Burlington County Institute of Technology

Curriculum Document

Course Title: AP Chemistry

Curriculum Area: Science

Credits: 5 Credits per course

Board Approved: August 2016

Course description:

The purpose of the course is to provide students with a collegiate level academic experience in chemistry within the high school setting. It is also to foster and grow self-sustaining, independent learners. This course is structured around the six big ideas articulated in the AP chemistry curriculum framework provided by the College Board. A special emphasis will be placed on the seven science practices, which capture important aspects of the work that scientists engage in, with learning objectives that combine content with inquiry and reasoning skills. A minimum of 25 percent of instructional time is dedicated to the lab activities. In addition, students will have to spend at least five hours a week studying outside of class. AP Chemistry is open to all students that have completed a year of chemistry who wish to take part in a rigorous and academically challenging course.

It is recommended that students have completed Chemistry or Honors Chemistry with an A and Algebra II with a B or better, or have the recommendation of their previous Chemistry teacher AND the instructor.

Course Title: **AP Chemistry**	
Unit Title: Atomic Structure and Properties of Matter	**Unit Number:** 1
Textbook Chapters: Zumdahl Chapters 1, 2, 3	
Pacing: Summer, 1st Week of September	
Curriculum Writers: Anne Marie Anenberg & Alex Mazella	

Desired Outcomes

Next Generation Science 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-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.**

New Jersey Common Core Standards:
Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8.
Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4

Established Goals:

Big Idea 1: The chemical and physical properties of materials can be explained by the structure and arrangement of atoms. These atoms retain their identity in chemical reactions. Molecules are named according to structure and the proportions of elements can be determined.

Big Idea 2: 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.

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.

Enduring Understandings:	**Essential Questions:**
1. The notion of the atom as the smallest pieces of matter. 2. Key experiments led to the discovery of electrons and to the nuclear model of an atom. 3. Development of the modern theory of atomic structure, including the ideas of atomic number, atomic mass, isotopes. 4. Atoms assemble to form molecules. 5. Stoichiometry is the study of quantities of products and reactants in chemical reactions. 6. Quantitative observations are a fundamental part of science. 7. Both the quantity and unit must be present in order for a measurement to be meaningful.	1. What is an atom? 2. What were the postulates of Dalton's atomic theory? 3. How is atomic structure related to electricity? 4. How did the studies of cathode rays and radioactivity explain the structure of the atom? 5. What were the limitations of Rutherford's gold foil experiment? 6. How can stoichiometry be used to predict quantities of reactants, products, percent yield and limiting reactants? 7. What is the importance of accurate and precise measurements in chemistry?

Students will Know:

- Evidence for the atomic theory
- Atomic masses; determination by chemical and physical means
- Atomic number and mass number; isotopes
- Ionic and molecular species present in chemical systems: net ionic equations
- Balancing of equations, including those for redox reactions
- Mass and volume relations with emphasis on the mole concept

Students will be able to:

- ***Chemical Foundations – Chapter 1*** - Manipulate measurement and units, use significant figures, use dimensional analysis, classify matter
- ***Atoms, Molecules, and Ions – Chapter 2*** – Describe early history of chemistry, Dalton's Atomic Theory, Avogadro's hypothesis, early experiments to characterize atomic structure, modern view of the atom, and organization of the periodic table. Apply Law of conservation of mass, and Law of definite and multiple proportions. Name compounds.
- ***Stoichiometry – Chapter 3*** – Use Atomic mass. Calculate mole and molar mass, percent composition of compounds. Determine empirical formula, Use chemical equations for stoichiometric calculations (emphasis on using dimensional analysis as the problem-solving technique of choice). Determine limiting reagent, percent yield and percent purity

Assessment Evidence

Performance Tasks:	**Other Evidence:**

• Summarize and Outline Textbook • Problems from text • Prior Free Response AP Chemistry Questions • Multiple Choice Questions from AP Chemistry Workbook • Laboratory Reports • Quiz on each chapter • Test on Unit using AP Format.	Modeling kit, worksheets

Learning Plan

Learning Activities:

- ***Laboratories to include:*** Measurement to determine accuracy and precision, Separation of dyes using chromatography, Gravimetric Determination of percent phosphorous in a plant food, Gravimetric Analysis of Calcium and Hard Water.
- ***Demonstrations to include:*** mole of different substances
- ***Animations to include:*** Millikan Oil Drop Experiment, Rutherford experiment

Course Title: **AP Chemistry**	
Unit Title: The Bonding of Matter	**Unit Number:** 2
Textbook Chapters: Zumdahl Chapters 7, 8, 9	
Pacing: 2nd, 3rd, and 4th Weeks of September	
Curriculum Writers: Anne Marie Anenberg & Alex Mazella	

Desired Outcomes

Next Generation Science 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-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-PS3-5 **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.**

New Jersey Common Core Standards:

Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8.
Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4

Established Goals:

Big Idea 1: The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.

