COURSE TITLE

Advanced Placement Chemistry

LENGTH

Full Year

DEPARTMENT

STEM Department

SCHOOL

Rutherford High School

DATE

September 10, 2018

Initial BOE Approval Date (Born on): 6/15/2015

Advanced Placement Chemistry

I. Introduction/Overview/Philosophy

Advanced Placement Chemistry consists of a full high school academic year that is comparable to a general chemistry course in college. The course expands upon the basic principles learned in Chemistry 1 and is concerned with further developing the students' understanding of the more advanced concepts of chemistry and providing experience with its methods and applications. To this end, the extensive use of laboratory experimentation, demonstrations and other hands-on activities are an integral part of the everyday chemistry classroom. All of the following should culminate in a sufficient knowledge of chemistry to excel in post high school academics or in the appropriate Advanced Placement exam.

Students in this course should attain a depth of understanding of fundamentals and a reasonable competence in dealing with chemical problems. This course will contribute to the development of their ability to think clearly and to express their ideas, orally and in writing, with clarity and logic. The laboratory experiences in AP Chemistry are equivalent to that of a typical college course.

II. Objectives

Course Outline:

1. Describe Properties of Materials by:
    a. Distinguishing between chemical properties and physical properties.
    b. Distinguishing between intensive properties and extensive properties
2. Describe Types of Materials by:
    a. Identifying States of Matter
    b. Identifying Types of Matter
        Substances (*elements* and *compounds)*
        Mixtures (homogeneous *and heterogeneous)*
3. Describe the Separation of a Mixture by:
    a. Isolating substances
    b. Identifying mixtures
    c. Purifying
4. Identify the Types of separation:
    a. Filtration (precipitation)
    b. Distillation (fractional distillation)
    c. Chromatography
    d. Extraction and crystallization
    e. Control of acidity
    f. Electrolytic precipitation
5. Describe Elements and Atoms by:
    a. Explaining Dalton's Atomic Theory
    b. Describing Atomic Structure and relating:
        1.) Electromagnetic radiation and characteristics of waves
        2.) Energy of electromagnetic radiation and atomic spectra

3.) Bohr model and Quantum mechanic model
4.) Quantum numbers and orbital shapes and energy
5.) Aufban Principle and electron configuration
6.) Valance electrons and orbital diagrams

6. Identify the Atomic Numbers by:
   a. Defining: atomic number, mass number, isotopes, and atomic mass
   b. Determining Atomic Mass from isotopic data
7. Describe the Laws of Chemistry by:
   a. Explaining the Law of Definite Proportions
   b. Expelling the Law of Multiple Proportions
   c. Defining the mole and molar mass
   d. Determining percent composition and empirical formulas
8. Explore Nuclear Chemistry by:
   a. Identifying alpha-particles, beta-particles, positrons, and gamma rays
   b. Describing kinetics of radioactive decay and half life
9. Describe Radioactivity by explaining:
   a. Alpha-particle production
   b. Beta-particle production
   c. Positron production
   d. Electron capture
   e. Gamma-ray production
10. Describe the relationships in the Periodic Table by:
   a. Identifying the Periods
   b. Identifying the Groups (*families*)- Representative Elements, Transition Elements and the Inner Transition Elements (*Lanthanide series and Actinide Series)*
11. Describe the arrangement of the Periodic Table by:
   a. Classifying the Elements-metals *(alkali, alkaline),* nonmetals *(halogens)*, metalloids *(B/ Siege, As/Sb, Te/Po, At)*, noble gases, and hydrogen
   b. Explaining Periodic Properties: Atomic Radii, Ionization Energy and Electron Affinity
12. Explain Ionic Bonding by:
   a. Describing the Ionic Bond
   b. Explaining Coulomb's Law
   c. Predicting Formulas of Ionic Compounds
   d. Describing Lattice Energy and its determination
13. Explain Covalent Bonding by:
   a. Describing the Covalent Bond
   b. Exploring Electronegativity
   c. Describing Polar Covalent Bonds
   d. Explaining Bond Energy and its relation to Bond Length
14. Explore Intermolecular Forces by:
   a. Identifying the van der Waals Forces, both Dipole-dipole attraction and Hydrogen bonding.
   b. Explaining London dispersion forces
15. Explain Metallic Bonding by:
   a. Describing the Metallic bond
   b. Identifying Metallic Properties
16. Explain Molecular Structure by:
   a. Drawing Lewis Structures
   b. Explaining Resonance

c. Describing the VSEPR Model and predicting molecular shapes
d. Describing Hybridization and how it explains molecular geometries

