thermodynamically favored reaction, and a cell with a negative E° involves a thermodynamically unfavored reaction.
  - $\Delta G^\circ = -nFE^\circ$
- In a real system under nonstandard conditions, the cell potential will vary depending on the concentrations of the active species. The cell potential is a driving force toward equilibrium; the farther the reaction is from equilibrium, the greater the magnitude of the cell potential.
- Equilibrium arguments such as Le Châtelier's principle do not apply to electrochemical systems, because the systems are not in equilibrium.
- The standard cell potential E° corresponds to the standard conditions of $Q = 1$. As the system approaches equilibrium, the magnitude (i.e., absolute value) of the cell potential decreases, reaching zero at equilibrium (when $Q = K$). Deviations from standard conditions that take the cell further from equilibrium than $Q = 1$ will increase the magnitude of the cell potential relative to Eo . Deviations from standard conditions that take the cell closer to equilibrium than $Q = 1$ will decrease the magnitude of the cell potential relative to E°. In concentration cells, the direction of spontaneous electron flow can be determined by considering the direction needed to reach equilibrium.
- Algorithmic calculations using the Nernst equation are insufficient to demonstrate an understanding of electrochemical cells under nonstandard conditions. However, students should qualitatively understand the effects of concentration on cell potential and use conceptual reasoning, including the qualitative use of the Nernst equation:
  - $E = E^\circ - (RT/nF) \ln Q$
- Faraday's laws can be used to determine the stoichiometry of the redox reaction occurring in an electrochemical cell with respect to the following:
  - Number of electrons transferred
  - Mass of material deposited on or removed from an electrode (as in electroplating)

<table>
<tr><td>

- Current
- Time elapsed
- Charge of ionic species
- I = q/t

</td><td></td></tr>
<tr><td colspan="2">Key Vocabulary: entropy, enthalpy, Gibbs free energy, kinetic control, thermodynamics, coupled reactions, galvanic cell, electrolytic cell, electrolysis, Faraday's constant, Faraday's Law, electroplate, spontaneous, nonspontaneous, thermodynamically favored, not thermodynamically favored, activation energy, salt bridge, cathode, anode, electrode, half cell, voltage, current, oxidation, reduction, standard reduction potential, Nernst equation</td></tr>
<tr><td colspan="2" align="center">Assessment Evidence</td></tr>
<tr><td>

Performance Tasks:

- Lab 40: Investigating Electrolytic Cells
  - Students will construct and investigate various electrochemical cells.
- Electroplating Lab
  - Students will predict the amount of plated solid during an electroplating reaction and will compare that to measured values in the lab.

</td><td>

Other Evidence:

- Introduction to Entropy Notes/Worksheet
- Absolute Entropy and Entropy Change Notes/Worksheet
- Gibbs Free Energy and Thermodynamic Favorability Notes/Worksheet
- Thermodynamic and Kinetic Control Notes/Worksheet
- Free Energy and Equilibrium Notes/Worksheet
- Free Energy of Dissolution Notes/Worksheet
- Coupled Reactions Notes/Worksheet
- Galvanic (Voltaic) and Electrolytic Cells Notes/Worksheet
- Cell Potential and Free Energy Notes/Worksheet
- Cell Potential Under Nonstandard Conditions Notes/Worksheet
- Electrolysis and Faraday's Law Notes/Worksheet
- Unit Test

</td></tr>
<tr><td colspan="2" align="center">Learning Plan</td></tr>
<tr><td colspan="2">

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Describe the functioning of a galvanic or electrolytic cell
- Create a visual representation of a galvanic or electrolytic cell
- Use pictorial representations to describe changes in entropy
- Calculate Gibbs free energy
- Calculate voltage
- Calculate current

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical

</td></tr>
</table>

processes

- Describe how to create a thermodynamically favored galvanic cell

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

- Calculate Gibbs free energy
- Calculate voltage
- Calculate current
- Calculate the mass of electroplated solid

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

- Accurately measure mass generated during an electrochemical cell
- Accurately measure and create a known concentration of solution

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.

- Use entropies of formation to calculate the entropy change of a given process
- Use Gibbs free energy change of formation to calculate the Gibbs free energy change of a give process

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.

- Use Le Chatelier's principle to explain how voltage of a galvanic cell changes under non-standard conditions

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

- Explain the expected direction of electron flow in a galvanic or electrolytic cell

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.

- Use the enthalpy and entropy of a system to calculate the change in Gibbs free energy
- Use the enthalpy and entropy of a system to predict the favorability of a chemical or physical change

HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

- Design an electrolytic cell

HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

- Use the known voltage of half reactions to determine the overall voltage of a galvanic or electrochemical cell

VOL Common Assessments:
PERSEVERE:
P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.

- Unit Test

P3(9-12): I can accept constructive feedback and use setbacks to adjust my learning journey in order to reach my goals.

- Investigating Electrolytic Cells Lab

ADAPT AND ADJUST AA3(9-12): I can adjust my expectations and behaviors to succeed in a changing and unpredictable environment. • Electroplating Lab
Teacher Resources: Brown/Lemay Textbook, I Do, We Do, You Do Notes, Formula Sheet, AP Classroom Daily Videos, Daily Video Guides, AP Classroom Progress Check, AP Chemistry CED, Guided Inquiry Activities, Unit Review Videos, Unit 9 1 pager, Topic Specific Videos

Chemistry CURRICULUM

REGION 14 SCHOOL DISTRICT

VISION OF A LEARNER

Grade Level(s): 10-12	**Curriculum Author(s):** Melissa Hodges

Course Description: Chemistry provides a deep dive into the study and understanding of matter and energy, their properties and transformations. Throughout the course, students familiarize themselves with concepts of atomic theory, the periodic table, chemical bonding, reactions, stoichiometry, states of matter, properties of gasses, and thermodynamics.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Scientific Reasoning, Matter, Chemical/Physical Properties & Problem Solving (5 weeks)	How is scientific knowledge created and communicated?	Biological, chemical and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules.	TI1(9-12); TCC3(9-12); CCE2(9-12): AA2(9-12)
Light & the Periodic Table (3 weeks)	How is an elements' properties related to its position on the periodic table?	The electron arrangement of atoms is governed by specific rules and that electron arrangement controls all chemical and physical properties of those elements.	TCC4(9-12); CCE3(9-12)
Structure of Matter: The Atom, Bonding & Nuclear Energy (3 weeks)	How does the structure of matter affect the properties and the uses of materials?	The periodic table is used to determine an atoms' mass number, atomic number, amount of each subatomic particle and its ability to create metallic, covalent or ionic bonds.	CCE1(9-12); TCC2(9-12)
Bonding & Molecular Structure (4 weeks)	How does the 3D structure of compounds relate to their physical and chemical properties?	Atoms in compounds will arrange themselves in a molecule to minimize repulsion and maximize attraction. The physical and chemical properties of those compounds can be explained by the attractive forces between them.	CCE2(9-12); CCE3(9-12)
Formula Writing, Naming Compounds	How are formulas of compounds created and what do they tell us about the properties of the substance?	Atoms react with one another to form new compounds so that each element	P1(9-12); P2(9-12)

(3 weeks)		has a complete octet in its valence shell.	
The Mole (4 weeks)	How do we mathematically describe amounts of matter?	The mole is a unit used to measure the number of atoms, molecules, or (in the case of ionic compounds) formula units in a given mass or volume of a substance.	P1(9-12); AA2(9-12)
Types of Reactions, Balancing Equations & Reaction Rates (4 weeks)	How can we predict the products and rate of a chemical reaction?	Atoms react with one another to form new substances in predictable patterns. Matter is neither created or destroyed during these processes.	CCE3(9-12); DE4(9-12)
Solutions, Equilibrium & Acids & Bases (4 weeks)	How do reactions respond to disturbances to the equilibrium mixture? How are solutes measured and how do they affect the properties of the solvent?	Once equilibrium is achieved, the amount of each reactant and product remains constant, even though the reaction continues or when external stresses are applied.	TI1(9-12), TCC2(9-12)
Stoichiometry (4 weeks)	What are the quantitative relationships in chemical reactions?	The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.	P4(9-12); TCC2(9-12)
Thermochemistry (3 weeks)	How is energy transferred during both chemical and physical processes and why do substances absorb/release heat at different rates?	Energy is conserved during all chemical and physical processes; it only changes form.	TI1(9-12); TCC2(9-12)
Gas Laws (3 weeks)	How do the properties of gasses change with temperature, pressure, amount of gas, and volume?	We can predict how a gas will change given changes in moles of gas, temperature, pressure and volume.	TI3(9-12); CCE3(9-12); TCC4(9-12)

<table>
<tr><th colspan="2">Unit 1 - Scientific Reasoning, Matter, Chemical/Physical Properties & Problem Solving</th></tr>
<tr><th colspan="2">Desired Results - Students will collect accurate data and communicate that data effectively.</th></tr>
<tr><td colspan="2">Established Goals:
<u>Common Core State Standards:</u>
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

<u>NGSS Standards:</u>
HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</td></tr>
<tr><td colspan="2">Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
AA2(9-12): I can assess my past successes and mistakes to change my approach.</td></tr>
<tr><td>Understandings: Students will understand that…
communicating the results of scientific laboratory investigations includes using data and results to prove or disprove a hypothesis.
scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data & ideas.</td><td>Essential Questions:
How is scientific knowledge created and communicated?
How does the structure of matter affect the properties and uses of materials</td></tr>
<tr><td>Students will know…</td><td>Students will be able to...</td></tr>
</table>

• basic safety rules when working in the laboratory including safety and laboratory equipment. • the parts of a chemical lab report. • the rules of proper significant figures based on the precision of the measuring device. • the difference between precision and accuracy. • the rules for calculating with scientific notation. • the formula for density. • differences between physical and chemical properties and changes. • the differences between intensive and extensive properties. • the process of dimensional analysis. • The density of a substance is calculated using D=M/V	• work in the chemical laboratory, demonstrating proper use of the lab & safety equipment. • communicate their laboratory findings by writing a chemical laboratory report. • collect valid data to determine mass, volume, density and temperature. • determine what data indicates precision and/or accuracy. • perform calculations with numbers in scientific notation. • determine density of various samples of matter. • separate a mixture of substances based on their physical and chemical properties. • classify which properties of a substance are intensive or extensive. • apply dimensional analysis to solve problems.
Key Vocabulary: Hypothesis, theory, law, physical properties, chemical properties, intensive property, extensive property, physical change, chemical change, dimensional analysis, scientific notation, significant figures, matter, mass, substance, heterogeneous mixture, homogeneous mixture, solutions, element, compound, qualitative measurements, quantitative measurements, accuracy, precision, accepted value, experimental value, error, percent error, International System of Units (SI), density, Kelvin scale, absolute zero	
Assessment Evidence	

Performance Tasks:
• Study of Chemical Changes Lab
• Measurement Lab
• Paper towel Lab (Cost analysis Honors Only)
  ○ This assessment allows students to demonstrate correct measurement techniques, procedure writing, data analysis and error analysis
• Graphical Analysis and Density Lab
• Unit Conversion lab (Complex Unit Honors Only)
• Separating a Mixture Lab Summative
  ○ Students will be given a mixture of salt, sand, iron and water and must develop a plan to separate them. They will take observations of the mixture before and after separating, including mass data, and will reflect on how successfully they achieved their goal in a formal lab
	Other Evidence:
	• Scientific Notation Worksheet
	• Scientific Notation Calculation Worksheet
	• Sig Fig Worksheet
	• Physical Chemical Change Worksheet
	• Element, Compound, Mixture Worksheet
	• Unit Quiz
	• Density Worksheet
	• Dimensional Analysis Worksheets
	• Unit Test
	• Lab Safety Quiz

report.	

Learning Plan
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Use mass and volume data to determine the density of substances RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Write laboratory procedures ● Write conclusions based on analysis of data HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays ● Graphically use mass and volume data to determine the density of substance ● Accurately measure objects and choose appropriate units ● Use scientific notation to accurately display data ● Use metric conversions appropriate to the size and quantity of data HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Write data consistent with the accuracy of the measuring device HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials ● Correlate mass and volume data to a substance’s density HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. ● Determine which brand of paper towel is most effective VOL Common Assessments: THINK CRITICALLY AND CREATIVELY TCC3(9-12): I can integrate relevant information to produce multiple valid solutions. ● Separating a mixture Lab TAKE INITIATIVE TI (9-12): I Can implement a realistic plan and adapt when necessary to achieve my goals. ● Paper Towel Lab COLLABORATE AND COMMUNICATE EFFECTIVELY CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success. ● Use the actionable feedback on the Paper Towel Lab to enhance performance on the Separating a Mixture Lab ● A Study of Chemical Changes Lab ADAPT AND ADJUST

AA2(9-12): I can assess my past successes and mistakes to change my approach. ● Use the actionable feedback on the Paper Towel Lab to enhance performance on the Separating a Mixture Lab ● Measurement Lab
Teacher Resources: Flinn Safety Laboratory video, Safety Contract & Assessment, Kendall Hunt Chemistry Textbook.Formula + Reference Sheets, Conclusion Writing Guide

Unit 2 - Light & the Periodic Table

Desired Results - Students will use the periodic table to predict properties of elements.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
NGSS Standards:
HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS4-1 - Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media
HS-PS4-3 - Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other
HS-PS-4-4 - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter
HS-ESS1-3 - Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
- TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

Understandings: Students will understand that...	**Essential Questions:**
• Electrons are arranged in atoms according to rules governing electron configuration. • atoms produce characteristic colors of light due to unique electron transitions.	• Why do elements and compounds produce different colors when ignited? • How is an elements' properties related to its position on the periodic table?