Big Idea 2: 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

Enduring Understandings:	Essential Questions:
1. Light or radiant energy has wavelike properties and is characterized by wavelength, frequency and speed. 2. Radiation given off by an object and the way in which light strikes a metal surface can free electrons and indicate electromagnetic radiation has particle like properties called Photons. 3. Atoms give off characteristic colors of light (line spectra) that provide clues about how many electrons are arranged in an atom. 4. Electrons exist in certain energy levels around the nucleus. 5. The arrangement of electrons in atoms in quantum mechanical model, using orbitals, completes the modern view of the atom. 6. The energies of orbitals as well as some fundamental characteristics of electrons described by Hund's Rule allows us to determine how electrons are distributed among various orbitals. 7. The conditions required to form a bond like Ionic or covalent. 8. The energies of formation of ionic substances and the lattice energies of these substances. 9. Bonds can be represented in diagrams called Lewis structures as single, double, and triple. 10. Electronegativity and its effect on bonding. 11. Distinguish between polar and nonpolar bonds. 12. The rules used for drawing Lewis structures, including formal charge of atoms in molecules. 13. Resonance structures are a blend of possible Lewis dot models for a molecule. 14. There are exceptions to the octet rule in cases with fewer than 8 electrons in the valence shell. 15. Energy changes occur during bond formation. 16. Predict the shape of, and bond angles in, simple molecules and ions using VSEPR theory. 17. The concept of the dative (coordinate) bond related to Lewis structures. 18. Polarization caused by small highly charged cations leads to ionic	1. What is the wave nature of radiant energy? (Frequency, wavelength and speed) 2. What are the major regions in the electromagnetic spectrum? 3. What is quantum of energy? How is energy related to light frequency? 4. What is a continuous spectrum and a discontinuous spectrum? 5. What is line spectrum and how is it formed? 6. What are the main ideas of Bohr's model? 7. What are atomic orbitals in terms of the shape, size and energy? 8. What is the connection between quantum numbers and orbitals? 9. How can the electronic configuration of atoms be determined using principles of energy, orbitals capacity and electron spin? 10. What are the Pauli Exclusion Principle, the Aufbau Principle and Hund's rule? 11. Why do atoms bond? 12. What is valence-bonding theory? 13. How are covalent bonds formed and nature of the covalent bond? 14. What is the concept of resonance related to Lewis structures? 15. What is the connection between concept of formal charge related to Lewis structures? 16. How do we predict the shape of, and bond angles in, simple molecules and ions using VSEPR theory? 17. How are molecular geometries predicted using a simple model (VESPR) largely based on Lewis dot model. 18. How is the concept of the dative (coordinate) bond related

compounds exhibiting some covalent character. 19. The differences in electronegativity in covalent molecules causes dipoles and some ionic character in covalent compounds. 20. Certain molecules exhibit polarity. 21. The shapes of simple molecules and ions is predicted using Lewis structures. 22. Understand the nature of sigma and pi bonds in bonding. 23. Identify different types of orbital hybridization.	to Lewis structures? 19. Can polarization caused by small highly charged cations lead to ionic compounds exhibiting some covalent character? 20. What differences in electronegativity in covalent molecules causes dipoles and some ionic character in covalent compounds? 21. Can Lewis structures be used to predict the shapes of simple molecules and ions? 22. How can we calculate bond energies and bond dissociation energies? 23. Why molecules form bonds and why do they have shapes? 24. What is hybridization? 25. How do you predict the hybridization given a molecule? 26. What are sigma and pi bonds? 27. How does polarity affect bond geometry? 28. Explain why water molecule is polar?