17. Explain how Elements form Compounds by:
    a. Identifying elements that are reactive.
    b. Identifying compounds that are formed.
18. Describe Nomenclature by:
    a. Explaining Common Ion Nomenclature
    b. Explaining Binary Compound Nomenclature
    c. Identifying Common Names
19. Describe Types of Chemical Reactions by:
    a. Explaining Combustion, Combination, and Replacement Reactions.
    b. Introducing Acid Base, Precipitation, and Redox Reactions.
    c. Describing Complex Ion Formation.
20. Explain Stoichiometry by:
    a. Relating Balanced Equations to Reaction Stoichiometry.
    b. Identifying Limiting Reactants and Percent Yield
    c. Exploring Combustion Analysis.
21. Describe Organic Chemistry by:
    a. Investigating the major structural features of organic molecules.
    b. Determining the structural features of hydrocarbons.
    c. Learning the principles of formal (IUPAC) nomenclature.
    d. Predicting physical states and properties from structures.
22. Identify the three Classes of Organic Compounds by:
    a. Describing aliphatic, aromatic, and fullerene compounds
    b. Identifying the formula and structure of various members of the Organic Families- hydrocarbon groups, alcohols, ethers, aldehydes, ketones, acids, esters, amines, aromatic functional groups, and complex aromatics.
23. Describe The Gas Laws by:
    a. Explaining Charles' Law, Boyle's Law, and Gay-Lussac's Law.
    b. Using The Combined Gas Law to solve gas law problems.
    c. Defining Standard Temperature and Pressure units.
24. Explore the Molar Volume of a Gas by:
    a. Describing Avogadro's Law.
    b. Defining the Molar Volume of a Gas at STP.
    c. Relating molar volume to the density of a gas.
    d. Using The Ideal Gas Law to solve gas law problems.
    e. Solving for Molar Mass using the gas laws.
25. Describe Dalton's Law by:
    a. Explaining Dalton's Law of Partial Pressure.
    b. Describing Water Vapor Pressure.
    c. Explaining Gas Collection over Water.
26. Explore Gas Stoichiometry by using Gas Volumes to solve stoichiometry problems.
27. Describe the Kinetic Theory of Gases by:
    a. Explaining the Kinetic Molecular Theory.
    b. Defining an Ideal Gas.
    c. Distinguish between an Ideal Gas and a Real Gas.
    d. Exploring the van der Waals equation.
    e. Explaining and determining the Root-Mean-Square Velocity of a gas.

f. Explaining and determining the Effusion and Diffusion of gases.

28. Describe Intermolecular Forces by:
    a. Exploring Intermolecular Forces.
    b. Explaining how the Intermolecular forces affect the properties of liquid.
29. Describe the Properties of a liquid by:
    a. Defining Surface Tension
    b. Explaining Capillary Action and Viscosity
    c. Explaining Vapor Pressure and boiling using a Vapor Pressure Curve.
30. Describe the Types of Solids by:
    a. Distinguishing between Crystals and Amorphous solids.
    b. Describing Crystal Classification.
    c. Defining the Unit Cell.
    d. Describing the Types of Crystals.
31. Explain Metals by:
    a. Describing the Metallic bond.
    b. Exploring Alloys.
    c. Distinguishing between Substitutional alloys and Interstitial alloys.
32. Explore Change in State by:
    a. Describing a Heating Curve.
    b. Using a Phase Diagram.
33. Describe Solution Composition by:
    a. Defining a solution.
    b. Identifying the types of solutions.
34. Explain the Factors Affecting Solubility by:
    a. Describing the solution process.
    b. Exploring Pressure, Temperature, and Structural effects on solubility.
35. Describe Measuring Concentration of a Solution by:
    a. Defining and determining mole fraction, mass percent, molality (*m*), and Molarity (M).
    b. Exploring molarity calculations.
36. Describe the Vapor Pressure of Solutions by:
    a. Exploring the Affect of nonvolatile solutes.
    b. Explaining Raoult's Law.
    c. Distinguishing between Ideal solutions and real solutions.
37. Describe Colligative Properties by:
    a. Defining a colligative property.
    b. Exploring boiling point elevation and freezing point depression.
    c. Describing osmosis and osmotic pressure.
    d. Explaining Van't Hoff factors and how they are used.
38. Distinguish between Heat and Temperature by:
    a. Giving examples of different forms of energy.
    b. Listing the important units in which energy is expressed and convert from one unit to another.
    c. Distinguishing between heat and work.
39. Explain the Measurement of Heat by:
    a. Describing the term *state function* and determine its importance in thermochemistry.
    b. Calculating the quantity of heat involved in a reaction at constant pressure, given the quantity of reactants and the enthalpy change on a mole basis for the reaction.
40. Determine Specific Heat and Heat Capacity by:

a. Defining the terms specific heat and heat capacity.
b. Calculating the quantities heat, given the quantity of material, temperature change or specific heat.
c. Calculating the heat capacity of a calorimeter, given temperature change and quantity of heat.
d. Using specific heat to determine temperature changes and quantities of heat.
e. Relating the concepts of chemical systems, surroundings, boundaries, and exothermic and endothermic changes.
f. Defining and calculating the thermal properties of matter--heat capacity, specific heat and molar heat capacity.