• Wavelength and frequency determine types of electromagnetic radiation. • the position of an element on the periodic table gives us information about its chemical and physical properties.	
Students will know… • the energy of light can be calculated using E = hv. • the wavelength and frequency of light can be calculated using c = λv. • every element and compound produces characteristic light when ignited that can be used to identify that element or compound. • the rules that govern where electrons exist in an atom. (2 electrons per orbital; electrons fill orbitals lowest in energy first; electrons sharing the same orbital will have opposite spins; electrons will fill separate orbitals before pairing) • periodic trends are all a result of the attraction between the nucleus and valence electrons.	**Students will be able to…** • explain and predict the arrangement of electrons in an atom. • use flame tests or electromagnetic spectra as a way of identifying elements. • predict chemical and physical properties of elements based on their position on the periodic table. • explain the why behind the periodic trends. • explain the relationship between frequency, wavelength and frequency of light.
Key Vocabulary: flame test, electron configuration, ionization energy, electronegativity, atomic radius, atomic orbital, wavelength, frequency, emission spectra, alkali metal, alkali earth metal, transition metal, halogen, noble gas	
Assessment Evidence	

Performance Tasks:
• The Periodic Table: It's in the Cards
    ○ Students will use their knowledge of electron structure, atomic number, effective nuclear charge, and periodic trends to create their own periodic table using only the properties of each element.
• Flame Tests Lab
    ○ Students will investigate the characteristic colors elements produce when heated or when electricity is applied to them.
	Other Evidence:
	• Structure of the Periodic Table and Periodic Trends POGIL
	• Periodic Trends Worksheet
	    ○ Periodic Trends Worksheet #2
	• Electron Configuration POGIL
	• Electron Configuration Worksheet
	• Wave nature of light POGIL
	• Electromagnetic Spectrum Calculations Worksheet
	• How Sunglasses Work Reading
	• Unit Test

Learning Plan	

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Use electron configurations to explain the electronic structure of atoms
- Use wavelength and frequency to determine characteristics types of light

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain how an elements' position on the periodic table is related to its' radius, electronegativity and ionization energy

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

- Calculated the wavelength, frequency and energy of electromagnetic radiation

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

- Use spectroscopes to measure the wavelength and color of emission spectra

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

- Use an elements position on the Periodic Table to predict its atomic radius, electronegativity or ionization energy
- Graphically analyze atomic number vs. atomic radius, electronegativity and ionization energy

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

- Use electron configurations to determine an element's amount of valence electrons
- Determine characteristic properties of groups of elements on the periodic table

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

- Use Coulomb's Law to explain periodic trends

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

- Calculate the wavelength, frequency and energy of electromagnetic radiation
- Use wavelength and frequency to determine characteristics types of light

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

- Analyze how elements produce characteristic colors and types of light

HS-PS-4-4 - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter

- Correlate wavelength and frequency to the type of electromagnetic radiation
- Discuss the practical applications of the various types of electromagnetic radiation

HS-ESS1-3 - Communicate scientific ideas about the way stars, over their life cycle, produce elements.

- Use emission spectra to determine the composition of stars

VOL Common Assessments:

THINK CRITICALLY AND CREATIVELY TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life. ● Flame test lab relates to the composition of stars and the effects of electromagnetic radiation COLLABORATE AND COMMUNICATE EFFECTIVELY CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products. ● It's in the Cards group activity
Teacher Resources: POGIL assignments, Kendall Hunt Textbook, teachengineering.org, Formula + Reference Sheets, Conclusion Writing Guide

Unit 3 - Structure of Matter: The Atom, Bonding & Nuclear Energy	
Desired Results - Students will use the Periodic Table to determine with structure of atoms.	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS-1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms HS-PS1-8 - Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. ● TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.	
Understandings: Students will understand that… ● atomic number, number of subatomic particles and mass number are related to the location of an element on the periodic table. ● atoms bond to complete their valence shell of electrons. ● chemical and physical properties of compounds are related to how the atoms are bonded. ● Nuclear energy does not produce greenhouse gasses, and therefore does not contribute to climate change.	**Essential Questions:** ● How does the structure of matter affect the properties and the uses of materials? ● How do science and technology affect the quality of our lives? ● What is the role of nuclear energy in our world?

● Certain isotopes of elements are radioactive, which have practical medical and technological applications.	
Students will know… ● the properties related to the three types of bonding. (ionic, covalent & metallic) ● how to use the subatomic particle makeup of an atom to determine mass number, atomic number, identity of an element and ionic charge. ● the difference between fission and fusion. ● how nuclear half-life is determined. ● Average atomic mass can be calculated using: Average Atomic Mass = (mass isotope)(%/100) + (mass isotope)(%/100) + …. ● Atoms react with one another to form new molecules or formula units based on how their valence electrons are shared or exchanged.	**Students will be able to…** ● determine whether various elements will react with each other covalently, ionically or metallically. ● determine the properties of a compound based on the elements involved in the formula. ● calculate mass number, atomic number, ionic charge using the number of subatomic particles of a particular element. ● calculate average atomic mass of an element, given the percent abundance of its various isotopes. (Honors only: calculate percent abundance of the various isotopes if given the average atomic mass). ● calculate the amount of radioactive substance that remains after a given period of time.
Key Vocabulary: Electrons, protons, neutrons, nucleus, atomic number, mass number, isotope, atomic mass, atomic mass unit, atom, molecule, molecular compounds, ionic compound, ions, cation, anions, chemical formula, formula unit, ionic bonds, covalent bonds & metallic bond, valence electrons	
Assessment Evidence	
Performance Tasks: ● Beanium Lab ○ Students will use lab data to simulate calculations of average atomic mass ● Types on Compounds Simulation ○ Students will investigate the properties of ionic, polar covalent and nonpolar covalent compounds ● Alpha Decay Simulation ● Beta Decay Simulation ● Future of Nuclear Power Discussion Response ○ Students will reflect on their previous understanding of climate change and their new understanding of nuclear energy to discuss the future of energy production.	**Other Evidence:** ● Atomic structure and Structure of the Periodic Table Worksheet ● Nuclear Reactions Worksheet ● Nuclear Reactions Video and Viewing Guide ● Pro/Con of Nuclear Power Debate ● Calculating Average Atomic Mass Worksheet ● Unit Quiz
Learning Plan	

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Use percent abundance and mass to determine the average atomic mass of an element

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain how to use data to determine the type of bonding in a compound

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

- Use mass and percent abundance of a fictitious element to determine that elements' average atomic mass
- Use average atomic mass and mass of isotopes to determine the percent abundance of each isotope (Honors Only)
- Use proton, neutron and electron data to determine the half life and type of nuclear decay of an element

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

- Accurately measure the mass and percent abundance of the fictitious element beanium

HS-PS-1-1 - 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

- Use the periodic table to predict the type of bonding between 2 elements

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

- Use simulation data to determine half life and type of nuclear decay

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

- Use data to determine the type of bonding between atoms

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

- Relate the type of bonding to the physical properties of compounds

VOL Common Assessment:
THINK CRITICALLY AND CREATIVELY
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Beanium Lab
- Types of Compounds Simulation
- Alpha/Beta Decay Simulations

COLLABORATE AND COMMUNICATE EFFECTIVELY
CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

- Future of Nuclear Power Discussion Response

Teacher Resources: Kendall Hunt Textbook, pHet.org, nuclear power CNBC video, nuclear technology CNBC video, Formula + Reference Sheets, Conclusion Writing Guide

Unit 4 - Bonding & Molecular Structure

Desired Results - Students will create and understand the 3D structure of compounds.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
NGSS Standards:
HS-PS-1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products

Understandings: Students will understand that… • the physical and chemical properties of substances is related to how atoms are bonded • atoms arrange themselves in compounds to minimize repulsion between electrons, but maximize attraction between neighboring atoms and compounds.	**Essential Questions:** • How do atoms bond and how can we predict the type of bond that will form? • How do atoms arrange themselves in 3-D space when they bond? • What do ionic, metallic and covalent compounds look like on a microscopic level?
Students will know... • bonding electrons arrange themselves in 3D space to minimize repulsion between them. • electronegativity differences and average electronegativity values determine if bonds are nonpolar, polar, metallic or ionic.	**Students will be able to…** • predict the type of bonding present between two atoms in a binary compound based on position in the periodic table and the electronegativity of the elements.

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- the strength of ionic bonds is related to the size of the ions and their charge.
- electrons are transferred to form ionic bonds; electrons and shared to form covalent bonds; electrons are shared in a “sea of electrons” to form metallic bonds.
- bonds form so that atoms will have 8 electrons in their valence shell.
- ionic compounds tend to dissolve in water, have high melting and boiling points, and conduct electricity when dissolved in water or as a liquid.
- nonpolar covalent compounds do not dissolve in water, do not conduct electricity and have low melting and boiling points.
- polar covalent compounds dissolve in water, do not conduct electricity and have medium melting and boiling points.
- metallic compounds do not dissolve in water, conduct electricity and have a variety of melting and boiling points.

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- use Lewis dot structures and VSEPR theory to predict the geometry of molecules and make predictions about molecular polarity, shape and bond angles.
    - Bond Angle and Shape Names (Honors Only)
- describe the relationships between the properties of polar and nonpolar molecules and the forces of attraction between the particles.
- explain the properties of ionic compounds.
- explain the properties (phase, vapor pressure, viscosity, etc.) of small and large molecular compounds in terms of the strengths and types of intermolecular forces.
- predict bond types based on physical and chemical properties.
- build covalent molecules using model kits and draw them in 3-D space.

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Key Vocabulary: Lewis Dot Structures, VSEPR theory, octet rule, bond polarity, molecular polarity, intermolecular forces, solubility, surface tension, boiling point, conductivity, polar, nonpolar, London Dispersion Forces, dipole-dipole forces, hydrogen bonding, resonance

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Assessment Evidence

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Performance Tasks:

- Lewis Dot Structure Puzzle Activity
- Molecular Modeling Activity
    - Students will first draw correct Lewis dot structures. They will then build those compounds using a molecular model kit and describe their shape and bond angles.
- IMFs and Properties Activity
    - Students will investigate how intermolecular properties affect the physical properties of substances

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Other Evidence:

- Lewis Dot Structure Worksheets
- Molecular Geometry POGIL
- IMFs Worksheet
- Polarity, IMFs, and Boiling Point activity
- Unit Test

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Learning Plan

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Curricula Calendars:

- College Prep Chemistry Calendar
- Honors Chemistry Calendar

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RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Students will accurately draw molecules as a representation of their structure in 3D space

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Students will explain the properties of covalent compounds related to their 3D structure

HS-PS-1-1 - 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

- Students will use the periodic table to predict the number of valence electrons of each element in a compound, and will then use those valence electrons to draw 3D models of compounds

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

- Students will use data to predict the type of attractions or bonding between atoms and will use their 3D models to predict properties

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

- Students will use data to predict the type of attractions or bonding between atoms and will use their 3D models to predict properties

VOL Common Assessment:

COMMUNICATE AND COLLABORATE EFFECTIVELY

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

- Unit Test - students will have developed throughout the unit

CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products

- Lewis Dot Structure Puzzle Activity
- Molecular Modeling Activity
- IMFs and Properties Activity

Teacher Resources: Kendall Hunt Textbook, POGIL, Formula + Reference Sheets, Conclusion Writing Guide

Unit 5 - Formula Writing, Naming Compounds

Desired Results - Students will write the formulas and names of compounds.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
NGSS Standards:
HS-PS1-1- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
- P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.
- P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.

Understandings: Students will understand that…
- atoms react with one another to form new molecules.

Essential Questions:
- How are formulas of compounds created and what do they tell you about the properties of the substance?

Students will know…
- the rules of naming ionic compounds.
- how to balance the charges of ions to create the proper ionic compound formula.
- the rules of naming covalent compounds.
- how to use the name of a covalent compound to write the correct formula.
- the rules of naming acids.

Students will be able to…
- translate the formula of an ionic compound into the name.
- construct the correct chemical formula from the name of a given ionic compound.
- translate the formula of a covalent compound into the name.
- construct the correct chemical formula from the name of a given covalent compound.
- translate the formula of an acid into the name.

<table>
<tr><td>how to use the name of an acid to develop the formula for the acid.</td><td>construct the correct chemical formula from the name of a given acid.</td></tr>
<tr><td colspan="2">Key Vocabulary: Polyatomic ion, acid, base, anion, cation, prefix, formula unit</td></tr>
<tr><th colspan="2">Assessment Evidence</th></tr>
<tr><td>Performance Tasks:
Ion Formula Writing Kit Activity
Students will use puzzle pieces that correspond to ions to build correct ionic compounds. The sizes of the puzzle pieces correlate to the charges on those ions. When the heights of the + and - cards match, students have built a correct ionic compound.</td><td>Other Evidence:
Ionic Formula Writing Worksheet
Ionic Naming Worksheet
Covalent Formula/Naming Writing Worksheet
Acid Formula Writing/Naming Worksheet
Mixed Formulas Writing/Naming Worksheet
Unit Test
CP test indicates formula type
Honors test mixes all formula types with no indicators</td></tr>
<tr><th colspan="2">Learning Plan</th></tr>
<tr><td colspan="2">RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
Students will translate the names of compounds to their appropriate chemical formulas and translate chemical formulas to appropriate names
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
Students will explain the process of writing the formulas and names of compounds
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
Students will use the charges on ions to correctly determine the formula of ionic compounds
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
Students will use an elements position on the periodic table to determine an element's charge
Students will use a nonmetal’s position on the periodic table to predict patterns in covalent bonding
HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
Students will differentiate between the naming systems for ionic, covalent and acidic compounds
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
Students will correlate naming systems to the physical and chemical properties of those compounds</td></tr>
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VOL Common Assessments PERSEVERANCE: P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others. ● Unit Exam: Students will be constantly assessed for mistakes throughout the unit P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges. ● Unit Exam: Students will use corrective feedback throughout the unit to find success on the unit exam ● Ionic Formula Writing Kit
Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 6 - The Mole	
Desired Results - Students will recognize the mole as the foundation of mathematics in Chemistry.	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others. ● AA2(9-12): I can assess my past successes and mistakes to change my approach	
Understandings: Students will understand that… ● Chemists use the mole to describe the amount of matter available in terms of number of particles, mass and volume ● Avogadro's number describes the amount of particles necessary to equal the mass on the periodic table. ● The percent composition or mass of each element in a compound can be used to calculate the empirical formula of that compound.	**Essential Questions:** ● How can we use data to determine the formula of a compound? ● How do Chemists calculate the amount of atoms or compounds?