Students will Know:

- Electron energy levels: atomic spectra, quantum numbers, atomic orbitals
- Periodic relationships including, for example, atomic radii, ionization energies, electron affinities, oxidation states
- Bonding Types: ionic, covalent, metallic, hydrogen bonding, van der Waals (including London dispersion forces)
- Relationships to states, structure, and properties of matter
- Polarity of bonds, electronegativities
- Molecular models
- Lewis structures
- Valence bond: hybridization of orbitals, resonance, sigma and pi bonds
- VSEPR Geometry of molecules and ions, structural isomerism of simple organic molecules and coordination complexes; dipole moments of molecules; relation of properties to structure

Students will be able to:

- ***Atomic Structure and Periodicity - Chapter 7*** – Define electromagnetic radiation, photon, dual nature of light. Use Planck's constant to calculate wavelengths, frequency and energy. Solve E=mc2 . Compare continuous vs. line spectra. Describe the Bohr atom, and modern view of atom including wave function and probability. Determine orbital shapes and energies and relate to Heisenberg Uncertainty Principle, Electron spin and Pauli principle, and Aufbau principle. Describe the history of periodic table. Explain periodic trends: atomic radii, ionization energy, electron affinity, electronegativity and oxidation states. Define properties of groups: Alkali metals, alkaline earth metals, halogens, and transition metals.

- ***Bonding: General Concepts - Chapter 8*** – Define the three types of bonds. Describe bond polarity and dipole moment. Relate electron configurations to size of atoms and ions. Describe the formations of ionic compounds and the ionic character of covalent bonds. Define bond energies, enthalpy and relate to chemical reactions. Draw Lewis structures that include consideration of exceptions to octet rule, formal charge, and resonance. Describe molecular shapes, VSEPR Theory, molecular polarity.
- ***Covalent Bonding: Orbitals - Chapter 9*** – Describe orbitals present in multiple bonds and hybrid orbitals. Define paramagnetism and diamagnetism.

Assessment Evidence

Performance Tasks:

- Summarize and Outline Textbook
- Problems from text
- Prior Free Response AP Chemistry Questions
- Multiple Choice Questions from AP Chemistry Workbook
- Laboratory Reports
- Quiz on each chapter
- Test on Unit using AP Format.

Other Evidence:

- Lewis Model worksheets
- VESPR worksheet
- Electron configuration worksheets

Learning Plan

Learning Activities:

Laboratories to include: Analysis of Food Dyes in Beverages (Beer's Law), Percent Copper in Brass (Copper Absorption Spectra)

Demonstrations to include: Magnet simulation of proton/electron attraction, polarity of water, model of orbital shapes and hybrid orbital shapes

Animations to include: Sodium and potassium in water, halogen properties, line spectra of sodium, hybridization, polar molecules

Activities to include: Balloon and clay models of orbitals, worksheets, and problems sets

Course Title: **AP Chemistry**	
Unit Title: Intermolecular Forces of Gases, Liquids, and Solids	Unit Number: 3
Textbook Chapters: Zumdahl Chapters 5, 10	
Pacing: 1st and 2nd Week of October	
Curriculum Writers: Anne Marie Anenberg & Alex Mazella	

Desired Outcomes

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

New Jersey Common Core Standards:

Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8.
Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4

Established Goals:

Big Idea 1: The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.

Big Idea 2: Chemical and physical properties of material can be explained by the structure and the arrangement of atoms, ion, or molecules and the forces between them.

Enduring Understandings:

1. Different units are used to express both press ure (atm, kPa, mm Hg) and temperature (oF oC, K).
2. Gases can be related using variables like pressure, temperature, amount, and volume.
3. The importance of the Ideal gas equation.
4. Use the van der Waals equation (modified ideal gas law) in calculations.
5. The molar gas volume is 22.4L.
6. The Kinetic theory explains the behavior of gases.
7. The difference between effusion and diffusion and perform calculations relating to those concepts.
8. Interactions of solids in reference to the occurrence, relative strength, and nature of dipole-dipole interactions, London dispersion forces, and hydrogen bonds explain molecular bonding.
9. Viscosity and surface tension define the nature of liquids.
10. Physical properties help to identify types of solids.
11. The unit cell is a crystalline structure.
12. Phase changes are related to the transition of matter between gaseous, liquid, and solid states.
13. The dynamic equilibrium that exists between a liquid and its gaseous states introduces the idea of vapor pressure.
14. Temperature and intermolecular forces play an important role in determining the physical state of a substance.