41. Understand the concept of Enthalpy by:
    a. Defining and relating enthalpy and enthalpy change to the change in internal energy and the change in volume during the process.
    b. Illustrating what is meant by the term *standard state* and identifying the standard states for common elements.
    c. Calculating the enthalpy change in a reaction.
    d. Explaining how standard molar enthalpies of formation are established.
    e. Applying Hess's Law in standard formation reactions.
    f. Differentiating between the state of a system and a state function.
    g. Determining the difference between energy change and enthalpy change.
    h. Preparing, manipulating, and interpreting thermochemical equations and enthalpy diagrams.
42. Apply the Laws of Thermochemistry by:
    a. Distinguishing between kinetic and potential energy and understanding the roles played by attractions and repulsions in potential energy.
    b. Relating molecular kinetic energy to heat and temperature.
43. Apply Hess's Law to problems in thermochemistry by:
    a. Calculating the enthalpy change in a process.
    b. Applying Hess's Law of heat summation.
    c. Defining standard state and standard formation reactions.
    d. Using Hess's Law to calculate enthalpy changes.
    e. Using standard enthalpies of formation to calculate enthalpy changes.
44. Employ Heats of Formation to solve problems in thermochemistry by:
    a. Identifying standard heat of formation and the type of chemical reaction with which it is associated.
    b. Relating ΔH to the heat of reaction at constant pressure.
45. Use Calorimetry by:
    a. Explaining how to use a calorimeter and interpreting the data obtained.
    b. Calculating the heat of a reaction at constant volume using bomb calorimeter data.
    c. Using data obtained by employing calorimeters to calculate thermal properties.
46. Become familiar with the First Law of Thermodynamics by:
    a. Defining it both verbally and by means of an equation.
    b. Describing how the change in the internal energy of a system is related to exchanges of heat and work.
    c. Demonstrating the meaning of concept state function as it relates to internal energy.
    d. Explaining how thermodynamics deals with the exchange of energy between a system and its surroundings.
    e. Analyzing why the heat and work that a system exchanges with its surroundings are not state functions, even though the net energy change is a state function.

f. Learning what influence energy changes have on the tendency for an event to occur spontaneously.

47. Investigate Pressure Volume Work and how it applies to thermodynamics by learning why the heat of a reaction at constant volume is not necessarily equal to the heat of reaction at constant pressure.
48. Distinguish between ΔE and ΔH by demonstrating the purpose of enthalpy by computations in reactions involving gases.
49. Predict spontaneous change using Free Energy and Entropy by:
    a. Deriving the free energy equation and applying it to thermodynamics.
    b. Defining free energy in terms of enthalpy and entropy.
    c. Writing and using the equations that define free energy and free energy change.
    d. Determining ΔG o from tabulated data.
    e. Interrelating Gibbs free energy to energy and entropy factors in determining the spontaneity of a chemical or physical change.
    f. Calculating standard free energy changes.
    g. Relating free energy change to work from a chemical reaction.
50. Investigate the effect of Temperature on Reaction Spontaneity by:
    a. Applying spontaneous change to chemical reactions.
    b. Using the Gibbs-Helmholtz equation at various temperatures.
    c. Knowing that $\Delta G = 0$ at equilibrium.
    d. Describing the relationship between ΔG and the maximum useful work derived from a spontaneous process.
    e. Relating free energy to equilibrium.
    f. Using ΔG to predict the outcome of a chemical reaction.
51. Become familiar with the Equilibrium Law by:
    a. Describing the conditions of equilibrium in a reversible reaction.
    b. Recognizing how equilibrium concentrations are established experimentally.
    c. Knowing that the concentrations of pure liquids and solids are omitted from the equilibrium constant expressions.
    d. Constructing equations using the equilibrium law to relate concentrations of reactants and products in a chemical system.
    e. Writing the equilibrium law for a heterogeneous reaction.
52. Derive a relation between Free Energy and Equilibrium by:
    a. Writing the thermodynamic equilibrium constant expression for chemical reactions.
    b. Computing values for the equilibrium constant from tabulated data.
    c. Determining absolute entropies of substances using the third law of thermodynamics.
53. Investigate LaChatelier's Principle by:
    a. Quantitatively predicting how a system at equilibrium will react in response to a stress.
    b. Becoming familiar with the concept of dynamic equilibrium.
    c. Applying LaChatelier's Principle to chemical equilibria.
54. Develop the Equilibrium Constant Expression by:
    a. Calculating the numerical value of the equilibrium constant from equilibrium conditions.
    b. Relating the equilibrium constant for a reaction to the rate laws of forward and reverse reactions.
55. Distinguish between Kp and Kc by:
    a. Determining Kc for various operations with chemical equations.
    b. Writing expressions for Kp and Kc with reactions that involve gases.
    c. Converting between Kp and Kc for gaseous reactions.
56. Solve problems involving Equilibrium Concentrations by:

a. Writing the equilibrium expression in terms of concentrations.
b. Calculating the equilibrium condition in a reversible reaction from a set of initial conditions.

