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Course: AP Chemistry

Unit Name: Thermodynamics

Grade Level: 11-12

Content Statements	**NJSLS:**
Entropy	
Entropy of formation	5.1.12.A-D: All
Laws of Thermodynamics	
Gibbs Free Energy	**NJSLS**
Enthalpy	
Heat	**RST.11-12.1**-10
Specific Heat Capacity	
Joules	
Hess' Law	
Formation Reactions	.
Enthalpy of Formation	
Enthalpy of fusion / vaporization	
Standard Molar Enthalpy of formation	
Summation method	
Overarching Essential Questions	**Overarching Enduring Understandings**
How much energy and entropy is released / absorbed during a chemical or physical reaction?	In all chemical and physical changes energy is released or absorbed in the form of enthalpy and entropy. This energy is quantifiable and an essential component when deciding if a reaction will occur.

Unit Essential Questions	**Unit Enduring Understandings**
What is temperature a measure of?	Two systems with different temperatures that are in thermal contact will exchange energy.
In what direction is energy transferred between 2 bodies?	The quantity of thermal energy transferred from one system to another is called heat.
Is the total energy between multiple systems fixed?	Energy is neither created nor destroyed, but only transformed from one form to another.
What are the main processes that chemical reactions use to change their energy?	Breaking bonds requires energy, and making bonds releases energy.
How can Hess's law be used to determine the enthalpy change of a reaction?	Chemical or physical processes are driven by a decrease in enthalpy or an increase in entropy, or both.
What is calorimetry and what does it measure?	
How is the net energy change of a chemical reaction related to the bond energy of the reactants and products?	
Using thermodynamic data, how can it be determined if a chemical reaction is spontaneous over a specific temperature range?	
Unit Rationale	**Unit Overview**
To measure the energy changes of chemical and physical reactions and to use it to predict the spontaneity of a reaction.	The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.

Resources
Chemistry and Chemical Reactivity, Kotz and Treichel, Saunders College Publishing
Chemistry and Chemical Reactivity Student Solutions Manual, Saunders College Publishing
Chemistry and Chemical Reactivity, Study Guide, Saunders College Publishing
Chemistry and Chemical Reactivity, Pocket Guide, Saunders College Publishing
www.wolframalpha.com
Suggested Student Activities
Lab Activity – Verifying Hess' Law

Course: AP Chemistry

Unit Name: Chemical Kinetics

Grade Level: 11-12

Content Statements	**NJSLS**
Order	
Rate law	5.1.12.A-D: All
Rate law constant	
Integrated rate law	**NJSLS**
Molecularity	
Catalyst	RST.11-12.1-10
Unimolecular	
Bimolecular	

Termolecular Rate equation Activation Energy Energy Diagram Spectrophotometer	
Overarching Essential Questions How do we mathematically describe the concentration – time – rate relationship between chemical species in a chemical reaction?	**Overarching Enduring Understandings** Rates of chemical reactions are determined by details of the molecular collisions.
Unit Essential Questions What factors influence the rate of a chemical reaction? How is a rate law determined from experimental data? What are the units of the rate law constant? How is the rate law of an elementary step in a reaction determined? What is activation energy and how is it overcome? What is the rate determining step in a multistep reaction? What is an intermediate and how is it identified in a multi step reaction?	**Unit Enduring Understandings** The rate of a reaction is influenced by the concentration or pressure of reactants, the phase of the reactants and products, and environmental factors such as temperature and solvent. The rate law shows how the rate depends on reactant concentrations. The magnitude and temperature dependence of the rate of reaction is contained quantitatively in the rate constant. Elementary reactions can be unimolecular or involve collisions between two or more molecules. Not all collisions are successful. To get over the activation energy barrier, the colliding species need sufficient energy. Also, the orientations of the reactant molecules during the collision must

What effect does a catalyst have on activation energy? What are some specific examples of catalysts?	allow for the rearrangement of reactant bonds to form product bonds. A successful collision can be viewed as following a reaction path with an associated energy profile. The mechanism of a multistep reaction consists of a series of elementary reactions that add up to the overall reaction. In many reactions, the rate is set by the slowest elementary reaction, or rate-limiting step. Reaction intermediates, which are formed during the reaction but not present in the overall reaction, play an important role in multistep reactions. Catalysts function by lowering the activation energy of an elementary step in a reaction mechanism, and by providing a new and faster reaction mechanism. Important classes in catalysis include acid-base catalysis, surface catalysis, and enzyme catalysis.
Unit Rationale Chemical reactions can be mathematically modeled and predicted in such a way that concentration and time are related.	**Unit Overview** Mathematical models can be developed through the collection of experimental data to accurately predict the behavior of systems.