Essential Questions:

1. What are the characteristics of gases?
2. How are the properties different for each state of matter?
3. What are the measurable quantities of gases?
4. Define the gas laws?
5. What is an ideal gas and a real gas?
6. What is the kinetic molecular theory?
7. What is the significance of the Ideal gas equation?
8. How do we relate gas density to temperature and molar mass?
9. Why are solids and liquids called condensed states of matter?
10. What are the intra and inter molecular forces?
11. How is each intermolecular force different?
12. Define viscosity and name the factors that affect viscosity?
13. What is surface tension and how is surface tension affected?
14. What is the phase diagram?
15. What is a heat curve?
16. What is vapor pressure?
17. What is the relation between vapor pressure and temperature?
18. What is a unit cell?

Students will Know:

- Laws of ideal gases
- Equation of state for an ideal gas
- Partial pressures Kinetic molecular theory
- Interpretation of ideal gas laws on the basis of this theory
- Avogadro's hypothesis and the mole concept

- Dependence of kinetic energy of molecules on temperature
- Deviations from ideal gas laws
- Liquids and solids from the kinetic-molecular viewpoint
- Phase diagrams of one-component systems
- Changes of state, including critical points and triple points
- Structure of solids; lattice energies

Students will be able to:

Gases - Chapter 5 – Use Gas laws determined by Boyle, Charles and Gay-Lussac to calculate pressure, volume, and/or temperature. Use Ideal gas law and apply gas stoichiometry in calculations. Perform calculations using Dalton's law of partial pressure. Describe Kinetic Molecular Theory. Define effusion and diffusion. Describe properties of real gases and the Van der Waal equation.

Liquids and Solids - Chapter 10 – Describe intermolecular forces of solids, liquids, and gases. Interpret information from vapor pressure graphs. Describe the properties of ionic and metallic solids.

Assessment Evidence

Performance Tasks:

- Summarize and Outline Textbook
- Problems from text
- Prior Free Response AP Chemistry Questions
- Multiple Choice Questions from AP Chemistry Workbook
- Laboratory Reports
- Quiz on each chapter
- Test on Unit using AP Format.

Other Evidence:

Gas Laws worksheets, crystal arrangements worksheet

Learning Plan

Learning Activities:

Laboratories to include: Vapor Pressure Lab, What's in the Bottle? (AP Lab Investigation #6)

Demonstrations to include: Diffusion vs. Effusion, Sublimation of dry ice, reading a barometer, balloon size with temperature change

Animations to include: air bags, kinetic energy of molecules,

Activities to include: worksheets, marshmallow in a syringe

Course Title: **AP Chemistry**	
Unit Title: Solutions	Unit Number: 4
Textbook Chapters: Zumdahl Chapters 4, 11	
Pacing: 3rd and 4th Week of October	
Curriculum Writers: Anne Marie Anenberg & Alex Mazella	

Desired Outcomes

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

New Jersey Common Core Standards:

Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8.
Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4

Established Goals:

Big Idea 2: Chemical and physical properties of material can be explained by the structure and the arrangement of atoms, ion, or molecules and the forces between them.

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.

Enduring Understandings:	**Essential Questions:**
1. The dissolving process of a liquid at the molecular level. 2. The relation between solubility and nature of the substance that dissolves it. 3. The solution process brings a change in energy and how particles are distributed in space. 4. Differences between unsaturated and saturated solutions. 5. Factors that affect solubility of a solute in a given solvent. 6. Colligative properties qualitatively describe solutions. 7. The number of moles of a solid substance present in a reaction can be calculated from data. 8. Molarity and molality quantitatively describe solutions. 9. Calculations relating to the Beer-Lambert law. 10. Proper dilution of solutions using M1V1=M2V2 11. The concept of vapor pressure 12. Relative changes (both quantitative and qualitative) in vapor pressure to addition of non-volatile solutes to solvents (Raoult's Law) 13. Raoult's Law in terms of ideal solutions of two volatile components AND deviations from ideal behavior 14. Equations relating to quantitative treatments of Boiling Point Elevation, Freezing Point Depression, Osmotic Pressure and the van't Hoff factor	1. What is a solution? 2. What is a solute and a solvent? 3. How do intermolecular forces affect solubility of a solute? 4. What is solubility? 5. What is Molarity, molality, mole fraction, Normality? 6. What are colligative properties? 7. What is the lowering of vapor pressure? 8. What is Raoult's Law? 9. How do we use equations to describe reactions in solution?