57. Use Partial Pressures and Kp to solve equilibrium calculations by:
    a. Using the ideal gas law and Dalton's law of partial pressures.
    b. Calculating new concentrations or partial pressures after stress has been exerted on a system.
    c. Writing the equilibrium law for gaseous reactions using partial pressures.
58. Define Reaction Quotients and apply to equilibrium constants by:
    a. Predicting the direction in which a reaction proceeds towards equilibrium.
    b. Using the magnitude of the equilibrium constant to make a qualitative estimate of the extent of the reaction.
59. Describe Precipitation Reactions by:
    a. Writing chemical equations to represent changes that take place when ionic solutes dissolve in water.
    b. Predicting products of metathesis reactions and the factors that cause them.
    c. Solving problems that deal with the stoichiometry of reactions in solutions.
60. Determine the Solubility Product Constant by:
    a. Expressing the solubility-product constant for a salt.
    b. Calculating Ksp from solubility data.
    c. Calculating the effect on an added common ion on the solubility of a slightly soluble salt.
    d. Writing equilibrium law for solubility and performing various calculations with data.
61. Describe Precipitate Formation by:
    a. Predicting whether a precipitate will form when two solutions are mixed.
    b. Explaining the effect of pH on a solubility equilibrium involving a basic or acidic ion.
    c. Explaining the general principles that apply to the groupings of metal ions in the qualitative analysis of an aqueous mixture.
    d. Writing and using solubility products when working with soluble oxides and sulfides of metals.
    e. Determining how selective precipitation can work to remove metal ions from solutions.
62. Explain Complex Ion Formation by:
    a. Formulating the equilibrium between a metal ion and a Lewis base.
    b. Describing how complex formation can affect the solubility of a slightly soluble salt.
    c. Calculating the concentration of metal ion in equilibrium with a Lewis base.
    d. Reviewing the formation and decomposition of complex ions.
    e. Identifying practical applications of complex ions.
63. Distinguish between Acids and Bases by:
    a. Exploring various acid and base definitions.
    b. Differentiating between strong and weak acids and bases.
    c. Identifying the six common strong acids and various weak acids.
    d. Recognizing the common strong and weak bases.
    e. Explaining how acid strength relates to the nature of the H-X bond.
    f. Predicting the relative acid strengths of oxyacids and oxyanions.
    g. Defining an acid or base in terms of the Lewis acid-base theory.
    h. Learning the Bronsted concept of acids and bases.
    i. Using the periodic table to organize information about acids.
    j. Defining acids and bases as independent both of solvents and the transfer of protons.
    k. Using the terminology of complex ions and writing formulas of complex ions.
64. Describe the Nature of Acids and Bases by:
    a. Explaining how acids and bases are prepared.

b. Identifying the properties of acids and bases.

65. Predict Acid Base Reactions by:
    a. Determining how acids and bases react with each other.
    b. Analyzing how acids and bases react with other substances.
    c. Learning how molecular acids and bases form ions.
    d. Writing chemical equations for the reactions of electrolytes in aqueous solutions.
    e. Judging from the formula of a salt if its ions can affect the pH of an aqueous solution.
    f. Explaining the relationship between an acid and its conjugate base, and between a base and its conjugate acid.
    g. Predicting whether a particular salt solution will be acidic, basic, or neutral.
66. Explore the concept of pH by:
    a. Explaining the autoionization of water.
    b. Explaining and calculating pH.
    c. Predicting qualitatively and calculating quantitatively the effect of an added common on the pH of an aqueous solution.
    d. Learning the extent of the self-ionization of water.
    e. Using the equations that define pH and pOH.
    f. Calculating the pH (or pOH) given the molar concentration of a dilute solution of a strong acid or a strong base.
    g. Using molarity data for buffer systems to calculate the pH of a buffered solution.
67. Describe the Acid Base Equilibria system by:
    a. Writing the acid-dissociation-constant expression for any weak acid in water.
    b. Calculating [H+] for a weak acid solution in water.
    c. Writing the base-dissociation-constant expression for a weak base in water.
    d. Calculating [H+] for any weak base solution in water.
    e. Calculating the percent dissociation for an acid or base.
    f. Writing the equation for Ka for an acid and using data to classify an acid.
    g. Judging the relative strengths of acids through various calculations.
    h. Writing the equation for Kb for a base and calculating various data regarding the base.
    i. Calculating values of pKb to judge various relative strengths of bases.
    j. Calculating pK from conjugate pairs.
68. Describe the Buffer System and how it operates by:
    a. Explaining how a buffer system is made and how it controls pH.
    b. Calculating the change in pH of a simple buffer solution.
69. Investigate Titration Process by:
    a. Explaining how indicators work.
    b. Calculating concentrations of each species present in a solution.
    c. Determining how the pH of solutions of acids or bases change and determining the principles involved in the choice of a good acid-base indicator.
70. Generate Titration Curves and explain their purpose by:
    a. Describing the titration of a strong acid by a weak base, and a weak acid by a strong base, or a weak base by a strong acid.
    b. Calculating the pH at any point in an acid-base titration.
71. Describe Oxidation Reduction by:
    a. Determining oxidation numbers.
    b. Writing oxidation, reduction and redox reactions.
    c. Balancing redox reactions.
72. Explain Electrolysis by:

a. Studying how an electrolysis apparatus is constructed and writing equations for the redox reactions that take place.
b. Describing electrolysis of molten salts and water.
c. Investigating electrolysis of aqueous solutions.