Students will know…

- Avogadro's number (6.02×10^{23}) relates how many particles are required to equal the mass on the periodic table.
- The molar mass of a compound is the added masses of the relevant elements from the periodic table.
- percent composition of elements in a compound can be calculated using:
  - $\%\text{Composition} = \dfrac{\text{Mass of Element}}{\text{Mass of Compound}} \times 100$
- The empirical formula indicates the lowest whole number ratio of elements in a compound, while the molecule formula indicates the actual number of each element in a compound
- Hydrates are ionic compounds bonded to a fixed number of water molecules

Students will be able to...

- calculate formula mass, molar mass, and percent composition of elements, compounds and hydrates.
- calculate the amount of atoms within a given amount of a compound (Honors Only)
- calculate the empirical formula of an unknown compound based on the percent composition of each element found in the compound
  - and determine the identity of the molecular compound (Honors Only).

Key Vocabulary: Mole, Avogadro's number, percent composition, empirical formula, molecular formula, hydrate

Assessment Evidence

Performance Tasks:

- Mole Buffet lab
  - Students will convert measured quantities of various substances to moles, liters, and molecules using the conversions learned in the unit.
- % Composition of Sugar in Gum
- Formula of a Hydrate Lab
  - Students will calculate the formula of a hydrate by heating it and collecting mass data before and after heating it. They will discuss why only the water leaves the compound and how they can use that to determine the formula of the compound.

Other Evidence:

- Mole Calculation Worksheets
- Percent Composition Worksheets
- Empirical Formula Worksheets
- Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Use percent composition data to calculate the empirical and molecular formula of compounds

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain how to use data to calculate the empirical formula of a compound

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

- Convert between mass, atoms, molecules, formula units, volume and moles
- Convert between molecules/formula units and individual atoms in a compound (Honors Only)

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

- Accurately measure the mass of a hydrate before and after heating
- Accurately measure various quantities to convert them to moles

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.

- Describe the changes that are occurring during the heating of a hydrate

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

- Describe the changes that are occurring during the heating of a hydrate
- Use lab data to determine the percent composition of a substance

HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

- Use the mass before an after heating a hydrated compound to determine its chemical formula

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

- Explain why only the water leaves a hydrated compound when it is heated
- Explain why chewing a piece of high sugar gum allows us to determine the amount of sugar in that gum

VOL Common Assessments:
PERSEVERANCE
P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.

- Formula of a Hydrate Lab

ADAPT AND ADJUST
AA2(9-12): I can assess my past successes and mistakes to change my approach

- Mole Buffet Lab
- % Composition of Sugar in Gum Lab

Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 7 - Types of Reactions, Balancing Equations & Reaction Rates

Desired Results - Students will predict the products of balanced chemical reactions and how chemists can affect the rate of those chemical reactions.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

NGSS Standards:
HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction
HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
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.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
- DE4(9-12): I can work respectfully with all members of my community and support the needs of others.

Understandings: Students will understand that…	**Essential Questions:**
• atoms react with one another to form new molecules in predictable ways.	• How can we affect the rate of a reaction? • How can we predict the products of a chemical reaction?

• the conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. • changes in temperature, concentration and surface area can affect the rate of a reaction.	
Students will know... • the rules related to writing and balancing a chemical equation. • the forms of evidence that a chemical reaction has occurred. • how to interpret a balanced chemical equation in terms of atoms, molecules & ions. • how to classify a reaction as synthesis, decomposition, single replacement, double replacement or combustion. • whether a reaction will occur using the activity series of metals. • whether a precipitate will be formed using the solubility rules. • how to predict the products of simple chemical reactions, given the reactants. • why some ionic solids dissolve while others do not. • the factors that will increase the rate of dissolution and rate of reaction. • how combustion reactions are related to climate change.	**Students will be able to...** • write, balance, classify and interpret a chemical equation. • increase or decrease the rate of a chemical reaction by adjusting various factors. • write the net ionic equation of a precipitation reaction. • collect data and use solubility tables to predict precipitate formation. • predict the products of various chemical reactions. • interpret how environmental data on carbon dioxide levels is linked to combustion reactions
Key Vocabulary: Chemical equation, skeleton equation, products, reactants, Law of conservation of mass & matter, reaction rate, catalyst, Synthesis/Combination Reactions, Decomposition Reaction, Single Replacement Reaction, Double Replacement Reaction, precipitate, Combustion Reaction & Net Ionic equations	
Assessment Evidence	

Performance Tasks:
• Types of Reactions Lab
  ○ Students will perform several reactions and will use their observations as well as the formulas of the starting materials to predict reactions types and balanced chemical equations.
• Reaction Rate Lab
  ○ Groups of students will investigate how temperature, concentration and surface area affect the rate of
	Other Evidence:
	• Translating Word Equations Worksheet
	• Balancing Equations Game
	• Balancing Equations Worksheet
	• Types of Reactions POGIL
	• Single Replacement Reaction Worksheet
	• Double Replacement Reaction Worksheet
	• Mixed Predicting Products Worksheet
	• Unit Test

reaction. They will then share their findings with the class.	

Learning Plan
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Translate sentences describing chemical reactions into balanced chemical equations RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Write a laboratory report detailing the procedure and results of an experiment investigating how temperature, surface area and concentration affect the rate of a reaction HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays ● Use the charges of ions to help predict products of a chemical reaction HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure time, temperature, mass and volume as they relate concentration, surface area and rate of reactions 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. ● Accurately predict the formulas of compounds based on ionic charge of individual elements 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. ● Predict the products of a chemical reaction 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. ● Collaborate with peers to investigate and determine how temperature, concentration and surface area affect the rate of a reaction (Reaction Rate Lab) HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction ● Balance chemical equations HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. ● Use Coulomb's law to explain why some ionic compounds dissolve in water while others do not 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. ● Evaluate the products of combustion reactions as they relate to climate change VOL Common Assessments: COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products. ● Types of Reactions Lab DEMONSTRATE EMPATHY DE4(9-12): I can work respectfully with all members of my community and support the needs of others. ● Reaction Rate Lab
Teacher Resources: Kendall Hunt Textbook, POGIL, pHet.org, Formula + Reference Sheets, Conclusion Writing Guide

Unit 8 - Solutions, Equilibrium & Acids & Bases	
Desired Results - Students will understand the properties of solutions.	
Established Goals: **Common Core State Standards:** RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities **NGSS Standards:** HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 - Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals. ● TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.	
Understandings: Students will understand that... ● reactions shift to establish a set ratio between products and reactants even when disturbed ● solids dissolve in water and that concentration can be measured. ● solutions have properties that are different than the original solvent	**Essential Questions:** ● How do reactions respond to disturbances to the equilibrium mixture? ● How are solutes measured and how do they affect the properties of the solvent?
Students will know... ● the change in freezing point of a solution can be calculated using: $\Delta Tf = Kfmi$ ● the change in boiling point of a solution can be calculated using: $\Delta Tb = Kbmi$	**Students will be able to...** ● apply freezing point depression and boiling point elevation to real world applications.

• the concentration of a solution can be calculated using:
  • Molarity = moles solute/liters solution
  • Molality = moles solute/kg solvent
  • (%W/V) = mass solute/mL solution x 100
• chemical equilibrium occurs when a reaction and its reverse reaction proceed at the same rate.
• once equilibrium is achieved, the amount of each reactant and product remains constant, even though the reaction continues.
• Equilibrium constants relate concentrations the products to the concentration of reactants
• The equilibrium and reaction quotients are calculated for the generic reaction ($aA + bB \leftarrow\rightarrow cC + dD$) using the formula: K or Q = $\frac{[C]^c[D]^b}{[A]^a[B]^b}$
• if a reaction at equilibrium is disturbed by a change in temperature, pressure, or the concentration of one of the components, the reaction will shift its equilibrium position to counteract the effect of the disturbance.
• acids are proton donors or begin with H and have pH values less than 7.
• bases are proton acceptors or end in OH and have pH values above 7.
• pH can be calculated using: pH = -log[H+]
• solutions have a lower freezing point and higher boiling point than the original solvent.
	• Calculate the new freezing point and boiling point of a solution as compared to the freezing and boiling points of the original solution.
	• Calculate the Equilibrium Constant and Reaction Quotient of a Reaction (Honors Only if time permits)
	• Calculate the concentration of a solution in terms of molarity, molality and %(W/V)
	• calculate the pH, [H+], [OH-] and pOH of acids and bases.
	• predict how a reaction will respond to changes in temperature, pressure and amount of product or reactant.
	• identify acids and bases based on their chemical formula.
	• explain the relationship between dissolved solid, amount of solvent and concentration.
	• interpret a solubility curve.

Key Vocabulary: molarity, molality, %(W/V), Arrhenius acids and bases, Bronstead-Lowry acids and bases, freezing point depression, boiling point elevation, equilibrium, Le Chatelier's principle, saturated, unsaturated, supersaturated, solubility curve, electrolyte, nonelectrolyte, weak electrolyte, strong electrolyte, equilibrium constant, reaction quotient	
Assessment Evidence	
Performance Tasks: • Concentration Lab ○ Students will be given a solution of unknown concentration and will have to design their own experiment to determine its molarity and %(W/V).	**Other Evidence:** • Concentration Worksheet • Dilutions Worksheet • pH worksheet • Acid/Base Property Worksheet

● Using Colligative Properties to Make Ice Cream Lab ● LeChatelier Principle Online Lab ○ Online Lab Handout ○ Students will investigate how they can affect the contents of a reaction mixture by adding/removing reactants and products, changing the pressure of the system, and heating or cooling the reaction vessel.	● Solubility Curves Worksheet ● Colligative properties worksheet ● Equilibrium Simulation ● Equilibrium Calculations ● Calculating Q ● Unit Test

Learning Plan
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Calculate the concentration of solutions ● Calculate the pH of solutions ● Calculate the new freezing point and boiling point of a solution ● Calculate the Equilibrium Constant and Reaction Quotient for a reaction (Honors Only) RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Design and run an experiment determining the concentration of a solution HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays ● Calculate the concentration of solutions ● Calculate the pH of solutions ● Calculate the new freezing point and boiling point of a solution ● Calculate the Equilibrium Constant and Reaction Quotient for a reaction (Honors Only) ● Determine the amount of dissolved solid using a solubility curve HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure temperature, mass and volume in order to accurately calculate concentration and freezing point depression 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. ● Understand how temperature affects both the rate of dissolution and amount of dissolved solid 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. ● Understand Le Chatelier's principle is related to and affects the amount of products and reactants in a chemical reaction VOL Common Assessment THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. ● Le Chatelier Simulation ● Using Colligative Properties to Make Ice Cream Lab TAKE INITIATIVE TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals. ● Concentration Lab
Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 9 - Stoichiometry

Desired Results - Students will calculate the predicted amount of products or reactants necessary for a chemical reaction.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

NGSS Standards:
HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that…	**Essential Questions:**
• The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.	• What are the quantitative relationships in chemical reactions?
Students will know...	**Students will be able to...**
• the mass, volume, concentration and particle amount of a reactant or product in a balanced chemical equation can be used to determine the mass, volume, concentration and particle amount of another reactant or product in the same equation. • The % yield of a reaction is calculated using: ○ $\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$	• calculate the mass, molar volume or number of molecules of product that can be formed by reacting specific quantities of reactants. • calculate the percent yield of a reaction by comparing the predicted amount of product to a measured amount of product • determine the limiting and excess reactants when given known quantities of all reactants. • calculate the amount of excess reactant after a reaction has gone to completion. (Honors Only)

	• perform a titration.

Key Vocabulary: mole, Avogadro's number, molar volume, stoichiometry, limiting reactant, excess reactant, percent yield, titration, burette, indicator, equivalence point, end point, concentration, molarity

Assessment Evidence	

Performance Tasks:
• Stoichiometry Lab
  ○ Students will perform a reaction and compare their calculated expected amount of product to their measured amount of product.
• Titration of Vinegar Lab
  ○ Students will titrate an unknown concentration of solution to determine its molarity.
	Other Evidence:
	• Stoichiometry Worksheet 1
	• Stoichiometry Worksheet 2
	• Stoichiometry POGIL
	• Percent Yield Worksheet
	• Limiting Reactant Worksheet
	• Limiting Reactant POGIL
	• Solution Stoichiometry Worksheet
	• Titration Worksheet
	• Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
- Calculate the predicted amount of products
- Calculate Percent Yield
- Calculate necessary amount of reactants
- Use visual representations of chemical reactions to determine the amount of product produced and the amount of reactants that remains

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Explain the necessary steps and results of a titration

HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
- Calculate the predicted amount of products
- Calculate Percent Yield
- Calculate necessary amount of reactants

HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
- Accurately measure mass and added volume using a burette

HS-PS1-7 - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
- Calculate the predicted amount of products
- Calculate necessary amount of reactants

VOL Common Assessment: THINK CRITICALLY AND CREATIVELY TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. ● Stoichiometry Lab PERSEVERANCE P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging. ● Titration Lab
Teacher Resources: Kendall Hunt Textbook, POGIL, Formula + Reference Sheets, Conclusion Writing Guide

Unit 10 - Thermochemistry

Desired Results - Students will explain and quantify heat exchange during chemical and physical processes.