Students will Know:

- Types of solutions and factors affecting solubility
- Methods of expressing concentration
- Raoult’s law and colligative properties (nonvolatile solutes); osmosis
- Nonideal behavior (qualitative aspects)
- Acid-base reactions; concepts of Arrhenius, Brønsted-Lowry and Lewis; coordination complexes; amphoterism
- Precipitation reactions Oxidation-reduction reactions
- Oxidation number
- The role of the electron in oxidation-reduction

Students will be able to:

Types of Chemical Reactions and Solution Stoichiometry – Chapter 4 – Describe the composition of solutions. Predict and identify precipitation reactions, acid/base reactions, oxidation/reduction reactions (including balancing thereof). Calculate concentrations of solutions. Solve stoichiometry problems involving solution chemistry, write and balance net ionic equations

Properties of Solutions - Chapter 11- Calculate the change in enthalpy of a solution. Explain Raoult's Law and the effect of temperature on a solution. Describe colligative properties of solutions. Calculate the effects of substances in solution according to boiling-point elevation and freezing-point depression.

Assessment Evidence

Performance Tasks:	Other Evidence:
• Summarize and Outline Textbook • Problems from text • Prior Free Response AP Chemistry Questions • Multiple Choice Questions from AP Chemistry Workbook • Laboratory Reports • Quiz on each chapter • Test on Unit using AP Format.	

Learning Plan

Learning Activities:

Laboratories to include: Iron redox titration, Analysis of hydrogen peroxide titration

Demonstrations to include: Precipitation reaction, dissolution of KMnO4

Animations to include: acid-base reaction, redox reaction,

Activities to include: Writing net ionic equations, practice problems

Course Title: **AP Chemistry**

Unit Title: Chemical Kinetics and Thermodynamics	Unit Number: 5

Textbook Chapters: Zumdahl Chapters 6, 12, 17

Pacing: All of November

Curriculum Writers: Anne Marie Anenberg & Alex Mazella

Desired Outcomes

Next Generation Science 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.**

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).**

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-PS1-5 **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.**

New Jersey Common Core Standards:

Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8.
Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4

Established Goals:

Big Idea 4: Rates of chemical reactions are determined by the details of the molecular collisions.

Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter

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<u>Enduring Understandings:</u>

1. The nature of energy and its representations notably kinetic and potential energy.
2. The conversion of energy.
3. The idea of calorimetry.
4. Relationship between foods and fuel values as source of energy.
5. Suitable equations for standard enthalpy of formation and enthalpy of combustion.
6. The use of Hess's law cycle or algebraic methods to calculate a given enthalpy change
7. Understand that reactions occur at different rates.
8. Experimental variables like reactants, temperature, and catalyst affect reaction rates.
9. Express reaction rates and how the rates of disappearance and rate of appearance are related to the stoichiometry of the reaction.
10. Concentration changes with time.
11. Temperature has an effect on rate, and requires a minimum input of energy called activation energy.
12. Collision Theory is a driving force of kinetics
13. Temperature, concentration, surface area and catalysts all affect the rate of reaction.
14. A Maxwell-Boltzman distribution plot is used to describe kinetics
15. Initial rate data is used to deduce orders, rate equations and rate constants (including units).
16. There is a link between the rate determining (slow step) in a reaction mechanism and the rate equation
17. The difference between exothermic and endothermic
18. The concept of entropy has both descriptive and calculation contexts
19. The concept of Gibbs Free Energy has both descriptive and calculation contexts
20. Apply the energetics of the ionic bond as described by the Born-Haber cycle and associated calculations

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<u>Essential Questions:</u>

1. What is a system?
2. What is the surrounding?
3. What is a closed system?
4. Distinguish between exothermic and endothermic reactions?
5. Explain enthalpy and enthalpy change?
6. What is Hess's law?
7. What is a calorimeter?
8. Explain the heats of reaction.
9. Compare heat and temperature.
10. Define the rate of a chemical reaction. Name the factors that affect the rates of reactions.
11. Identify the intermediate product or a reaction mechanism.
12. Describe the rate law for a chemical reaction.
13. Explain how energy is involved in chemical reactions?
14. Define activation energy, and describe an activated complex.
15. List the factors that affect reaction rates and explain them according to collision theory.
16. What is a reaction mechanism?
17. What is the purpose of a catalyst?