73. Describe Electrolytic Cells by:
    a. Diagramming and labeling an electrolytic cell.
    b. Explaining the process that occurs at the anode and cathode.
    c. Investigating the chemical reactions that can be studied electrically.
    d. Computing the amount of chemical change caused by the flow of a given amount of electricity.
74. Explain the various Applications of Electrochemical Cells by:
    a. Describing the phenomenon of corrosion in terms of electrochemical principles.
    b. Investigating the practical applications of electrolysis.
75. Describe Voltaic Cells by:
    a. Diagramming and labeling a voltaic cell.
    b. Determining how a spontaneous redox reaction can be set up to deliver electrical energy in a galvanic cell.
    c. Using standard reduction potentials to predict spontaneous cell reduction.
76. Explain the various Applications of Voltaic Cells by:
    a. Investigating the chemistry of some common types of batteries and researching possible future developments.
    b. Exploring Faraday's Laws, standard half-cell potentials, Nernst equation.
    c. Predicting the direction of redox reactions.
77. Explain Stoichiometry of Electrolytic Process by:
    a. Determining the mass of material plated.
    b. Calculating the charge of an electron.
78. Describe the Rate of a Chemical Reaction by:
    a. Determining the exact rate of a chemical reaction by using calculus.
    b. Determining the initial rate of a chemical reaction graphically and numerically.
    c. Defining reaction order and using the rate law to determine the order of a chemical reaction.
    d. Applying the method of initial rates to determine the rate law for a reaction.
    e. Comparing the speeds of reactions.
    f. Investigating the influences on the speed of a reaction.
    g. Expressing and measuring rates of reactions.
79. Solve problems involving Reaction Concentration and Time by:
    a. Using the concept of the half-life of a reaction.
    b. Quantitatively relating the rate of a reaction to the concentrations of the reactants.
    c. Calculating the concentration of a reactant at any time during the reaction.
    d. Relating the speed of a reaction to time.
80. Investigate Reaction Rate and Temperature by:
    a. Relating the increase in the rate of a reaction to an increase in temperature.
    b. Determining the quantitative effect of temperature on the rate of a reaction.
81. Explain Reaction Mechanisms by:
    a. Describing the factors that affect collision frequency.
    b. Explaining how transition-state theory extends the theoretical explanation of chemical kinetics.
    c. Defining reaction mechanism.

d. Deriving the rate law from a simple mechanism using the concepts of steady-state condition and rate-determining step.
e. Using the rate law for a reaction to predict the products in a reaction.

82. Explore Activation Energy and Catalysts by:
    a. Explaining the concept of activation energy.
    b. Using the Arrhenius equation in calculations involving rate constants, temperatures, and activation energy.
    c. Explaining how a catalyst modifies the rate of a chemical reaction.
    d. Differentiating between a homogeneous catalyst and a heterogeneous catalyst.

Student Outcomes:

After successfully completing this course, the student will:

- Apply problem-solving skills to develop and test hypotheses by planning experiments where they conduct observations, gather and analyze data, draw conclusions and communicate results.
- Appreciate that many people and cultures have contributed to the advancement of science and that major discoveries and events depend on many individuals.
- Relate scientific principles to technology.
- Apply mathematical concepts in scientific problem solving as a means of expressing scientific theories.
- Develop and utilize technical skills in a laboratory setting.
- Use appropriate safety procedures and practices in the laboratory.

New Jersey Student Learning Standards

CAREER READY PRACTICES

CRP1 Act as a responsible and contributing citizen and employee.

Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

CRP2 Apply appropriate academic and technical skills.

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation

CRP4 Communicate clearly and effectively and with reason.

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP7. Employ valid and reliable research strategies.
Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP10. Plan education and career paths aligned to personal goals.
Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

CRP11. Use technology to enhance productivity.
Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

CRP12. Work productively in teams while using cultural global competence.
Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

TECHNOLOGY

Standard 8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Strand A. Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
8.1.12.A.4- Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
8.1.12.A.5- Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

Strand C. Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

8.1.12.C.1- Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.

21ST CENTURY LIFE AND CAREERS

9.2 Career Awareness, Exploration, and Preparation

Strand C: Career Preparation

9.2.12.C.1 Review career goals and determine steps necessary for attainment.

9.2.12.C.2 Modify Personalized Student Learning Plans to support declared career goals.

COMPANION STANDARDS FOR SCIENCE AND TECHNICAL SUBJECTS

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

RST.11-12.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

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

WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.

NEW JERSEY STUDENT LEARNING STANDARDS- SCIENCE

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-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-PS1-6. 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.

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-PS2-4. 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.
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-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
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).
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.

III. Proficiency Levels

AP Chemistry is available to junior and senior students who have successfully completed Chemistry. In addition, these students should be taking or have completed Algebra 2.

IV. Methods of Assessment

Student Assessment
The teacher will provide a variety of assessments, among them are: homework, teacher made tests and quizzes, projects, presentations, and laboratory reports.

Curriculum/Teacher Assessment
The teacher will provide the subject area supervisor with suggestions for changes on an ongoing basis.

V. Grouping

AP Chemistry is a junior/senior level course. Students taking this course should have successfully completed Biology and Chemistry.

VI. Articulation/Scope & Sequence/Time Frame

Course length is one year.

VII. Resources

Texts/Supplemental Reading/References

Resources include but are not limited to:
1. Text

a. Brady and Senese, Chemistry: Matter and Its Changes. John Wiley and Sons. New York, 2004.

2. Additional References
   a. Brady and Holum, Chemistry: The Study of Matter and Its Changes. John Wiley and Sons.New York. 1996.
   b. Zumdalhl, Steven S. Chemistry. Houghton Mifflin Company. New York. 1996.
   c. Pauling, Linus. General Chemistry. Dover Publications, New York, 1988.
   d. Masterson, William L. and Slowinski, Emil J. Chemical Principles, 6th Edition. Saunders College Publishing, 1985.

VIII. Suggested Activities

Appropriate activities are listed in the curriculum map.

IX. Methodologies

AP Chemistry is a laboratory science with class time spent on laboratory experiments. Group instruction, cooperative learning hands-on activities and individual projects are also utilized.

X. Interdisciplinary Connections

Connections are made to mathematics, particularly to algebra and calculus by the use of various processes and formulas. Cooperative projects involving topics in calculus and chemistry serve to strengthen this connection. The use of spreadsheets to collect, graph and interpret data forms the connection to technology. Writing assignments and laboratory reports utilize skills taught in language arts literacy.