Established Goals:
Common Core State Standards:
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

NGSS Standards:
HS-PS1-4 - Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that... ● energy is conserved during all physical and chemical changes. ● heat interacts with substances differently causing them to change temperature at different rates.	**Essential Questions:** ● How is energy transferred during both chemical and physical processes? ● Why do objects absorb and/or release heat differently?
Students will know… ● energy is conserved during all chemical and physical processes; it only changes form.	**Students will be able to…**

• endothermic processes require energy; exothermic processes release energy.
• temperature does not change during a phase change because the added or released heat goes to breaking or forming intermolecular forces.
• heat flows from warmer objects to colder objects.
• specific heat describes how much heat something can absorb before it changes temperature.
• ΔH can be calculated using:
    • Hess's Law
    • $\Delta H=mC\Delta T$
    • $\Delta H = mH_{fus}$
    • $\Delta H = mH_{vap}$
    • $\Delta H = \Sigma\Delta H_f^\circ products - \Sigma\Delta H_f^\circ reactants$
    • Enthalpy stoichiometry
	• use calorimetry as a means of identifying substances or determine the quantity of heat that was transferred between the two objects.
	• use calorimetry to calculate the specific heat of a substance
	• determine the final temperature of 2 objects after a heat exchange (Honors Only)
	• determine the state of matter when given a substances pressure and temperature
	• perform mathematical calculations to determine how much heat is absorbed or released during chemical and physical processes.
	• relate change in temperature to kinetic energy.
	• explain heat transfer during phase changes vs. heating or chemical reactions.
	• relate the units of energy Joules to calories and Calories (Food Calories).

Key Vocabulary: endothermic, exothermic, specific heat, calorimetry, enthalpy, heat of fusion, heat of vaporization, Hess's Law, heats of formation, energy stoichiometry, kinetic energy, temperature, potential energy, Joules, calories, Calories, phase diagram, vapor pressure	
Assessment Evidence	

Performance Tasks:
• Food Calorimetry Lab
• Specific Heat of a Metal Lab
    ○ Students will use calorimetry to experimentally determine the specific heat of a metal. They will then compare that value to a known set of values to determine the identity of the metal.
• Heat of Fusion of Ice Lab (College Prep)
    ○ Students will experimentally determine the heat of fusion for ice when given the correct mathematical formula.
• Heat of Fusion of Ice Lab (Honors)
    ○ Students must develop their own experimental plan to determine the heat of fusion of ice.
	Other Evidence:
	• Endo/Exothermic worksheet
	• Calorimetry POGIL
	• Specific Heat and Calorimetry Worksheet
	• Energy changes during a phase change
	• More Phase Change Calculations Worksheet
	• Heat stoichiometry Worksheet
	• Hess's Law worksheet
	• Heats of Formation Worksheet
	• Which Equation do I Use Worksheet
	• Unit Test

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed	

visually or mathematically into words

- Calculate the enthalpy change during chemical and physical processes
- Use potential energy diagrams to explain heat exchange

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain how substances absorb or release heat and that that heat exchange is related to temperature change
- Explain how to calculate the heat of fusion of a solid

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

- Calculate the enthalpy of chemical and physical processes

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

- Accurately measure temperature, volume and mass to calculate heat exchange

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.

- Calculate enthalpy changes during a chemical reaction
- Use potential energy diagrams to determine if a reaction is endothermic or exothermic

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

- Use specific heat and calorimetry as an explanation for why substances do not change temperature at the same rate

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.

- Use calorimetry to calculate the specific heat or heat of fusion of materials
- Use calorimetry to calculate the amount of Calories in a known quantity of food
- Use calorimetry to calculate the final temperature of both objects after a heat exchange (Honors Only)

HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

- Use calorimetry to calculate the heat of fusion of ice
- Discuss the flaws in assuming energy is conserved during all heat exchanges as it relates to accurate experimental data

VOL Common Assessments:
TAKE INITIATIVE
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.

- Heat of Fusion of Ice Lab

THINK CRITICALLY AND CREATIVELY
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Unit Test

• Food Calorimetry Lab • Specific Heat of a Metal Lab
Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 11 - Gas Laws

Desired Results - Students will predict how gasses are affected by temperature, pressure, volume and moles of gas.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

NGSS Standards:

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.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TI3(9-12): I can formulate and investigate probing questions to further my learning.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
- TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

Understandings: Students will understand that...

- Pressure and Volume of a gas increase with increased temperature or moles of gas
- Pressure and volume of a gas are inversely related

Essential Questions:

- How do the properties of gasses change with temperature, pressure, amount of gas, and volume?
- How can we measure gasses?

Students will know…

- the total pressure of a mixture of gasses equals the sum of the pressures that each would exert if it were present alone.
- Kelvin temperature directly relates particle speed to temperature and must be used in all gas laws calculations.
- the pressure of a gas can be changed by changing the volume of the container or by changing the temperature.

Students will be able to...

- use the combined gas law to calculate the new pressure, temperature and volumes of gasses given an initial set of conditions.
- use the ideal gas law to calculate the pressure, volume, moles or temperature of a gas given the other variables.
- predict how a gas will change given changes in temperature, pressure and volume.

• pressure, volume, moles and temperature of a gas are related using the ideal gas law: PV = nRT. • the results of changes in temperature, pressure or volume of a gas can be predicted using the combined gas law: ○ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	• use a phase diagram to predict phase changes and current states of matter • use a vapor pressure curve to predict how temperature affects the rate at which a substance evaporates • calculate the molar mass and density of a gas given appropriate data (Honors Only) • explain what causes pressure • Calculate the amount of gas produced during a chemical reaction (Honors Only)
Key Vocabulary: Charles Law, Gay-Lussac's Law, Boyle's Law, combined gas law, ideal gas law, pressure, moles, partial pressure, kinetic molecular theory of gasses, Kelvin temperature, vapor pressure, phase diagram	
Assessment Evidence	

Performance Tasks:
• Charles Law Lab
• Soda Can Lab (College Prep)
    ○ Students will use the ideal gas law to experimentally determine the pressure of carbon dioxide in an unopened soda can.
• Soda Can Lab (Honors)
    ○ Students will use gas laws to experimentally determine the pressure of carbon dioxide in an unopened soda can. The Honors students must decide which formula presented in this unit is appropriate for solving the problem.
	Other Evidence:
	• Gas law simulation
	• KMT POGIL
	• Gas Behavior Worksheet
	• Gas Law Practice Problems
	• Mixed Gas Law Worksheet
	• Phase Diagram Worksheet
	• Vapor Pressure Worksheet
	• Gas law stoichiometry worksheet (Honors Only)
	• Applications of PV=nRT worksheet (Honors Only)
	• Unit Test

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words • Calculate the pressure, temperature, volume or moles of a gas given the other quantities RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes • Explain how to calculate the pressure of a gas in a closed system • Explain how temperature, pressure, volume and moles of gasses are related and affect each other HSN-Q.A.1 - Use units as a way to understand and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays	

● Interpret a vapor pressure curve ● Interpret a phase diagram ● Calculate the pressure, temperature, volume or moles of a gas given the other quantities HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure mass, volume and temperature of gasses 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. ● Predict and explain how temperature will affect the volume and pressure of a gas ● Explain how heat and pressure affect the state of matter ● Explain how temperature affects the amount and pressure of evaporated liquid VOL Common Assessment TAKE INITIATIVE TI3(9-12): I can formulate and investigate probing questions to further my learning. ● Charles Law Lab THINK CRITICALLY AND CREATIVELY TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life. ● Gas Laws Simulation COLLABORATE AND COMMUNICATE EFFECTIVELY CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products. ● Pressure Inside a Soda Can Lab
Teacher Resources: Kendall Hunt Textbook, POGIL, Formula + Reference Sheets, Conclusion Writing Guide

PSYCHOLOGY CURRICULUM

	
Grade Level(s): 10-12	**Curriculum Author(s):** Stephen Bunovsky
Course Description: This half-year course offers a comprehensive overview of the scientific study of behavior and mental processes. Students will explore key concepts, theories, and research methods in psychology, including the biological bases of behavior, learning and memory, cognition, personality, motivation and emotion, psychological disorders, therapy, and social psychology. Through engaging lessons and interactive activities, students will gain an understanding of how biological, cognitive, and social factors influence behavior, and will learn to apply psychological principles to real-world situations. By the end of the course, students will be equipped with a foundational knowledge of psychology, preparing them for further study and enhancing their understanding of human behavior.	

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner Attribute and Indicator**
Introduction/Biological Bases of Behavior	How do the structure and function of the brain and nervous system influence our thoughts, feelings, and behaviors?	The brain and nervous system play fundamental roles in shaping human behavior and cognitive processes.	TCC1(9-12), CCE1(9-12), TI1(9-12), P2(9-12)
Learning and Conditioning	What are the key principles of learning, and how do they explain changes in behavior?	Learning is a dynamic process that involves acquiring, retaining, and applying knowledge or skills, influenced by various factors such as experience, reinforcement, and memory processes.	TCC3(9-12), CCE3(9-12), TI3(9-12), P4(9-12), AA3(9-12)
Cognition and Memory	How do cognitive processes such as memory, thinking, problem-solving, and decision making influence our behavior?	Cognitive processes such as perception, memory, learning, and decision-making are fundamental to understanding human behavior and experiences.	TCC1(9-12), TCC2 (9-12) CCE1(9-12), CCE4(9-12), TI4(9-12), P2(9-12)

Motivation, Emotion, and Personality	How do different theories of personality explain the unique and stable patterns of thoughts, feelings, and behaviors in individuals?	Personality encompasses enduring patterns of thoughts, feelings, and behaviors that shape individuals' unique psychological makeup and influence their interactions with the world.	TCC4 (9-12), CCE1 (9-12), DE2 (9-12), TI2 (9-12), AA1(9-12)
Psychological Disorders and Their Treatments	What are the defining characteristics of psychological disorders, and how do they impact individuals and society?	Psychological disorders involve disruptions in cognition, emotion, and behavior that significantly impair individuals' functioning and quality of life, requiring understanding, diagnosis, and treatment.	TCC1(9-12), CCE1(9-12), TI3(9-12), TCC2(9-12), CCE4(9-12)
Social Psychology	How do social influences shape individual behavior, attitudes, and perceptions in group settings?	Social psychology mechanisms, such as conformity, obedience, and persuasion, play pivotal roles in shaping individuals' behaviors,attitudes, and beliefs within social contexts.	TCC3(9-12), CCE3(9-12), TI3(9-12), P4(9-12), AA3(9-12)

(adapted from Wiggins, G. & McTighe, J. (2005). Understanding by Design (2nd Edition). ASCD.)

Unit 1 - Introduction/Biological Bases of Behavior

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
Connecticut Secondary Social Studies Frameworks

- **INQ 9-12.1** Explain how a question reflects an enduring issue in the field.
- **INQ 9-12.2** Explain points of agreement and disagreement experts have about interpretations and applications of disciplinary concepts and ideas associated with a compelling question.
- **INQ 9-12.15** Use disciplinary and interdisciplinary lenses to understand the characteristics and causes of local, regional, and global problems; instances of such problems in multiple contexts; and challenges and opportunities faced by those trying to address these problems over time and place.

Common Core Standards

- **CCSS.ELA-Literacy.RH.9-10.7:** Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
- **CCSS.ELA-Literacy.RH.11-12.7:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.
- AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that… ● Psychologists use several perspectives and research methods to help explain human behavior and mental processes. ● Human behavior and mental processes are simultaneously biological, psychological, and social phenomena.	**Essential Questions:** ● How do the major perspectives in psychology help us understand human behavior and mental processes? ● How do the structure and function of the brain and nervous system influence our thoughts, feelings, and behaviors?
Students will know... ● The definition of psychology and its terms and concepts. ● The major perspectives in psychology (biological, cognitive, behavioral, psychodynamic, humanistic). ● Common research methods used in psychology. ● The parts of a neuron and their functions. ● Major brain structures and their functions. ● The central and peripheral nervous systems. ● The role of neurotransmitters.	**Students will be able to...** ● Explain the importance of different perspectives in psychology. ● Compare and contrast various research methods. ● Label the parts of the neuron and their functions. ● Identify major brain structures and their functions. ● Recognize the role of neurotransmitters.
Key Vocabulary: psychology, behavior, mental processes, biopsychosocial model, neuron, neurotransmitter, central and peripheral nervous systems, synapse, action potential, brainstem, cerebral cortex, limbic system, neuroplasticity	
Assessment Evidence	
Performance Tasks: Zombie Brain Project: **AA1, TCC1, CCE1, TI1, P2** Superhero Brain Project **AA1, TCC1, CCE1, TI1, P2**	**Other Evidence:** Interim options include: ● Writing prompt: What's Wrong With This Study?, ● Quiz or Poster Design: Neurons and Neurotransmitters ● Socratic Seminar on an essential question from this unit. **AA1, TCC1, CCE1, TI1, P2**

Learning Plan
Content-Based Vocabulary Assessment **P2** Experiment Analysis/Troubleshooting **P2** Formative assessment: Quiz on brain structures. **P2** Lecture and Direct Instruction **CCE1** Discussion and Socratic Seminar **CCE1** Projects and Presentations: Zombie Brain Project and/or Superheroes Project **AA1, CCE1**
Teacher Resources: *Psychology: Principles in Practice,* 40 Studies That Changed Psychology, DVD: *The Secret Life of the Brain,* Newsela

Unit 2 - Learning and Conditioning

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Connecticut Secondary Social Studies Frameworks

- **INQ 9-12.12** Present adaptations of arguments and explanations that feature evocative ideas and perspectives on issues and topics to reach a range of audiences and venues outside the classroom using print and oral technologies and digital technologies.
- **INQ 9-12.15** Use disciplinary and interdisciplinary lenses to understand the characteristics and causes of local, regional, and global problems; instances of such problems in multiple contexts; and challenges and opportunities faced by those trying to address these problems over time and place.