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21. Charge density plays a role in determining some physical properties of ionic compounds	

Students will Know:

- Concept of rate of reaction
- Use of experimental data and graphical analysis to determine reactant order, rate constants, and reaction rate laws
- Effect of temperature change on rates
- Energy of activation; the role of catalysts
- The relationship between the rate-determining step and a mechanism
- State functions
- First law: change in enthalpy; heat of formation; heat of reaction; Hess's law; heats of vaporization and fusion; calorimetry
- Second law: entropy; free energy of formation; free energy of reaction; dependence of change in free energy on enthalpy and entropy changes
- Relationship of change in free energy to equilibrium constants and electrode potentials

Students will be able to:

Chemical Kinetics - Chapter 12 – Calculate reaction rates and rate laws. Determine rate laws from data. Describe integrated rate laws and graphic representation. Define reaction mechanism and catalysis.

Thermochemistry – Chapter 6 – Describe the nature of energy. Describe the First Law of Thermodynamics. Define state functions, work, heat and internal energy. Define enthalpy and relate to calorimetry. Use Hess's Law to calculate energy in reactions. Use standard enthalpies of formation to determine enthalpy of reaction. Relate thermochemistry to present and future energy sources.

Spontaneity, Entropy, and Free Energy - Chapter 17 – Describe conditions for a spontaneous process. Define entropy and Free energy. Calculate entropy changes in chemical reactions. Calculate Free energy in chemical reactions. Explain dependence of free energy on pressure. Relate free energy to equilibrium and work.

Assessment Evidence

Performance Tasks:

- Summarize and Outline Textbook
- Problems from text
- Prior Free Response AP Chemistry Questions
- Multiple Choice Questions from AP Chemistry Workbook

Other Evidence:

• Laboratory Reports • Quiz on each chapter • Test on Unit using AP Format.	

Learning Plan

Learning Activities:

- Laboratories to include: Crystal Violet kinetics, peroxide decomposition, designing a hand warmer
- Demonstrations to include: iodine clock experiment, spontaneous endothermic reaction
- Animations to include: catalyst, kinetic
- Activities to include: marbles in a pan (order does not return to original)

Course Title: **AP Chemistry**	
Unit Title: Equilibrium	Unit Number: 6
Textbook Chapters: Zumdahl Chapters 13, 14, 15, 16	
Pacing: All of December	
Curriculum Writers: Anne Marie Anenberg & Alex Mazella	
Desired Outcomes	
Next Generation Science 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.** HS-PS1-7 **Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** **New Jersey Common Core Standards:** Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8. Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4	
Established Goals: ***Big Idea 6:*** 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.	
Enduring Understandings: 1. A balance exists in nature known as dynamic equilibrium. 2. Expressions can be written for the concentration of a solution as the equilibrium constant Kc in a given chemical equation. 3. The magnitude of an equilibrium constant, and how to determine the ways in which its value is affected when equations are reversed or changed.	**Essential Questions:** 1. What is meant by "Dynamic Equilibrium"? 2. How is an equilibrium constant calculated? 3. What is the law of mass action? 4. How is the equilibrium constant applied? 5. What factors affect the equilibrium constant? 6. How can LeChatelier's principle be applied to different