XI. Differentiating Instruction for Students with Special Needs: Students with Disabilities, Students at Risk, English Language Learners, and Gifted & Talented Students

Differentiating instruction is a flexible process that includes the planning and design of instruction, how that instruction is delivered, and how student progress is measured. Teachers recognize that students can learn in multiple ways as they celebrate students' prior knowledge. By providing appropriately challenging learning, teachers can maximize success for all students.

Differentiating in this course includes but is not limited to:

Differentiation for Support (ELL, Special Education, Students at Risk)

- Peer mentoring on problems
- Differentiated teacher feedback on assignments
- Modeling out problems on whiteboard
- Visual aids as we project problems on whiteboard
- Study guides
- Tiered assignments
- Scaffolding of materials and assignments
- Re-teaching and review
- Guided note taking
- Exemplars of varied performance levels
- Multi-media approach to accommodating various learning styles

Differentiation for Enrichment

- Supplemental reading material for independent study
- Flexible grouping
- Tiered assignments
- Topic selection by interest
- Enhanced expectations for independent study
- Elevated questioning techniques using Webb's Depth of Knowledge matrix

XII. Professional Development

The teacher will continue to improve expertise through participation in a variety of professional development opportunities.

XII. Curriculum Map/Pacing Guide

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Chemical Foundations ● Chemical calculations with scientific notation, sig. figures and estimation. ● Chemical nomenclature of ionic & covalent substances ● Develop balanced equations from observed phenomenon. ● Relate quantities (mass, volumes, pressures etc.) to determine stoichiometric relationships in a reaction. Refresh on Atomic Structure and PTE organization. (Isotopes – Group patterns of reactivity)	2 weeks	*For Support:* Summer Assignment Pack and *Zumdahl –Chemistry* Chapters 1-3 *For Enrichment:* Albert IO as a resource for experience in dealing with AP level MC questions. Inquiry based instruction as pertaining to lab work.	HS-PS 1-1 HS-PS 1-2 HS-PS 1-7 HS-PS 2-4 CRP1,2,4,7,8,10,11,12 9.2.12.C.1 9.2.12.C.2 WHST.11-12.6	*Formative Assessment:* Homework will generally be a daily event to reinforce and deepen understanding of topics currently under consideration. Inquiry Based Lab – *Vonderbrink* – AP Lab Manual Exp. # 5. " Finding Moles of Reactants and Products of a Reaction" Students will write a lab report to present their findings. *Summative Assessment* Unit exam that emphasizes stoichiometric principles and nomenclature. The underlying theme of particles reacting as also addressed – students will need to draw a particle model of a given reaction.

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Gas Laws & KMT ● Connect particles, moles, masses & volumes of substances to one another. ● Relate temperature to the motion of particles in a gas. ● Qualitatively analyze data from real gases to identify deviations from ideal behavior and relate these to molecular interactions. Qualitatively use the Boltzmann distribution to explain average kinetic energy	2 weeks	*For Support:* Brady & Senese Text – Ch. 11 – Properties of Gases. *For Enrichment:* *Phet* Simulation on Gas Law behavior. Albert IO for MC question practice. Student designed lab to demonstrate Graham's Law – best idea will be carried out by class and results compared across groups.	HS-PS 1-2 HS-PS 1-4 HS-PS 1-5 HS-PS 3-1 CRP1,2,4,7,8,10,11,12 8.1.12.C.1 RST.11-12.3 RST.11-12.4 WHST.11-12.2	*Formative Assessment:* Classwork – group based problem solving. Homework - packets covering all gas laws likely to be encountered in AP exam. Periodic quizzes as new gas laws are introduced. *Summative Assessment* *Vonderbrink* - AP Lab Manual Exp. # 9 – "Determining the Molar Mass of a Volatile Liquid" Timed unit exam on all gas law topics. MC and FRQ format will be used. Part of the assessment will be to evaluate a gas model in terms of varying conditions of P,V & T.
Chemical Kinetics ● Interpret the results of an experiment regarding the factors that may influence the rate of a reaction. ● Analyze concentration vs. time data to determine the rate law for a zero, first & second order reaction.	5 weeks	*For Support:* AP Chemistry Video Series from *Bozeman Science.* A well-done presentation covering the basic concept of kinetics and the effects of reactant concentrations. Brady & Senese Text – Ch. 15:	HS-PS 1-5 HS-PS 3-1 HS-PS 3-2 CRP1,2,4,7,8,10,11,12 WHST.11-12.2 RST.11-12.3 RST.11-12.4	*Formative Assessment:* Students are grouped into the order of the simulated reaction they were assigned. Assigned spokespersons discuss their group's lab activity, present their graphs and explain how their