Resources
Chemistry and Chemical Reactivity, Kotz and Treichel, Saunders College Publishing
Chemistry and Chemical Reactivity Student Solutions Manual, Saunders College Publishing
Chemistry and Chemical Reactivity, Study Guide, Saunders College Publishing
Chemistry and Chemical Reactivity, Pocket Guide, Saunders College Publishing
www.wolframalpha.com
Suggested Student Activities
Lab - Spectrophotometric analysis of the dichromate ion.
Catalytic decomposition of hydrogen peroxide using the iodide ion
Manganese dioxide as a catalyst in a chemical reaction

Course: AP Chemistry

Unit Name: Chemical Reactions

Grade Level: 11-12

Content Statements	**NJSLS :**
Oxidation	
Reduction	5.1.12.A-D: All
Synthesis	
Metathesis	**NJSLS**
Decomposition	
Acid Base Reaction	RST.11-12.1-10
Bronsted-Lowry	
Lewis Theory	

Galvanic Cell Gas Forming Reactions Electrochemistry Electron Transfer Proton Transfer Titration Buffer Solution Henderson-Hasslebach Conjugate Acid-Base Pair ICE Chart Equilibrium constants Equilibrium expressions Solubility product constants Acid and Base constants Activity series Reduction table Qualitative analysis	
Overarching Essential Questions What are the main classifications of chemical reactions? What are the main differences between types of chemical reactions? How can the amounts of products and reactants within a chemical reaction be stoichiometrically related?	**Overarching Enduring Understandings** Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer or electrons
Unit Essential Questions How are chemical changes represented?	**Unit Enduring Understandings** Chemical changes are represented by a balanced chemical equation that identifies the ratios with which reactants reach and products form.

How can quantitative information be derived from stoichiometric calculations that utilize the mole ratios from the balanced chemical equations? What is the role of stoichiometry in real-world applications? What are synthesis, decomposition, neutralization and oxidation – reduction reactions? How are they classified? How do they differ from one another? In oxidation-reduction reactions, how does the transfer of electrons help identified what is oxidized and what is reduced? What are examples of evidence for the occurrence of a chemical reaction? How can net changes in energy for a chemical reaction be classified? What kinds of reactions involve the conversion between chemical and electrical energy?	Chemical reactions can be classified by considering what the reactants are, what the products are, or how they change from one into the other. Classes of chemical reactions include synthesis, decomposition, acid-base, and oxidation reduction reactions. Chemical and physical transformations may be observed in several ways and typically involve a change in energy.
Unit Rationale Chemical reactions are the backbone of industry, medicine, and many other fields. The ability to fully describe and quantify these reactions is of the utmost importance to society.	**Unit Overview** Through the process of experimentation and data collection involving the various types of chemical reactions, the quantities of reactants, products, and energies can be quantified and predicted using stoichiometry.

Resources

Chemistry and Chemical Reactivity, Kotz and Treichel, Saunders College Publishing

Chemistry and Chemical Reactivity Student Solutions Manual, Saunders College Publishing Chemistry and Chemical Reactivity, Study Guide, Saunders College Publishing Chemistry and Chemical Reactivity, Pocket Guide, Saunders College Publishing www.wolframalpha.com
Suggested Student Activities Lab – Qualitative analysis of anions Lab – Net Ionic equations Lab – Electrochemical Series Lab – Redox Titration Lab – Electrolysis, the faraday, and Avogadro's number Lab – Synthesis of aspirin and oil of wintergreen Lab – Synthesis of a coordination compound Lab – Analysis of a coordination compound Lab – Synthesis of esters

Course: AP Chemistry

Unit Name: Equilibrium

Grade Level: 11-12

Content Statements	**NJSLS :**
Equilibrium ICE Chart Equilibrium constants LeChatelier's Principle	5.1.12.A-D: All