Common Core Standards

- **CCSS.ELA-Literacy.RH.9-10.7:** Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
- **CCSS.ELA-Literacy.RH.11-12.9:** Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
- **CCSS.ELA-Literacy.RH.9-10.9:** Compare and contrast treatments of the same topic in several primary and secondary sources.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

- **TCC3(9-12)**: I can integrate relevant information to produce multiple valid solutions.
- **CCE3(9-12)**: I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
- **TI3(9-12)**: I can formulate and investigate probing questions to further my learning.
- **P4(9-12)**: I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.
- **AA3(9-12)**: I can adjust my expectations and behaviors to succeed in a changing and unpredictable environment.

Understandings:

- The basics of classical and operant conditioning explain how we learn through association (like Pavlov's dogs) and through rewards and punishments (like Skinner's behavioral experiments).
- Learning principles apply to everyday life, such as forming habits, changing behaviors, and understanding influences like advertising.

Essential Questions:

- What are the key principles of learning, and how do they explain changes in behavior?
- How can the principles of learning be applied in real-life situations to help people?

Students will know...

- The difference between classical and operant conditioning
- Key concepts in classical conditioning
- The principles of operant conditioning
- The processes of observational learning
- Cognitive factors in learning

Students will be able to...

- Explain how classical conditioning works using examples.
- Discuss the principles of operant conditioning with real-life application
- Compare positive and negative reinforcement
- Analyze the impact of observational learning on behavior
- Interpret the role of cognitive processes in learning

Key Vocabulary: learning, classical conditioning, operant conditioning, reinforcement, punishment, observational learning, extinction, spontaneous recovery, generalization, discrimination

<table>
<tr><th colspan="2">Assessment Evidence</th></tr>
<tr><td>Performance Tasks:

Options can include:
Behavior Modification Project - Students will design a theoretical behavior modification plan using principles of learning and conditioning. They will document the process and likely outcomes, and present their findings in a comprehensive report. Behavior Modification Project
Experiment/Commercial Design Experiment Design (for lower-ability students) Create a commercial
TCC3, CCE3, TI3, P4, AA3</td><td>Other Evidence:

Options include:
Socratic Seminar - What have Pavlov, Watson, and Bandura taught us about learning?
Quiz - positive/negative reinforcement and/or reinforcement schedules
Writing Prompt: How do casinos use classical and operant conditioning to take your money?
TCC3, CCE3, TI3, P4, AA3</td></tr>
<tr><th colspan="2">Learning Plan</th></tr>
<tr><td colspan="2">Content-Based Vocabulary Assessment P2
Experiment Design P2
Formative assessment: Quiz on Reinforcement Schedules P2
Lecture and Direct Instruction CCE4
Discussion and Socratic Seminar CCE4</td></tr>
<tr><td colspan="2">Teacher Resources: Psychology: Principles in Practice, 40 Studies That Changed Psychology, Newsela</td></tr>
</table>

Unit 3 - Cognition and Memory

Desired Results - Goals, Transfer, Meaning, Acquisition
Established Goals: **Connecticut Secondary Social Studies Frameworks** ● **INQ 9-12.11** Construct explanations using sound reasoning, correct sequence (linear or nonlinear), examples, and details with significant and pertinent information from data, while acknowledging the strengths and weaknesses of the explanation given its purpose. ● **INQ 9-12.8** Identify evidence that draws information directly and substantively from from multiple sources to detect inconsistencies in evidence in order to revise or strengthen claims. **Common Core Standards** ● **CCSS.ELA-Literacy.RH.11-12.9:** Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources. ● **CCSS.ELA-Literacy.RH.9-10.1:** Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information. ● **CCSS.ELA-Literacy.RH.9-10.5:** Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.
Vision of A Learner Attributes: Students will be able to independently use their learning to... ● **TCC1:** Ask questions and engage in problem solving. ● **TCC2:** Analyze data and resources from multiple perspectives. ● **CCE1:** Engage others in meaningful conversations while respecting multiple perspectives. ● **CCE4:** Express ideas in a variety of ways, according to context, purpose, and audience. ● **TI4:** Reflect to understand oneself, anticipate challenges, and drive self-improvement. ● **P2:** I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.

Understandings: Students will understand that... ● Memory is a complex and dynamic process involving encoding, storage, and retrieval. ● Cognition encompasses a variety of mental processes including perception, thinking, problem-solving, and decision-making	**Essential Questions:** ● How do cognitive processes and memory systems influence our perception, learning, and decision-making? ● What factors influence the accuracy and reliability of our memories and cognitive processes?
Students will know... ● Key concepts and terminology (e.g., encoding, storage, retrieval, cognitive biases). ● Prominent memory models and theories ● Factors influencing memory accuracy and reliability (e.g., attention, emotions, context). ● Types of memory (e.g., sensory, short-term, long-term, episodic, semantic). ● Applications of cognitive psychology in real-world contexts (e.g., improving memory, understanding biases). ● Sleep stages and common sleep disorders ● The importance of REM sleep and its relationship with memory and learning abstract tasks.	**Students will be able to...** ● Analyze and evaluate memory models and cognitive theories. ● Design and conduct simple experiments on memory and cognition. ● Apply cognitive strategies to enhance personal learning and decision-making. ● Reflect on and improve their own cognitive processes and memory strategies. ● Communicate findings and collaborate effectively with peers.
Key Vocabulary: cognition, heuristics, biases, algorithm, concept, creativity, intelligence, memory, encoding, storage, retrieval, short-term memory, long-term memory, working memory	
Assessment Evidence	
Performance Tasks: Options can include: ● Cognitive Process Portfolio Cognitive Process Portfolio or Poster **TCC3** ● Cognition Expo Project Cognition Expo Project **TI3**	**Other Evidence:** Options can include: ● Cognitive Bias Reflection Prompt ● Socratic Seminar: Should we trust our memories? ● Writing Prompt on Clive Wearing ● Dream journals (for a week) **TCC1, TCC2, CCE1, CCE4, TI4, P2**

Learning Plan
- Content-Based Vocabulary Assessment **P2**   - Formative assessment on Casinos **TCC1**   - Lecture and Direct Instruction **CCE4**   - Discussion and Socratic Seminar **CCE4**
Teacher Resources: *Psychology: Principles in Practice,* 40 Studies That Changed Psychology, Edpuzzle documentary on Clive Wearing, Newsela

Unit 4 - Motivation, Emotion and Personality

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Connecticut Secondary Social Studies Frameworks:

- INQ 9–12.1 Explain how a question reflects an enduring issue in the field.
- INQ 9–12.2 Explain points of agreement and disagreement experts have about interpretations and applications of disciplinary concepts and ideas associated with a compelling question.

Common Core Standards:

- **CCSS.ELA-Literacy.RH.11-12.2:** Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
- **CCSS.ELA-Literacy.RH.9-10.4:** Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

- **CCSS.ELA-Literacy.RH.11-12.9:** Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

- TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
- CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
- DE2(9-12): I can honor my own feelings and show empathy toward others through my actions.
- TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.
- AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...	**Essential Questions:**
• Emotions are complex and result from both physiological reaction and sometimes cognitive interpretations of situations. • Personality has roots in both nature and nurture.	• How do different theories of motivation explain human behavior, and what factors influence an individual's motivation in various contexts? • In what ways do emotions and personality traits shape an individual's experiences and interactions, and how can understanding these concepts improve personal and social well-being?
Students will know... • Major theories of motivation • Major theories of emotion • The brain regions involved in emotion • The sympathetic nervous system's role in emotion • The trait theory of personality (esp. Big 5 personality dimensions) • The role of nature vs. nurture in personality development	**Students will be able to...** • Explain and differentiate between major theories of motivation, emotion, and personality • Conduct research on psychological topics, including finding credible sources, synthesizing information, and presenting findings. • Write structured essays that discuss psychological concepts, support arguments with evidence, and demonstrate understanding of the subject matter. • Create and deliver presentations on psychological topics, effectively communicating ideas to an audience. • Interpret and analyze data from psychological studies,

	understanding research methods, and drawing informed conclusions from empirical evidence
Key Vocabulary: motivation, drive, homeostasis, intrinsic motivation, extrinsic motivation, emotion, arousal, James-Lange Theory, Cannon-Bard Theory, Two-Factor Theory, personality, trait theory, temperament, Big 5 Personality Dimensions, psychodynamic personality theory	
Assessment Evidence	
Performance Tasks: Summative Options: ● Essay: Big 5 Self-Assessment Reflective Essay Self-Assessment Using the Big 5 ● Reflective Essay: Motivation, Emotion, and Personality Reflective Essay: Motivation, Emotion, and Personality **TCC4**	**Other Evidence:** Interim options can include: ● Myers-Briggs Type Indicator Activity ● TAT-style writing response ● Reflection: The Hero's Journey Reflection: The Hero's Journey ● Writing Prompt: What motivates me? **TCC4**
Learning Plan	
Quizzes: 1.Motivation/Emotion and 2. Personality Theories **AA1** **Exit Tickets**: To check for understanding of key terms and concepts **TCC4** **Think-Pair-Share**: Students can reflect and discuss how their experiences can be explained by the unit's major theories **CCE1** **Socratic Seminar/Class Discussions**: The role of nature/nurture in personality development - "How did you become you?" **DE2, CCE1** **Self and Peer Assessments**: Using the Big 5 Personality Dimensions **CCE1, TI2**	
Teacher Resources: Open source simulations of major personality tests, *Psychology: Principles in Practice,* 40 Studies That Changed Psychology, Newsela	

Unit 5 - Psychological Disorders and Their Treatments

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Connecticut Secondary Social Studies Frameworks:

- **INQ 9–12.3** Explain points of agreement and disagreement experts have about interpretations and applications of disciplinary concepts and ideas associated with a supporting question.
- **INQ 9–12.4** Explain how supporting questions contribute to an inquiry and how, through engaging source work, new compelling and supporting questions emerge.

Common Core Standards:

- **CCSS.ELA-Literacy.RH.11-12.9:** Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
- **CCSS.ELA-Literacy.RH.11-12.7:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
- **CCSS.ELA-Literacy.RH.11-12.5:** Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

- **TCC1(9-12)**: I can ask purposeful, insightful questions to find a variety of innovative solutions.
- **TCC2(9-12)**: I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
- **CCE1(9-12)**: I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
- **CCE4(9-12)**: I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.
- **TI3(9-12)**: I can formulate and investigate probing questions to further my learning.

<table>
<tr><td>Understandings: Students will understand that...
Students will understand that psychological disorders are complex conditions with varying symptoms, causes, and impacts, and that they can affect individuals differently depending on a range of biological, psychological, and social factors.
Students will understand that there are multiple approaches to treating psychological disorders, including psychotherapy, medication, and lifestyle changes, and that effective treatment often requires a personalized, multi-faceted approach tailored to the individual's specific needs and circumstances.</td><td>Essential Questions:
What are the major psychological disorders, and how do their symptoms, causes, and impacts vary among individuals?
What treatment options are available for psychological disorders, and how do different therapeutic approaches address the diverse needs of individuals?</td></tr>
<tr><td>Students will know...
The criteria for abnormal behavior
The major categories and treatments of psychological disorders
The causes and symptoms of major psychological disorders
Ethical issues in treatment
The effectiveness of various treatment approaches</td><td>Students will be able to...
Identify and describe major psychological disorders and their symptoms.
Explain the potential causes of psychological disorders, including biological, psychological, and social factors.
Compare and contrast different treatment approaches for psychological disorders
Analyze case studies to determine appropriate diagnoses and suggest potential treatment plans.
Evaluate the effectiveness of various treatments based on research and evidence, considering factors such as side effects, accessibility, and individual differences.</td></tr>
<tr><td colspan="2">Key Vocabulary: psychological disorder, anxiety disorder, mood disorder, schizophrenia, personality disorder, obsessive-compulsive disorder, post-traumatic stress disorder, diagnosis, DSM-5, stigma, labeling, psychotherapy, cognitive-behavioral therapy, psychoanalysis, group therapy, humanistic therapy, biomedical therapy, medication, electroconvulsive therapy (ECT), effectiveness, Therapeutic Alliance</td></tr>
</table>