4. Equilibrium takes a finite time to be achieved. 5. Values for Kc and associated data are determined from initial concentrations. 6. The partial pressures in a chemical equation can be expressed as the equilibrium constant Kp. 7. There are basic differences between acids and bases. 8. Bronsted-Lowry, Arrhenius, and Lewis define acids and bases. 9. Acids and bases form conjugate pairs. 10. Strong and Weak acids are differentiated in terms of ionization. 11. Water undergoes autoionization into an acid and a base. 12. K_w is the ionic product of water constant. 13. LeChatelier's principle helps to understand the common ion effect. 14. Buffer solutions have an effect on the pH. 15. An acid is a hydrogen ion donor 16. A base is a hydrogen ion acceptor 17. The degree of ionization/dissociation determines the strength of an acid and a base 18. In a neutralization reaction an acid and base react to form a salt and water 19. The application of LeChatelier's Principle helps to predict the shift in position of equilibria and optimum conditions in reactions 20. The relationship of Kc to Kp is critical to equilibrium, and the different formats of Kc (reciprocals and roots) are related to simultaneous equilibria 21. Calculations are involved with understanding the concept of solubility product and the common ion effect 22. Phase diagrams and heating and cooling curves help to describe chemical equilibrium	reactions? 7. What is an Arrhenius acid and base? Give some examples? 8. Define Bronsted-Lowry acid and bases. 9. What is a conjugate acid- base pair? 10. What is the autoionization of water? 11. What is meant by pH? 12. What is a strong acid and strong base? 13. How are the weak acid and weak base dissociation constants calculated? 14. What are the types of acids and bases? 15. What is the relation between K_a, K_b, and K_w? 16. What is the common Ion effect? 17. What is a buffer solution? What is buffer capacity? 18. How do buffer solutions behave when pH changes? 19. What is a titration? Describe the different titrations in solutions? 20. What is the purpose of an indicator? How do indicators work? 21. What are titration curves? 22. What are redox titrations?

<u>Students will Know:</u>

- Concept of dynamic equilibrium, physical and chemical; Le Chatelier’s principle; equilibrium constants
- Quantitative treatment
- Equilibrium constants for gaseous reactions: Kp, Kc

- Equilibrium constants for reactions in solution
- Constants for acids and bases; pK; pH
- Solubility product constants and their application to precipitation and the dissolution of slightly soluble compounds
- Common ion effect; buffers; hydrolysis

Students will be able to:

Chemical Equilibrium - Chapter 13 – Describe equilibrium conditions and calculate the equilibrium constant. Identify heterogeneous equilibrium. Solving equilibrium problems using an ICE table. Apply LeChatelier's principle to equilibrium problems.

Acids and Bases - Chapter 14 – Describe the nature of acids and bases, acid strength, and the pH scale. Calculate pH of strong and weak acid solutions. Define a base. Identify polyprotic acids. Describe acid/base properties of salts and oxides. Define Arrhenius acid/base and Bronsted-Lowry acid/base. Solve acid/base problems in relation to equilibrium and pH.

Acid-Base Equilibria - Chapter 15 – Solve problems with acid or base solutions with a common ion. Describe and do calculations with buffered solutions. Identify buffer capacity. Solve problems with titrations and pH curves. Choosing the appropriate indicator for titrations

Solubility and Complex Ion Equilibria - Chapter 16 – Solve problems using the solubility product constant (Ksp). Describe and do calculations related to the Common Ion Effect, pH, and solubility. Solve problems with complex ions and formation constants.

Assessment Evidence

Performance Tasks:

- Summarize and Outline Textbook
- Problems from text
- Prior Free Response AP Chemistry Questions
- Multiple Choice Questions from AP Chemistry Workbook
- Laboratory Reports
- Quiz on each chapter
- Test on Unit using AP Format.

Other Evidence:

Learning Plan

Learning Activities:

- Laboratories to include: Applications of LeChatlier's Principle, Acid-Base Titrations, Buffers in Household Products
- Demonstrations to include: pH indicators, buffers and pH change, Effect of temperature on nitrogen dioxide. Animations to include:

equilibrium, pH indicators
- Activities to include: Identify strong acids and bases, Determine pH of strong and weak acids.

Course Title: **AP Chemistry**	
Unit Title: Electrochemistry and Organic Chemistry	Unit Number: 7
Textbook Chapters: Zumdahl Chapters 18, 19, 22	
Pacing: 1st, 2nd, and 3rd Week of January	
Curriculum Writers: Anne Marie Anenberg & Alex Mazella	

Desired Outcomes

Next Generation Science 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-PS1-7 **Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.**

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-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-PS3-5 **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.