Equilibrium expressions Product and Reactant favored Solubility product constant Acid Base equilibrium Titration pH pOH Ka, Kb, Kw, Ksp Buffer	**NJSLS** RST.11-12.1-10
Overarching Essential Questions How is the process of equilibrium related different categories of reactions? How equilibrium reactions are mathematically modeled and quantified?	**Overarching Enduring Understandings** Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to the initial conditions and external perturbations.
Unit Essential Questions In what classes of reactions are both forward and reverse processes considered? How does the reaction quotient Q help to determine if a system is at equilibrium? How do variables such as molarity, pressure, and temperature effect a system at equilibrium? How can the equilibrium constant, K, relate to the amount of product and reactant present in the system?	**Unit Enduring Understandings** Chemical equilibrium is a dynamic, reversible state in which rates of opposing processes are equal Systems at equilibrium are responsive to external perturbations, with the response leading to a change in the composition of the system. Chemical equilibrium plays an important role in acid-base chemistry and in solubility The equilibrium constant is related to temperature and the difference in Gibbs free energy between reactants and products.

What is LeChatelier's principle? In which direction will a system shift if Q and K are not equal? How can equilibrium concepts be used to describe the proton transfer of acid-base reactions? How is pH and pOH calculated? How can pH and pOH be related to pKa and pKb? How is the solubility of a substance understood in terms of chemical equilibrium? How is the Gibbs free energy related to the equilibrium constant?	
Unit Rationale Chemical equilibrium can be observed in many types of reactions including acid-base and precipitations. The process of equilibrium is far reaching and must be investigated in these various types of reactions.	**Unit Overview** The process of equilibrium for chemical reactions will be mathematically modeled so predictions for the amounts of reactants and products can be accurately calculated.

Resources

Chemistry and Chemical Reactivity, Kotz and Treichel, Saunders College Publishing

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Chemistry and Chemical Reactivity, Study Guide, Saunders College Publishing

Chemistry and Chemical Reactivity, Pocket Guide, Saunders College Publishing www.wolframalpha.com
Suggested Student Activities Lab – Spectrophotometric determination of an equilibrium constant Lab – LeChatelier's Principle Lab – Standardization of NaOH using KHP Lab – Determination of concentration by acid-base titration Lab – Preparation of buffer solutions

Course: AP Chemistry

Unit Name: Atomic theory and the mole concept

Grade Level: 11-12

Content Statements	**NJSLS :**
Atom	
Mole	5.1.12.A-D: All
Molecule	
Electron	**NJSLS**
Proton	
Neutron	RST.11-12.1-10
Spectrophotometry	
Mass Spectrometer	
Atomic Theory	

Periodicity Subatomic particles Quantum Theory Isotopes Conservation of atoms	
Overarching Essential Questions How is matter understood in terms of chemical elements, the fundamental building block of all matter?	**Overarching Enduring Understandings** The chemical elements are fundamental building materials of all matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.
Unit Essential Questions What are molecules composed of, and how do elements combine? How is chemical analysis used to determine the atoms and composition of a substance? What is the mole and how is it used to count atoms? What are the particles that compose the atom and what are their properties? How can the electronic structure of the atom be described? What are the main periodic trends of elements?	**Unit Enduring Understandings** All matter is made of atoms. There are a limited number of types of atoms; these are elements. The atoms of each element have unique structures arising from interactions between electrons and nuclei. Elements display periodicity in their properties when the elements are organized according to increasing atomic number. This periodicity can be explained by the regular variations that occur in the electronic structures of atoms. Periodicity is a useful principle for understanding properties and predicting trends in properties. Its modern day uses range from examining the composition of materials to generating ideas for designing new materials. Atoms are so small that they are difficult to study directly; atomic models are constructed to explain experimental data on collections of atoms.

What is the best currently accepted atomic model? Explain how the theoretical model of the atom is not an exact description, but rather a work in progress open for refinement. How has mass spectrometry refined the past atomic models? How can spectrophotometers be used to probe the structure of atoms and molecules? How are chemical reactions represented using symbols? How can the conservation of atoms be used to compute the masses of substances involved in reactions?	Atoms are conserved in physical and chemical processes.
Unit Rationale The current accepted atomic model helps us understand the structure of the atom and how molecules and atoms behave during chemical and physical reactions.	**Unit Overview** Matter will be investigated from the subatomic level through the macroscopic scale, with mathematical relationships linking both.