<table>
<tr><th colspan="2">Assessment Evidence</th></tr>
<tr><td>Performance Tasks:
● Inquiry Research Project/Presentation on a psychological disorder of student's choice. Inquiry Research ProjectTI3, CCE4, TCC1, TCC2, CCE1</td><td>Interim ideas can include:
● Socratic Seminar - The negative effects of "labeling"TCC1, CCE4, CCE1
● Writing Prompt - Why do you think teens are increasingly affected by anxiety and depression?TCC1, CCE4</td></tr>
<tr><th colspan="2">Learning Plan</th></tr>
<tr><td colspan="2">Exit Tickets/Think-Pair-Share: Use on a daily basis to check for understanding of key terms and conceptsTCC2(9-12)
Graphic Organizers: given a list of disorders, students should fill in the major classification, type of disorder, symptoms, and treatmentsTCC1(9-12)
Socratic Seminar/Class Discussions: Why do you think teens are increasingly affected by anxiety and depression?CCE4(9-12), TI3(9-12):
Quick Writes: Introduce this unit's writing prompt the day before with a quick write about teens and anxiety/depression to generate ideasCCE4(9-12)</td></tr>
<tr><td colspan="2">Teacher Resources: Open sources and school databases for inquiry project, NoodleTools, Psychology: Principles in Practice, 40 Studies That Changed Psychology, Newsela, Video: Back from Madness, DVD: Depression: Out of the Shadows, DVD: A Beautiful Mind</td></tr>
</table>

Unit 6 - Social Psychology
Desired Results - Goals, Transfer, Meaning, Acquisition
Established Goals: **Connecticut Secondary Social Studies Frameworks:** ● **INQ 9–12.1** Explain how a question reflects an enduring issue in the field. ● **INQ 9–12.2** Explain points of agreement and disagreement experts have about interpretations and applications of disciplinary concepts and ideas associated with a compelling question. **Common Core Standards:** ● **CCSS.ELA-Literacy.RH.9-10.1:** Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information. ● **CCSS.ELA-Literacy.RH.9-10.3:** Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them. ● **CCSS.ELA-Literacy.RH.11-12.5:** Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.
Vision of A Learner Attributes: Students will be able to independently use their learning to... ● TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions. ● TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. ● TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life. ● CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. ● CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

<table>
<tr><td>Understandings: Students will understand that...
People’s behavior is heavily influenced by social factors such as conformity, compliance, and obedience.
Our perceptions and interpretations of ourselves and others in social situations shape our behavior and judgements.</td><td>Essential Questions:
To what extent do social situations influence our behavior and mental processes?
How do ethics in human experimentation limit what psychologists were able to do in the past, and is what we learned worth the cost?</td></tr>
<tr><td>Students will know...
Key principles of group behavior
Factors that influence interpersonal relationships (attraction, aggression, prosocial behavior)
The causes of prejudice and discrimination
The impact of social influences on behavior
Principle of group behavior (conformity, obedience, group dynamics)</td><td>Students will be able to...
Identify and describe major experiments in social psychology.
Explain the potential psychological and social factors that influenced participant’s behaviors in famous experiments.
Compare and contrast the validity of different psychological experiments
Analyze the causes of prejudice and discrimination
Evaluate the ethical considerations of experiments in social psychology.</td></tr>
<tr><td colspan="2">Key Vocabulary: social psychology, conformity, obedience, group dynamics, social loafing, social facilitation, prejudice, discrimination, attribution theory, cognitive dissonance</td></tr>
<tr><td colspan="2" align="center">Assessment Evidence</td></tr>
<tr><td>Performance Tasks:
Social Psychology Portfolio: Students will create a portfolio that demonstrates their understanding of key social psychology concepts through a variety of reflective and analytical tasks.
Social Psychology in the News Social Psychology in the News

TCC3, CCE3, TI3, P4, AA3</td><td>Other Evidence:
Socratic Seminar - pertaining to what we learned from famous experiments in social psychology or the ethics of famous experiments in social psychology Social Psychology Socratic Seminar CCE1
Writing Prompt: Explain what each of the major experiments in social psychology tells us about either conformity or obedience to authority. Use examples from real life to support your answers. Social Psychology Writing Prompt CCE4</td></tr>
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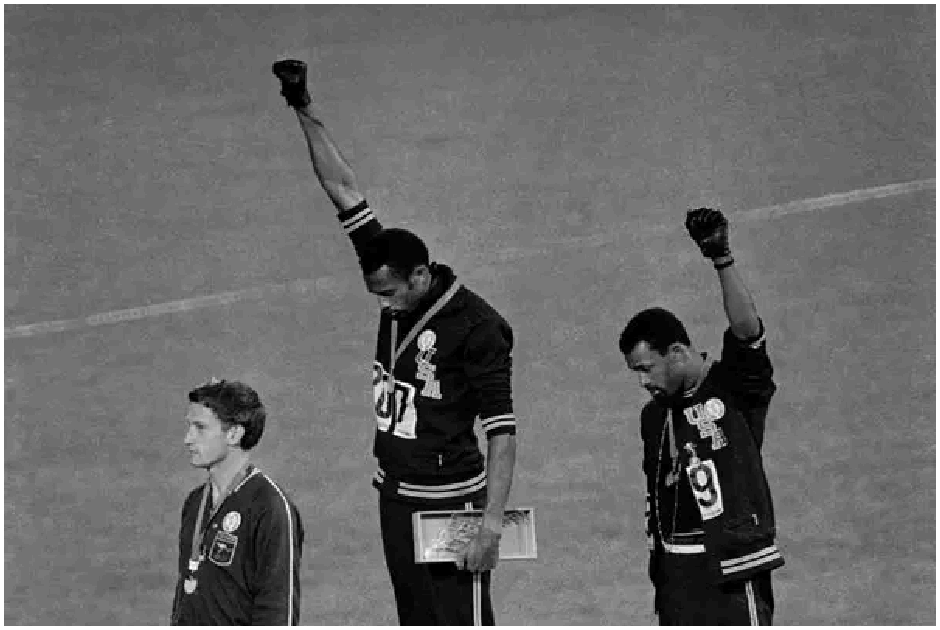
Learning Plan
Quizzes: Short, frequent quizzes to check for understanding of key concepts and theories related to the current unit of study.**TCC2(9-12)** **Exit Tickets**: Check for understanding of terms and concepts at the end of lessons.**TCC2(9-12)** **Think-Pair-Share**: Utilize with key vocabulary to ask students to think of real-life examples of terms and concepts. Ex. What are ways that prejudice and discrimination are taught? **CCE1(9-12**) **Socratic Seminar/Class Discussions**: Do the benefits of famous experiments in social psychology outweigh the costs?**CCE1(9-12. CCE4(9-12)** **Quick Writes**: Ask students what were the major take-aways from famous experiments in social psychology.**CCE1(9-12**
Teacher Resources: Open sources and school databases, NoodleTools, *Psychology: Principles in Practice,* Edpuzzle Original Footage of *Stanford Prison/Milgram's Shock Experiment/Asch's Conformity Experiment*, 40 Studies That Changed Psychology, Newsela

UCONN ECE CONTEMPORARY ISSUES IN SPORT CURRICULUM



Grade Level(s): 10-12	**Curriculum Author(s):** Kyle Brennan

Course Description: Contemporary Issues in Sport is a half-year class that explores the socio-cultural, economic, and political issues in sport. It analyzes sport as a social institution and evaluates the impact of sport in American culture. Topics in this multidisciplinary study include sports' intersection with social issues, economics, psychology, politics, law, history, geography, media studies, and science. Students will be challenged to take initiative by organizing the inquiry process from start to finish — identifying interests, developing questions, performing research, critically analyzing sources, engaging in discussions, and reflecting upon multiple perspectives. Students will be able to obtain college credits through the University of Connecticut's Early College Experience program. *Credit Type: Humanities, .5 Credit*

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner “I Can” Statements**
Sports, Culture, and Nationalism	To what extent do sports reflect and/or influence cultural values?	Sports can reflect societies by allowing for common cultural experiences and creating a sense of belonging, whether in a small group, a whole nation, or all of humanity.	TCC2(9-12), CCE4, DE4, TI2(9-12), P2, AA2(9-12)
Sports and Social Issues	Should athletes use their platforms to speak out on social and political issues?	Athletes have used their platforms to speak out on social and political issues to various degrees since the 1950s, generating both controversy and change.	CCE1, DE2, TI3(9-12), P2, AA2(9-12)
Sports and Economics	What is the most significant economic issue in the sports world, and how should it be addressed?	Economic issues in sports mirror economic issues in the rest of society, including gender pay equality, uneven distribution of income, the influence of labor unions, the growth of gambling, economic rights of college students, and government spending, all of which cause disagreements.	TCC1(9-12), CCE3(9-12), DE1, TI2(9-12), P2, AA4
Sports and an Evolving Society	Are sports changing for the better or worse?	Sports have changed drastically over the past century, going from leisure-based activities with little regulation, specialized training, or business opportunities into a highly popular, regulated, competitive, and lucrative industry with pros and cons.	TCC2(9-12), CCE4, DE1, TI3(9-12), P2, AA1

Unit 1 - Sports, Culture, and Nationalism

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Connecticut Secondary Social Studies Frameworks

- **US.Inq.3.a** Gather relevant information from multiple sources representing a wide range of views and mediums while using the origin, authority, structure, context, and corroborative value to guide the selection of credible sources.
- **US.Inq.4.a** Construct arguments using precise and knowledgeable claims, with evidence from multiple sources, while acknowledging counterclaims and evidentiary weaknesses.
- **US.His.5.b** Analyze the role of popular culture, subculture, and counterculture in shaping public perception of national identity during the post-World War II era (e.g., Beat Generation, Rock and Roll, Motown, Jazz, Hippies, television sitcoms, Hollywood films).

Common Core State Standards

- **CCSS.ELA-LITERACY.RH.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
- **CCSS.ELA-LITERACY.SL.11-12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- **CCSS.ELA-LITERACY.SL.11-12.4** Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2**
- I can express ideas in a variety of ways, according to context, purpose, and audience. **CCE4**
- I can be inclusive and help others in need. **DE4**
- I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge. **TI2**
- I can strengthen weaknesses through purposeful strategies, practice, and effort. **P2**
- I can assess my past successes and mistakes to change my approach. **AA2**

Understandings: Students will understand that... ● Sports satisfy the human instinct to play, demonstrated by people of all ages in all cultures throughout history. ● Modern sports emerged in the mid-1800s and continue to increase in popularity because of increased standards of living, the media, and their appeal to human interests. ● Sports can reflect societies by allowing for common cultural experiences and creating a sense of belonging, whether in a small group, a whole nation, or all of humanity. ● Sports can play an important role in helping people cope with both personal and national crises.	**Essential Questions:** ● To what extent do sports reflect and/or influence cultural values? ● What differentiates a game from a sport? ● Why are sports so popular? ● To what extent do sports reflect nationalism and influence international relations? ● To what extent can sports help people recover from personal and national crises?
Students will know... ● Humans play at all stages of life, from infancy to childhood to adulthood to late life, which stems from the human instinct to seek pleasure. ● All cultures have valued play throughout human history, from the Mesoamerican ballgame and Roman gladiators to American baseball and Chinese table tennis. ● Modern sports developed in the mid-1800s due to industrialization, urbanization, technology, and education, and they continue to increase in popularity because of increased accessibility, media attention, and their satisfaction of human instincts to seek pleasure and shared belonging. ● Governments historically have used sports as a propaganda vehicle, which can positively and negatively stoke nationalism, especially during global competitions such as the Olympics and the World Cup. ● Sports can play a major role in national healing from crises, such as baseball's role during World War II, the Miracle on Ice's role during the Cold War, and sports' role after the September 11 terrorist attacks.	**Students will be able to...** ● create and define criteria that make for successful, evidence-based arguments in debate, Socratic seminar, informal discussion, written, and presentation settings. ● take initiative by selecting interest-based topics, developing guiding questions, and planning steps for research and production. ● collaborate with classmates to set and achieve goals while developing leadership skills. ● critically analyze written and visual sources, considering strengths and weaknesses of the source material. ● engage respectfully in discussions, acknowledging similar and different perspectives. ● defend an argument using relevant evidence from credible sources. ● present the findings of research through clear visuals and speaking. ● ask questions to drive learning and challenge the viewpoints of others. ● discuss key people, events, and concepts related to sports, culture, and nationalism.