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
• Relate the integrated rate law to the equation of a line to determine the order of a particular reaction from given experimental data. • The kinetics of half-life processes are examined for 1st & 2nd order reactions. • Explain why some molecular collisions are productive and others are not in terms of energy distribution and orientation. • Evaluate alternative explanations (mechanisms) to find which are consistent with overall rate data and which may infer the presence of an intermediate. • Translate among and between energy profile models, particulate models, and symbolic models a chemical reaction occurring in the presence or absence of a catalyst. • Explain changes in reaction rates arising from use of various types and kinds of catalysts.		Kinetics – The Study of Rates of Reaction. *For Enrichment:* Paired students will be assigned a simulated reaction. Using integrated rate laws they will find the order of their reaction using the graphical method. From this exercise they will generate the correct rate law for the reaction. Class will examine the equations of zero, 1st. or 2nd. order kinetics and use the equations to determine either reactant or product amounts as a function of time. Sulfur Clock reaction activity will enable students a hands-on means to apply the differential method for rate law determination and the value of the rate constant (*k).* Students will perform a spectroscopic analysis of the Reaction kinetics of crystal violet (*Chemistry w/ Vernier Exp. # 30)*		graphs show either, zero, 1st. or 2nd. order kinetics. Students will take a short quiz related to the Sulfur Clock reaction. As a class we discuss the data and calculations leading to the value of the rate constant *(k).* *Summative Assessment* Unit exam (timed) and done over a lab day to allow for coverage of MC questions and FRQ questions regarding all aspects of zero, 1st. or 2nd. order kinetics.
Chemical Equilibrium • Characteristics & conditions of eq'm. • Equilibrium expression derivation	8 weeks	*For Support:* Brady & Senese Text – Chapters 16 – 19.	HS-PS 1-2 HS-PS 1-4 HS-PS 1-5 HS-PS 1-6	*Formative Assessment:* Homework – substantial commitment.

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
from the forward and reverse rates. ● Understand that eq'm. is a special point where the rate constant of forward rxn = rate constant of reverse rxn. ● The equilibrium constant K_c. ● The Reaction Quotient – Q and its relationship with K_c. ● Factors affecting equilibrium position. ● Le Chatelier's Principle and stressors to a chemical system. ● Additional aspects of aqueous equilibria including acid/base equilibria. ● Buffers and Titrations of Strong/Weak acid/base species. ● Heterogeneous equilibria including *Ksp,* common ion effect and selective precipitation.		Albert IO for MC question practice. Bozeman Science Videos. Kahn Academy video lectures on the Equilibrium Constant. *For Enrichment:* Dueling Aquariums – variation using graduated cylinders and straws to introduce the forward and reverse rate concept. This activity is later used to demonstrate the Le Chatelier principle. Cobalt Chloride demo to show temperature effect on eq'm. Several acid/base titration experiments will be run to determine the manner in which pH changes represent an equilibrium among major species in solution.	HS-PS 1-7 HS-PS 3-2 CRP1,2,4,7,8,10,11,12	Classwork in group setting to reinforce a a consistent understanding of the eq'm. concept. Students will demonstrate that they can prove $K_{eq} = k_f/k_r$. *Summative Assessment* A series of quiz and test events will occur in this very extensive unit. Quizzes will nail down specific topic goals. Tests will be a means to assess student ability to integrate the concepts of kinetics and equilibrium into a cohesive body of knowledge.

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Thermodynamics ● Laws of Thermodynamics. ● Spontaneous processes as a function of enthalpy and entropy. ● Spontaneity and Gibbs Free Energy. ● Relationship of free energy to the equilibrium of a system. ● Reaction Rate and spontaneity.	1.5 weeks	*For Support:* Brady & Senese Text – Ch. 20 - Thermodynamics Albert IO for MC questions. Bozeman Science AP Chem Video series. *For Enrichment:* Experiment # 18 - *Chemistry with Vernier –* Additivity of Heats of Reaction: Hess's Law.	HS-PS 3-1 HS-PS 3-4 HS-PS 1-5 HS-PS 1-6 CRP1,2,4,7,8,10,11,12 WHST.11-12.6 WHST.11-12.2 RST.11-12.3 RST.11-12.4	*Formative Assessment:* Homework – substantial reading and problem solving commitment. Lab Report on; *Enthalpy of Reaction & Hess's Law.* *Summative Assessment* Unit test covering the concepts of; Heat Capacity Calorimetry ΔH ΔS ΔG ΔG^o Connection of thermodynamics to kinetics and equilibrium
Electrochemistry ● Redox Reactions ● Balancing Redox Eqns. In acid/base conditions. ● Determining E_{cell} by half-reaction method. ● Galvanic vs Electrolytic cells Electroplating	1.5 weeks	*For Support:* Brady & Senese Text – Ch. 21- Electrochemistry. Fuse School Videos on electrochemical and electroplating cells. Albert IO for MC question practice. *For Enrichment:* Students will design an experimental procedure to confirm Avogadro's number using electrolysis.	HS-PS 1-2 HS-PS 1-5 HS-PS 3-2 HS PS 3-5 CRP1,2,4,7,8,10,11,12 WHST.11-12.6	*Formative Assessment:* Homework & problem solving in-class. *Summative Assessment* Unit test on redox reactions, standard reduction potential, cell emf and electrolysis