Resources

Chemistry and Chemical Reactivity, Kotz and Treichel, Saunders College Publishing

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Chemistry and Chemical Reactivity, Study Guide, Saunders College Publishing

Chemistry and Chemical Reactivity, Pocket Guide, Saunders College Publishing

www.wolframalpha.com
Suggested Student Activities Lab – Electrolysis, the Faraday and Avogadro's number Lab – Molecular models and Lewis structures Lab – Periodic trends in elements

Course: AP Chemistry

Unit Name: Intermolecular forces and the properties of materials

Grade Level: 11-12

Content Statements	**NJSLS :**
Chemical Properties	
Physical Properties	5.1.12.A-D: All
Particle Spacing	
Ions	**NJSLS**
Dipole	
Induced dipole	RST.11-12.1-10
Van der Waals forces	
Intermolecular forces	
Coulomb's Law	
London Dispersion forces	
Hydrogen bonding	
Metallic bonding	

VSEPR model Ionic Solids Covalent network solids Molecular solids	
Overarching Essential Questions How can the physical and chemical properties of matter be described and predicted from the arrangement of atoms, ions or molecules and the forces between them.	**Overarching Enduring Understandings** Chemical and Physical properties of materials can be explained by the structure and the arrangement of atoms, ions or molecules and the forces between them
Unit Essential Questions How can the different properties of solids and liquids be explained at the atomic and macroscopic levels? What mathematical relationships can describe the gaseous state of matter? What are London dispersion forces and how can their relative strengths be predicted? What are dipole forces and how do they vary from hydrogen bonding forces? How can intermolecular forces be used to predict the properties of substances? What is electronegativity, and how is it used to describe covalent bonding?	**Unit Enduring Understandings** Matter can be described by its physical properties. The physical properties of a substance generally depend on the spacing between the particles that make up the substance and the forces of attraction among them. Forces of attraction between particles are important in determining many macroscopic properties of a substance, including how the observable physical state changes with temperature. The strong electrostatic forces of attraction holding atoms together in a unit are called chemical bonds. The type of bonding in the solid state can be deduced from the properties of the solid state.

What is ionic bonding, and how can it be used to describe a crystal lattice? What is metallic bonding and how does it describe the unique properties of metals? What is the VSEPR model and how is it used to predict the Lewis diagrams of molecules? What are ionic solids and their general properties? What are metallic solids and their general properties? What are covalent network solids and their general properties? What are molecular solids and their general properties?	
Unit Rationale Intermolecular forces can be predicted using the current atomic model and molecular geometries. These IM forces can then be used to make predictions on properties and behaviors of matter.	**Unit Overview** Intermolecular forces will be described using molecular and atomic theories, then those predictions will be applied to various materials.

Resources

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Chemistry and Chemical Reactivity, Study Guide, Saunders College Publishing Chemistry and Chemical Reactivity, Pocket Guide, Saunders College Publishing www.wolframalpha.com
Suggested Student Activities Lab – Chromatography Lab – Enthalpy of vaporization and fusion.

Reapproved June 2017

Appendix

Differentiation	
Enrichment	● Utilize collaborative media tools ● Provide differentiated feedback ● Opportunities for reflection ● Encourage student voice and input ● Model close reading ● Distinguish long term and short term goals
Intervention & Modification	● Utilize “skeleton notes” where some required information is already filled in for the student ● Provide access to a variety of tools for responses ● Provide opportunities to build familiarity and to practice with multiple media tools ● Leveled text and activities that adapt as students build skills ● Provide multiple means of action and expression ● Consider learning styles and interests ● Provide differentiated mentors ● Graphic organizers

ELLs	● Pre-teach new vocabulary and meaning of symbols ● Embed glossaries or definitions ● Provide translations ● Connect new vocabulary to background knowledge ● Provide flash cards ● Incorporate as many learning senses as possible ● Portray structure, relationships, and associations through concept webs ● Graphic organizers

21st Century Skills

- Creativity
- Innovation
- Critical Thinking
- Problem Solving
- Communication
- Collaboration

Integrating Technology

- Chromebooks
- Internet research
- Online programs
- Virtual collaboration and projects
- Presentations using presentation hardware and software