Key Vocabulary: Sigmund Freud; pleasure principle; culture; Mesoamerican ballgame; Roman gladiators; baseball; industrialization; communitas; crowd psychology; nationalism; the Star-Spangled Banner; globalism; transculturation; Olympics; Pierre de Coubertin; propaganda;

1936 Berlin Olympics; Adolf Hitler; Jesse Owens; World Cup; World War II; Cold War; Soviet Union; 1980 Lake Placid Winter Olympics; Miracle on Ice; September 11 terrorist attacks; Major League Baseball (MLB)

Assessment Evidence	
Performance Tasks: • **Summative:** Multimedia research presentation on a sport, explaining how it reflects and/or influences its home society. Students will have choice on the topic and format of presentation. **TCC2, TI2, CCE4, P2, AA2**	**Other Evidence:** • **Interim:** Three-group argumentative project answering the question, "Sports best helped America cope with which event: World War II, the Cold War, or 9/11?" Each group will create a set of artifacts for a gallery walk, which will be used for evidence in a three-way team debate. **TCC2, CCE4, DE4, TI2** • **Interim:** Mini-debates (one-on-one, two-on-two, etc.) on questions proposed by students and/or essential questions. **TCC2, CCE4, DE4, TI2, P2, AA2**

Learning Plan
• Teach research skills of locating and evaluating sources (CRAAP test, SOAPS, etc.), searching for and skimming through resources, and citing material **TCC2, TI2** • Develop success criteria for debates, seminars, projects, and presentations by viewing negative and positive models, considering prior experiences, etc. **AA2** • Review positive peer feedback strategies for group activities **DE4** • Reading assignments with SAT-style questions **P2** • Content-based quiz on key vocabulary and concepts **P2** • Written responses and/or discussions on videos and articles (especially those in the resources below) **CCE4** • Participation assessments (i.e. guided notes, Pear Deck, etc.) **CCE4**
Teacher Resources: *Social Issues in Sport (4th ed.)*; *Man, Play, and Games* by Roger Callois; *Citizenship in a Republic* by Theodore Roosevelt; "Calcio Storico" episode of "Home Game" series on Netflix; "First Pitch" documentary in ESPN's 30-for-30 series; "Miracle on Ice" documentary in ESPN's SportsCentury series; Franklin D. Roosevelt's "Green Light Letter" to MLB Commissioner Kenesaw Mountain Landis; United States Holocaust Memorial Museum article on the 1936 Berlin Olympics and Britannica article on Jesse Owens and Adolf Hitler; NPR article on The Star-Spangled Banner in sports; Project Syndicate articles on nationalism at the World Cup and the Olympics; course materials from "Sports and Society" by Coursera and Duke University; Nonnewaug LMC databases and resources

Unit 2 - Sports and Social Issues	
Desired Results - Goals, Transfer, Meaning, Acquisition	
Established Goals: **Connecticut Secondary Social Studies Frameworks** ● **CG.Inq.3.a** Gather relevant information from multiple sources representing a wide range of views and mediums while using the origin, authority, structure, context, and corroborative value to guide the selection of credible sources. ● **CG.Inq.4.a** Construct arguments using precise and knowledgeable claims, with evidence from multiple sources, while acknowledging counterclaims and evidentiary weaknesses. ● **US.His.2.c** Analyze the effectiveness of individual and group responses to public policies that they deem to be discriminatory. **Common Core State Standards** ● **CCSS.ELA-LITERACY.W.11-12.1** Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. ● **CCSS.ELA-LITERACY.SL.11-12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. ● **CCSS.ELA-LITERACY.SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2** ● I can engage others in meaningful conversations while respecting multiple perspectives. **CCE1** ● I can recognize and respect my own feelings and those of others. **DE2** ● I can formulate and investigate probing questions to further my learning. **TI3** ● I can strengthen weaknesses through purposeful strategies, practice, and effort. **P2** ● I can assess my past successes and mistakes to change my approach. **AA2**	
Understandings: Students will understand that... ● Athletes have used their platforms to speak out on social and	**Essential Questions:** ● Should athletes use their platforms to speak out on social and

political issues to various degrees since the 1960s, generating both controversy and change. ● Sports figures and organizations have made contributions to the Civil Rights Movement, feminist movement, and movements for other social causes, oftentimes ahead of the curve in other parts of society. ● Title IX's passage in 1972 is correlated with an increase in women's access to sports and gender equity, although parts of the law remain controversial to some. ● Sports governing bodies at the state, national, and international are struggling to enact rules for transgender women that result in all participants agreeing on a level playing field. ● Outcry against cultural appropriation has resulted in many schools and teams replacing Native American nicknames and symbols, while others see the names and images as tributes.	political issues? ● To what extent is protesting during the national anthem effective? ● What role have sports played in gaining rights for black, Hispanic, female, and LGBTQ+ individuals? ● Are sports the most equal institution we have in America? ● Are the requirements of Title IX and gender equity fair to school-based sports programs? ● How should the rights of transgender athletes and other female athletes be balanced? ● Should schools and teams be allowed to use Native American nicknames and symbols?
Students will know... ● Most athletes prior to the 1960s enjoyed their celebrity status without controversy, but as the counterculture movement grew in the United States, more athletes began to use their platforms in the media and at major events to speak on social and political issues, which generated both controversy and change. ● Two of the most notable sports protests happened in 1967, when Muhammad Ali was stripped of his world heavyweight boxing title for refusing his draft appointment to the Vietnam War, and in 1968, when John Carlos and Tommie Smith made a Black Power salute on the podium at the Mexico City Olympics. ● Spurred by the feminist movement and athletes like Billie Jean King, Title IX's passage in 1972 banned sex-based discrimination in schools and other programs receiving federal assistance, which boosted equity for women in sports. ● There were fewer activist athletes from the 1980s through the early 2010s because most athletes saw that remaining uncontroversial allowed for more economic opportunities, although this has changed in the age of social media. ● Sports have helped advance the causes of LGBT athletes, although arguably more slowly than other movements. There	**Students will be able to...** ● refine criteria that make for successful, evidence-based arguments in debate, Socratic seminar, informal discussion, written, and presentation settings. ● take initiative by selecting interest-based topics, developing guiding questions, and planning steps for research and production. ● exercise creativity in displaying new learning. ● collaborate with classmates to set and achieve goals while developing leadership skills. ● critically analyze written and visual sources, considering strengths and weaknesses of the source material. ● engage respectfully in discussions, acknowledging similar and different perspectives. ● defend an argument using relevant evidence from credible sources. ● ask questions to drive learning and challenge the viewpoints of others. ● write persuasively and effectively to a specific audience. ● reflect upon successes and shortcomings of prior work and use those reflections to inform changes.

remains disagreement about the ethics and fairness of allowing transgender females to compete in women's sports. ● American teams and schools started using Native American nicknames and symbols in the 1910s, but many institutions have changed since the mid-1990s after activists accused these symbols of being cultural appropriation rather than tributes.	● discuss key people, events, and concepts related to sports and social issues.
Key Vocabulary: activism; John Carlos and Tommie Smith; Civil Rights Movement; Muhammad Ali; Vietnam War; counterculture; Billie Jean King; Battle of the Sexes; Babe Didrikson Zaharias; feminism; Title IX; Colin Kaepernick; Pat Tillman; Megan Rapinoe; race; Reconstruction; Jim Crow laws; segregation; Joe Louis; Jackie Robinson; Michael Jordan; Jim Thorpe; Florida State Seminoles; cultural appropriation; sexual orientation; Martina Navratilova; gender; transgender; Renee Richards; Lia Thomas	
Assessment Evidence	
Performance Tasks: ● **Summative:** Students write a position paper relating to one of the essential questions from the unit. Students will propose their own topic and thesis, and they will complete research to support their perspective. **TCC2, CCE1, DE2, TI3, P2, AA2**	**Other Evidence:** ● **Interim:** Students create a trading card of an athlete, past or present, with the goal of convincing the class that the athlete is one of the four most socially impactful athletes in history. Cards will be presented in one-on-one "speed-dating" format, after which students will create a Mount Rushmore of the top four. **TCC2, CCE1, DE2, TI3** ● **Interim:** Mini-debates (one-on-one, two-on-two, etc.) on questions proposed by students and/or essential questions. **TCC2, CCE1, DE2, TI3, P2, AA2**
Learning Plan	
● Teach persuasive writing skills, including organization, hooks, word choice, selection of evidence, and attacking counterclaims **TCC2, P2, AA2** ● Review research skills of locating and evaluating sources (CRAAP test, SOAPS, etc.), searching for and skimming through resources, developing guiding questions, and citing material **TCC2, TI3, P2** ● Refine success criteria for debates, seminars, projects, and presentations by viewing negative and positive models, considering prior experiences, etc. **P2, AA2** ● Reinforce positive peer feedback strategies for writing and group activities **P2** ● Reading assignments with SAT-style questions **P2** ● Content-based quiz on key vocabulary and concepts **P2** ● Written responses and/or discussions on videos and articles (especially those in the resources below) **CCE1, P2** ● Participation assessments (i.e. guided notes, Pear Deck, etc.) **CCE1, P2**	

Teacher Resources: *Social Issues in Sport (4th ed.)*; excerpts from the "Muhammad Ali" documentary series by Ken Burns; video on the 1968 Mexico City Olympics protest by Vox; Newsela article on Title IX; Newsela article on national anthem protests; CIAC policy on transgender student-athletes; The Flip Side debate materials on swimmer Lia Thomas competing as a transgender woman and recent articles about developments involving transgender athletes; Associated Press article on recent debates about Native American symbolism in sports; course materials from "Sports and Society" by Coursera and Duke University; Nonnewaug LMC databases and resources

Unit 3 - Sports and Economics	
Desired Results - Goals, Transfer, Meaning, Acquisition	
Established Goals: **Connecticut Secondary Social Studies Frameworks** ● **CG.Inq.3.a** Gather relevant information from multiple sources representing a wide range of views and mediums while using the origin, authority, structure, context, and corroborative value to guide the selection of credible sources. ● **CG.Inq.4.a** Construct arguments using precise and knowledgeable claims, with evidence from multiple sources, while acknowledging counterclaims and evidentiary weaknesses. ● **CG.Inq.4.f** Evaluate and implement strategies for individual and collective action to address local, regional, and global problems in classrooms, schools, and out-of school civic contexts. **Common Core State Standards** ● **CCSS.ELA-LITERACY.RH.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem. ● **CCSS.ELA-LITERACY.SL.11-12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. ● **CCSS.ELA-LITERACY.SL.11-12.6** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.	
Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated) ● I can ask purposeful, insightful questions to find a variety of innovative solutions. **TCC1** ● I can lead group progress through active listening, questioning, and giving advice. **CCE3** ● I can seek, listen to, and understand multiple perspectives. **DE1** ● I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge. **TI2** ● I can strengthen weaknesses through purposeful strategies, practice, and effort. **P2** ● I can create opportunities to extend my learning by remaining open-minded in any situation. **AA4**	
Understandings: Students will understand that... ● Modern sports' rise with industrialization and capitalism in the	**Essential Questions:** ● What is the most significant economic issue in the sports world,

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mid-1800s started the business of sports, which has grown exponentially in recent decades – and has brought with it a set of economic issues.
Economic issues in sports mirror economic issues in the rest of society, including gender pay equality, uneven distribution of income, the influence of labor unions, the growth of gambling, economic rights of college students, and government spending, all of which cause disagreements.
College athletics, which historically was for student-athletes on scholarship without any other financial benefits, are being forced to give student-athletes more economic rights after decades of controversy and scandals.
The growth of mass media and the internet in large part caused the rapid change of sports from a game to a business, and media continues to be a top driver in the economics of sports.

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and how should it be addressed?
What impacts will the growth of sports betting have on society?
What economic rights should student-athletes have?
To what extent should the gender pay gap in professional sports be addressed?
Have labor unions made more positive or negative impacts in sports?
Does the media cause more problems or create more opportunities in sports?
Do professional athletes make too much money?
Should governments provide tax dollars to build sports venues?

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Students will know...

Sports were mostly seen as a form of leisure until the early 1900s, when the rise of mass media turned athletes, such as Babe Ruth, into celebrities and sports into a business.
The expansion of radio starting in the 1920s, television starting in the 1940s, ESPN in 1979, and the internet starting in the 1990s all contributed to the growth of sports' popularity and revenue potential.
Owners of most sports teams engaged in anti-competitive practices to hold down player salaries, such as baseball's reserve clause, and provide poor working conditions until players in major American sports leagues began to unionize in the 1950s.
Although athletes' salaries have skyrocketed since unionization, many feel as though owners hoard too much sports revenue through measures such as salary caps, and disputes between players and owners often cause labor strikes or lockouts.
Sports owners and leagues take many steps to increase revenue, such as relocating teams to growing media markets in the Sun Belt of the South and West, marketing more heavily overseas, selling more advertising, and negotiating enormous

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Students will be able to...

refine criteria that make for successful, evidence-based arguments in debate, Socratic seminar, informal discussion, written, and presentation settings.
take initiative by selecting interest-based topics, developing guiding questions, and planning steps for research and production.
collaborate with classmates to set and achieve goals while developing leadership skills.
critically analyze written and visual sources, considering strengths and weaknesses of the source material.
engage respectfully in discussions, acknowledging similar and different perspectives.
defend an argument using relevant evidence from credible sources.
ask questions to drive learning and challenge the viewpoints of others.
role-play to understand how the American legislative process works.
develop probing questions designed to learn new information and elicit desired responses.