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Atomic Structure & PTE ● Properties of Light & the nature of Waves ● Atomic Spectra of H and the concept of Energy Levels. ● The Bohr Model and the Quantum Mechanical Model ● Electron Configuration & Periodicity ● Valence electrons & Patterns of Reactivity ● Lewis Structures	1.5 weeks	*For Support:* Brady & Senese Text – Ch. 8 – The Quantum Mechanical Atom Spectroscopic examination of Hydrogen emission spectra. *For Enrichment:* Phet Simulation of the Photoelectric Effect.	HS-PS 1-1 HS-PS 1-2 HS-PS 3-2 HS-PS 3-3 HS-PS 1-8 CRP1,2,4,7,8,10,11,12	*Formative Assessment:* Homework covering all aspects of Modern Atomic Theory. In-class generation of electron configuration of main group elements. Students calculate the λ and ν of the H atom bright lines. Given accepted values they determine their relative accuracy. *Summative Assessment* In-class exam of MC and FRQ. Emphasis is upon periodic trends and the predictive nature of the PTE.
Chemical Bonding ● Characteristics of Ionic, Covalent and Metallic Bonding ● Bond & molecule polarity. ● Lewis structures – resonance and formal charge. ● VSEPR & molecular geometry. ● Predict the type of bonding likely to occur given information on electronegativity and hybridization of orbitals.	2.5 weeks	*For Support:* Brady & Senese Text – Ch. 9 & 10 Phet simulation of "Molecule Shapes" Albert IO for MC question practice. *For Enrichment:* Building Molecular Models Lab	HS-PS 1-1 HS-PS 1-2 HS-PS 1-3 HS-PS 1-4 CRP1,2,4,7,8,10,11,12 WHST.11-12.6 RST.11-12.3. RST.11-12.4	*Formative Assessment:* Homework to gain experience in drawing Lewi structures – identifying resonance and applying VSEPR rules. Periodic quizzes to ensure full understanding among the three bonding catagories: Ionic, Covalent

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Connect the energy of a reaction to the energy stored in the bonds of the reaction substances.				& Metallic. *Summative Assessment* In-class timed exam containing MC and FRQ question geared from prior AP tests.
Solutions & Intermolecular Forces ● Explain clearly and with proper use of terms the nature of London forces, dipole-dipole and hydrogen bonding. ● Make qualitative predictions about bulk material characteristics based upon the IMF present or absent in a particular substance. ● Explain the solution process from an energy perspective. ● Explain the process of liquid chromatography as a separation and purification techniques. ● Justify a process as a physical or chemical change based upon the changes in intramolecular forces or intermolecular forces.	2 weeks	*For Support:* Brady & Senese Text – Ch. 12 & 14 Albert IO for MC question practice. *For Enrichment:* Lab activity: Chromatography of dyes used in *M&M* candies.	HS-PS 3-1 HS-PS 3-2 HS-PS 1-3 CRP1,2,4,7,8,10,11,12 WHST.11-12.6 RST.11-12.3 RST.11-12.4	*Formative Assessment:* Homework - Lab Report on chromatography experiment *Summative Assessment* Quizzes covering the application of IMF to given materials. In-class timed exam covering all topics of the unit. Emphasis placed on difference between intra and inter- molecular forces – correct use of terminology in essay question responses will be stressed.

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Spectroscopy ● PES Spectroscopy ● UV-Vis Spectroscopy ● IR Spectroscopy	1 week	*For Support:* Abert IO MC questions. Phet photoelectric effect simulator. *For Enrichment:* Lab activity to examine various elements in a gas discharge tube and relate colors to wavelengths and energy levels.	HS-PS 1-1 HS-PS 1-3 HS-PS 2-6 WHST.11-12.6	*Formative Assessment:* Students will interpret various scans to associate results with atoms and molecules under consideration. *Summative Assessment* Unit test to identify specific elements, molecules and functional groups by interpreting results of each type of spectroscopic analysis.
AP Exam Review A unit-by-unit review of all topics.	2 weeks	*For Support:* *Princeton AP Chem Exam Review.* *5 Steps to a Five – Review Tests & Problems.* Albert IO for MC question practice. *For Enrichment:* Bozeman Science - AP Chem Video Series - covering all the "Big Ideas"	Amalgam of all previously cited standards.	*Formative Assessment:* Homework and Class work - roughly evenly distributed among all topics. *Summative Assessment* AP Exam May, 2019

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Post AP Exam Capstone Topic – Colligative Properties. ● Freezing point depression of an aqueous solution. ● Boiling point elevation of an aqueous solution.	2 weeks	*For Support:* Brady & Senese Text – Ch. 14 Section 14.7 *For Enrichment:* Students will conduct a lab exercise to make ice cream in a bag taking advantage of the FPD of salt and H_2O	HS-PS 1-1 through 1-8 HS-PS 3-1 HS-PS 3-3 HS-PS 3-4 CRP1,2,4,7,8,10,11,12	*Formative Assessment:* Homework to address the quantitative issues of molal boiling and freezing points of water. Group work to derive a heating curve of pure water and its phase changes from 0^o C to 100^o C. *Summative Assessment* Lab report following the AP required format.
Post AP Exam Capstone Project. Student lab groups will choose one among four possible lab topics. Students will propose the hypothesis and then build the procedure to test their concept. Results will be presented to the class for explanation, discussion and critique.	3 weeks	*For Support:* *Chemistry with Vernier – Experimental Ideas.* *For Enrichment:* Flinn Scientific videos and YouTube videos provide a good resource to explore experimental ideas.	HS-PS 1-1 through 1-8 HS-PS 3-1 HS-PS 3-3 HS-PS 3-4 CRP1,2,4,7,8,10,11,12	*Formative Assessment:* Classwork to enable lab groups to assess possible lab procedural steps and review w/ instructor. Labwork time provided to enable "tweaking" of procedures as needed. *Summative Assessment* In-Class presentation of a formalized lab report and a Power Point presentation to communicate results to the class.