New Jersey Common Core Standards:

Literacy in Science and Technical Subjects RST.11- 12.1-6, RST.11-12.1.8.
Writing in History/Social Studies, Science, and Technical Subjects WHST.11-12.1d-e, WHST.11-12.2a-e, WHST.11-12.4

Established Goals:

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons

Enduring Understandings:

1. The definition of oxidation and reduction are in terms of electrons.
2. Standard electrode potential is central to electrochemistry.
3. A cell diagram (line notation) is an illustration for the apparatus needed in electrochemistry.
4. Standard electrode potentials are measured under certain conditions.
5. The nature and purpose of a salt bridge is critical to electrochemistry.
6. The Nernst equation is used to derive the relationship between cell potential and concentration of cell components.
7. A relationship exists between Gibbs free energy, equilibrium constants, and the Ecell.
8. Electrolysis forces a nonspontaneous reaction to occur.
9. The Atomic # and Mass # of an isotope is used to calculate the numbers of protons, neutrons and electrons present.
10. The term isotope refers to changes in the number of neutrons in an atom.
11. Radioactivity and the properties of radioactive particles determine the stability of an atom.
12. Half-life is the time it takes for an atom to decay.
13. Radioactivity has many uses.
14. The neutron:proton ratio is used to make predictions about stability.
15. Nuclear fission and fusion have differing definitions.
16. In very general terms, radioactivity involves the

Essential Questions:

1. How are electrochemical cells created and what is the source of electrical current?
2. How are redox equations balanced using the half-reaction method?
3. How can the Nernst equation be used to calculate cell potential?
4. How is electrochemistry related to batteries, corrosion, electrolysis and other commercial electrolytic processes?
5. How do mass and energy interchange in nuclear chemistry?
6. How are balanced equations written for nuclear processes written?
7. How is the half-life of a radioactive sample determined?
8. How does a nuclear power plant work?
9. What is the importance of detection and uses of radioactivity?
10. How can the vast number of organic molecules be named and categorized?
11. What is the importance of organic chemistry to the understanding of living systems, materials and energy sources?

rearrangement of the nucleus and chemical reactions involve the rearrangement of electrons. 17. IUPAC rules are used to name aliphatic organic compounds. 18. Organic molecules undergo reactions (Combustion, Substitution, Acid Base, Addition & Esterification) similar to those of inorganic molecules.	

Students will Know:

- The definition of oxidation and reduction in terms of electrons.
- The definition of standard electrode potential
- How to construct a cell diagram (line notation) and draw a diagram (picture) of the apparatus needed
- The conditions that standard electrode potentials are measured under
- The nature and purpose of a salt bridge
- How to predict the likelihood or otherwise of chemical reactions using standard electrode potentials and understand how those predictions may not prove to be accurate
- The Nernst equation, and how to use it
- The relationship between Gibbs free energy, equilibrium constants and Ecell, and be able to perform related calculations
- Electrolysis and be able to perform quantitative calculations relating to it
- Nuclear chemistry: nuclear equations, half-lives, and radioactivity; chemical application
- The method of naming and organizing organic compounds
- Characteristics of alkanes, alkenes and alkynes
- Types of polymers and their properties and applications
- The importance of organic chemistry to the understanding of living systems, materials and energy sources

Students will be able to:

Electrochemistry - Chapter 18 – Determine oxidation states. Balance Redox Equations. Describe voltaic cells. Use standard reduction potentials to calculate cell potential, electrical work, and free energy. Determine cell potential based on concentrations of solution. Relate electrochemistry to batteries, corrosion, electrolysis, and commercial electrolytic processes.

The Nucleus: A Chemist's View - Chapter 19 - Describe the difference between alpha, beta, and gamma particles. Explain Radioactive Decay and the calculation of an element's half-life. Explain the difference between nuclear fission and nuclear fusion.

Organic and Biological Molecules- Chapter 22 - Naming of alkanes, alkenes and alkynes. Describe some basic information about alkanes, alkenes and alkynes including functional groups. Describe relationship to the petrochemical industry.

Assessment Evidence

Performance Tasks:	**Other Evidence:**
• Summarize and Outline Textbook • Problems from text • Prior Free Response AP Chemistry Questions • Multiple Choice Questions from AP Chemistry Workbook • Laboratory Reports • Quiz on each chapter • Test on Unit using AP Format.	

Learning Plan

Learning Activities:

- Laboratories to include: Electrolysis and Ksp.
- Demonstrations to include: rusting of iron,
- Animations to include: standard reduction potential, copper-zinc cell, tarnish of copper
- Activities to include: calculate free energy, determination precipitation using Ksp, and identification of chemicals in a battery, drawing models of organic molecules and building organic molecules. Using software to draw complex organic structures