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media rights deals. ● Female athletes have historically received less pay than male athletes for a variety of reasons, many of which are controversial, but women's tennis was the first sport to secure equal prize money starting at the 1973 U.S. Open, and the U.S. women's national soccer team did the same in 2022. ● A Supreme Court decision in 2018 allowed states to legalize sports betting, changing the way sports are marketed and sparking controversy over the role of betting in sports and society. ● The NCAA changed its longtime amateurism rules in 2021, following several Supreme Court rulings, to allow student-athletes to monetize their name, image, and likeness. While students now have expanded economic rights, there is controversy about recruiting advantages and the effects on the landscape of college sports.	● reflect upon successes and shortcomings of prior work and use those reflections to inform changes. ● discuss key people, events, and concepts related to sports and economic issues.
Key Vocabulary: capitalism; mass media; Babe Ruth; ESPN; competition; supply and demand; reserve clause; salary cap; revenue sharing; National Football League (NFL); labor union; strike; lockout; media market; Sun Belt; conference realignment; Women's Tennis Association (WTA); gender pay gap; National Collegiate Athletic Association (NCAA); sports betting; fantasy sports; point shaving; name, image, and likeness (NIL)	
Assessment Evidence	
Performance Tasks: ● **Summative:** Students will participate in an activity in which they identify significant economic issues involving sports and propose solutions. One option is a mock Congressional hearing in which students receive different roles based on their interests, and they will be divided into Congresspeople asking questions, witnesses giving testimony, and writers in the audience who will opine on which issue was most compelling. **TCC1, CCE3, DE1, TI2, AA4**	**Other Evidence:** ● **Interim:** Interview a current or former college student-athlete and use those conversations, along with some research, to participate in a soccer ball Socratic seminar on the question, "What economic rights should student-athletes have?" **TCC1, CCE3, DE1, TI2, AA4** ● **Interim:** Mini-debates (one-on-one, two-on-two, etc.) on questions proposed by students and/or essential questions. **TCC1, CCE3, DE1, TI2, P2, AA4**
Learning Plan	
● Teach interviewing skills by harnessing curiosity and developing both open- and closed-ended questions **TCC1, CCE3, DE1** ● Review research skills of locating and evaluating sources (CRAAP test, SOAPS, etc.), searching for and skimming through resources,	

developing guiding questions, and citing material **TCC1, TI2, P2** ● Refine success criteria for debates, seminars, projects, and presentations by viewing negative and positive models, considering prior experiences, etc. **P2** ● Reinforce positive peer feedback strategies for writing and group activities **P2** ● Reading assignments with SAT-style questions **P2** ● Content-based quiz on key vocabulary and concepts **P2** ● Written responses and/or discussions on videos and articles (especially those in the resources below) **DE1, P2** ● Participation assessments (i.e. guided notes, Pear Deck, etc.) **DE1, P2**
Teacher Resources: *Social Issues in Sport (4th ed.)*; Los Angeles Daily News article on Babe Ruth as the first sports celebrity; Chicago Tribune column on the impact of ESPN; "Hoop Schemes" episode of "Bad Sport" series on Netflix; New York Times article on women receiving equal pay for the first time at the 1973 U.S. Open; Time article on U.S. women's soccer earning equal pay; recent articles on economic issues involving college athletics, including NIL; recent articles on economic issues involving sports betting; ideas by the Civic Educator on how to run a mock Congressional hearing; course materials from "Sports and Society" by Coursera and Duke University; Nonnewaug LMC databases and resources

Unit 4 - Sports and an Evolving Society	
Desired Results - Goals, Transfer, Meaning, Acquisition	
Established Goals: **Connecticut Secondary Social Studies Frameworks** ● **US.Inq.3.a** Gather relevant information from multiple sources representing a wide range of views and mediums while using the origin, authority, structure, context, and corroborative value to guide the selection of credible sources. ● **US.Inq.4.a** Construct arguments using precise and knowledgeable claims, with evidence from multiple sources, while acknowledging counterclaims and evidentiary weaknesses. ● **CG.Inq.4.e** Analyze the characteristics and causation of local, regional, and global problems issues using a multidisciplinary lens. **Common Core State Standards** ● **CCSS.ELA-LITERACY.W.11-12.1** Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. ● **CCSS.ELA-LITERACY.SL.11-12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. ● **CCSS.ELA-LITERACY.SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.	
Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated) ● I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2** ● I can express ideas in a variety of ways, according to context, purpose, and audience. **CCE4** ● I can seek, listen to, and understand multiple perspectives. **DE1** ● I can formulate and investigate probing questions to further my learning. **TI3** ● I can strengthen weaknesses through purposeful strategies, practice, and effort. **P2** ● I can evaluate different approaches and justify the best pathway to success. **AA1**	
Understandings: Students will understand that... ● Sports have changed drastically over the past century, going	**Essential Questions:** ● Are sports changing for the better or worse?

from leisure-based activities with little regulation, specialized training, or business opportunities into a highly popular, regulated, competitive, and lucrative industry with pros and cons. ● Competitive sports can both positively and negatively impact athletes' mental health, and speaking out about mental health struggles was seen as taboo in both sports and society until recently. ● Advanced statistics, analytics, and algorithms continue to shift the strategy of sports, the manner in which teams are constructed, and the way athletes' success is viewed, which generates debate between traditionalists and modernists. ● Comparing people from different eras can be challenging because of different standards in each time period, although this fuels timeless debate. ● Youth sports have shifted from a largely recreational and multi-sport approach to one where children are often pressured to specialize in one sport at a high level, which can lead to college scholarships but also burnout and injuries. ● Modern science and training have produced bigger, stronger, and faster athletes as well as more advanced equipment, but they've also raised questions about cheating, safety, ethics, fairness, and the limits of physical human achievement.	● How should society view mental health, especially in sports? ● Can we fairly assess and compare people from different eras? ● Are algorithms and analytics doing more to hurt or help sports and society? ● Should athletes be allowed to use performance-enhancing drugs? ● Do the benefits of youth sports specialization outweigh the detriments?
Students will know... ● The development of leagues and governing bodies, such as Major League Baseball, the International Olympic Committee, FIFA, the National Football League, and the National Collegiate Athletic Association helped standardize rules for sports and organize competition starting around the turn of the century. ● Some characteristics of modern sports include specialization in training and positions, standardized rules, a preoccupation with records, and strong connection with business and media. ● Athletes such as Simone Biles and Naomi Osaka speaking out about mental health in 2021 began to reduce the stigma around athletes' mental well-being. ● The sports industry is one of many that now relies heavily on	**Students will be able to...** ● steer an inquiry-based learning process from start to finish. ● refine criteria that make for successful, evidence-based arguments in debate, Socratic seminar, informal discussion, written, and presentation settings. ● take initiative by selecting interest-based topics, developing guiding questions, and planning steps for research and production. ● collaborate with classmates to set and achieve goals while developing leadership skills. ● critically analyze written and visual sources, considering strengths and weaknesses of the source material. ● engage respectfully in discussions, acknowledging similar and

analytics, which can be seen in its mixed impacts in changing the strategy in sports such as baseball, basketball, and football.
- Youth sports have turned into a big business of their own as parents look toward college scholarships, although only 2% of high school athletes end up receiving some form of athletic scholarship.
- The rise of performance-enhancing drugs in the late 1900s tainted numerous sports, especially the Olympics, cycling, and baseball.
- Increased awareness of head injuries and concussions, and the still-to-be-understood syndrome of CTE, threatens the future of some sports, such as football and boxing.

different perspectives.
- develop and defend a multi-faceted argument using relevant evidence from credible sources.
- ask questions to drive learning and challenge the viewpoints of others.
- reflect upon successes and shortcomings of prior work and use those reflections to inform changes.
- connect all learning in a course by exploring different pathways and using trial and error.
- discuss key people, events, and concepts related to sports and STEM issues.

Key Vocabulary: mental health; Simone Biles; Naomi Osaka; analytics; sabermetrics; algorithm; shift; performance-enhancing drugs; Ben Johnson; Steroid Era; Barry Bonds; Lance Armstrong; scholarship; specialization; concussion; chronic traumatic encephalopathy (CTE)

Assessment Evidence

Performance Tasks:

- **Summative:** Students write a position paper relating to one of the essential questions from the unit. Students will propose their own topic and thesis, and they will complete research to support their perspective. **TCC2, CCE1, DE2, TI3, P2, AA2**
- **Final exam:** Students will complete a hexagonal thinking activity in which they must make a visual arrangement demonstrating how 25 key concepts from the course are related to each other, then use the arrangement to write a short essay on the question, "How do sports reflect values, trends, and movements in society?" **CCE4, TI3, P2, AA1**

Other Evidence:

- **Interim:** Small groups of students will choose two comparable athletes from the same sport who played in different generations. They must develop criteria by which they will assess each athlete, research available information, and defend a claim about which athlete is the best while also acknowledging limitations of their claim. Students will then engage in a debate to determine the greatest athlete in history. **TCC2, CCE4, DE1, TI3, P2, AA1**
- **Interim:** Mini-debates (one-on-one, two-on-two, etc.) on questions proposed by students and/or essential questions. **TCC2, CCE4, DE1, TI3, P2, AA1**

Learning Plan

- Use the Question Formulation Technique to scaffold development of research questions **TI3, P2, AA1**
- Review research skills of locating and evaluating sources (CRAAP test, SOAPS, etc.), searching for and skimming through resources, developing guiding questions, and citing material **TCC2, TI3**
- Refine success criteria for debates, seminars, projects, and presentations by viewing negative and positive models, considering prior experiences, etc. **AA2**

- Reinforce positive peer feedback strategies for writing and group activities **P2**
- Reading assignments with SAT-style questions **P2**
- Content-based quiz on key vocabulary and concepts **P2**
- Written responses and/or discussions on videos and articles (especially those in the resources below) **CCE1**
- Participation assessments (i.e. guided notes, Pear Deck, etc.) **CCE1**

Teacher Resources: *Social Issues in Sport (4th ed.)*; academic journal article on the origins of the NCAA; The Flip Side debate materials on Simone Biles' mental health-related withdrawal from the 2021 Tokyo Olympics; video clips from the Dan Patrick Show about comparing athletes from different eras; Axios charts on analytics' impact in major sports; The Atlantic article on Moneyball in sports and other industries; recent articles on analytics' role in sports; NCAA recruiting facts; National Athletic Trainers' Association article on youth sports specialization; CommonLit article on concussions; template for hexagonal thinking project; course materials from "Sports and Society" by Coursera and Duke University; Nonnewaug LMC databases and resources

Regional School District 14 Textbook Adoption Proposal Form

Instructions - After the text selection process is finished, please submit the following to the Director of Teaching and Learning for the chosen text:

- Completed adoption proposal form
- A copy of the cost proposal/quote from the vendor
- 1-3 copies of the Student Textbook and the Teacher's Guide for review.

School/Grade/Department: Nonnewaug High social studies	Date: 8/9/2024
Evaluating Team Members: Kyle Brennan	
Textbook Information	
Title of the Proposed Textbook: *Social Issues in Sport*	Edition: 4th Edition
Author(s)/Editors: Ronald B. Woods and B. Nalani Butler	
Publisher (please include name of contact person, address, phone, and fax) Human Kinetics, 1607 North Market Street, Champaign, IL 61825 Fax: 217-351-1549 Contact: Allison Loosli (allisonl@hkusa.com, 800-747-4457)	
Text Readability Level: 11 (Flesch-Kincaid)	Copyright Year: 2021
Is this a more current edition of an approved text already in use? (If yes, please include the title, copyright date, and publisher of the text being replaced) No. There is no text for the existing Sports and Society course. This text is required by UConn as part of the ECE Contemporary Issues in Sport course.	
Proposed Textbook Cost	
Cost of The Proposed Text:	$134.00
Number of Texts Requested:	10
Approximate Cost of Shipping:	+$160.80
Total Cost:	$1,500.80
Additional Information Required	
Titles of Other Texts Reviewed: none	
Advantages of The Proposed Text: This is the required text for the UConn ECE Contemporary Issues in Sport course. The text covers a wide range of topics relevant to our curriculum and will	

work as a strong guide and supplemental material to the ECE course. Much of the information is up to date and includes information provided in helpful graphics and other features that make the text more readable. This text is also important to differentiating between UConn ECE Contemporary Issues in Sport and the lower-level Sports and Society course because it will include additional depth and additional topics that we may not cover as thoroughly during class time.
Other School Districts Utilizing The Proposed Text: All school districts teaching UConn ECE Contemporary Issues in Sport must incorporate this text. Some high schools introducing this course for the first time in 2024-25 include Naugatuck, North Branford, Norwich Free Academy, Rockville, and Westhill.

Evaluation of The Proposed Textbook			
Content - Please place an “x” in the appropriate rating.	**Yes**	**No**	**N/A**
1. Are the instructional goals clearly stated in terms of what students should know and be able to do?	x		
2. Does the content align with the state and district curriculum standards?	x		
3. Does the content challenge students of varying levels?	x		
4. Is the content age appropriate in terms of interests, concepts, etc.?	x		
5. Does the content reflect recent scholarship in this subject area?	x		
6. Are there connections made within and across content areas?	x		
7. Are gender, racial, ethnic, religious, and socio-economic groups, past and present, accurately and fairly represented?	x		
8. Does the content (both pictorial and written) reflect the pluralistic, multi-ethnic nature of our global society?	x		
9. Are all sides of a controversial issue treated objectively?	x		
Please provide a brief explanation any “no” responses above:			
Assessment of Student Learning - Please place an “x” in the appropriate rating.	**Yes**	**No**	**N/A**
1. Are there formal and informal assessment practices integrated throughout the text?	x		
2. Do the assessments provide a balanced profile of students’ acquisition of skills, knowledge, understanding, and their ability to apply their learning to real world situations?	x		
3. Will the assessments provide meaningful feedback to teachers to improve instruction and learning?	x		
Please provide a brief explanation any “no” responses above:			
Instructional Support - Please place an “x” in the appropriate rating.	**Yes**	**No**	**N/A**
1. Are there up-to-date reference sources listed?	x		

2. Is there a focus on higher level thinking skills?	x		
3. Are the units and lessons organized in a manner that are easy to use?	x		
4. Do the activities engage students in problems and questions before solutions and answers are introduced?	x		
5. Do the materials allow for a variety of activities that address different learning styles?	x		
6. Do the materials provide ways of building students' competency with the Vision of A Learner attributes?	x		
7. Do the materials provide opportunities for parents and community members to be involved in learning activities?	x		
8. Are the typeface, type size, illustrations, and visual aids suitable for the students who will be using this text?	x		
9. Is the text/supplemental material available in different languages?		x	
10. Is the text/supplemental material available on audiobook?		x	
11. Do the instructional methods reflect current learning theory and pedagogy?	x		
12. Are the authors (contributors) recognized for their expertise in this subject area and their experience with students at a similar level to those who will be utilizing this text?	x		
Please provide a brief explanation any "no" responses above: There is an online supplement to the text but it's unclear whether it includes accommodations for other languages or audio.			
Overall Summary and Rationale for Utilizing This Textbook: This textbook will be an excellent resource for our students because of its wide array of topics, good readability and inclusion of graphics, updated information, and ability to both add depth to the course and make connections to other supplemental materials.			

Approval Signatures	
Department Chairperson:	Date:
Principal:	Date:
Director of Teaching and Learning:	Date: