Advanced Placement Chemistry Syllabus

Liberty High School / Mr. Little

Course Description:
This class emphasizes the use of technology to explore scientific materials as part of the continuation of Honors Chemistry. To develop the requisite intellectual and laboratory skills, students have a minimum of 400 minutes (5-80 Minute Block Sessions) in a five-day cycle, which is adequate classroom and laboratory time. 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.**

The student will also have completed experiments and problems designed to prepare them for taking standardized chemistry tests, such as the SAT II Chemistry exam. Basic concepts of nomenclature, mole relationships, and stoichiometry are reviewed to help provide background for lab experiments performed. In-depth studies include analytical chemistry techniques, solutions, equilibria, thermochemistry, kinetics, electrochemistry, materials science, organic chemistry, and biochemistry. The curriculum is based upon those topics and skills recommended by the College Board for the Advanced Placement Chemistry program. A key component of this course is more challenging labs that are representative of those conducted in a typical college course.

Laboratory Requirements:
Students are required to keep a formal laboratory notebook. This notebook is graded with each lab. The notebook goes with the student to the university to evaluate their placement in a college laboratory program. This lab journal/notebook will be a separate, bound notebook (such as a composition book) and will be used to keep an accurate, chronological journal of all lab work, using a scientific format. A formal lab report created with a word processing program will be handed in as a final summary of each major experiment. Students will have at least two weeks to complete a formal lab report. The goal is to create a portfolio of experiments that will earn the student the equivalent of one year of college chemistry lab credit. The lab notebook will follow the following format:

1. Table of Contents in FRONT of lab notebook
    - Date experiment performed
    - Title of experiment
    - Page number
2. Pages all numbered
    - Do not skip pages
3. Handout stapled (two staples) to copy produced from lab manual (ONLY if needed)
4. Criteria
    - Title
    - Purpose- State the problem/questions clearly; substantiate the question and explain the reason for the investigation
    - Procedure- Detailed steps performed in the lab (some labs need full procedure written)… labs must have any procedural changes noted
5. Data Table or Pictures
    - All tables or figures MUST have an appropriate title / description
    - Data must have numbers with descriptive units in correct significant figures
    - Data must be recorded directly into lab book
6. Discussion / Analysis and Conclusion
    - Explain all calculations which produced data in data table
    - Answers to questions should be written in complete sentences with question stated in answer
    - Explanation of data and results
    - All calculations using data

TEXTBOOK:
Chemistry, The Central Science, 13th AP Edition, by Brown, LeMay and Bursten. New Jersey: Prentice Hall, 2015.

REVIEW BOOK
The Princeton Review- AP Chemistry Prep. New York, NY: Penguin Random House, 2020.

LABORATORY MANUALS:
College Board, *AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices Teacher Manual*

Vonderbrink, Sally Ann. *Laboratory Experiments for Advanced Placement Chemistry:* 2nd Edition

WEB RESOURCES and ONLINE HOMEWORK:
http://www.mrlittlescience.com
https://apchemistrynmsi.wikispaces.com/AP+Chemistry+Class+Lecture+Notes+AND+instructional+videos

Past AP Exam Questions:
http://apcentral.collegeboard.com/apc/public/exam/exam_information/221837.html

- **CLASSROOM POLICIES**

MATERIALS:
Bring a pen / pencil, TI-30X IIS calculator (REQUIRED), Practice Problems Book (red book), lab notebook, and notebook / folder / binder each day. A textbook will be provided to do problems at home. A class set of books will be used in class. Also, students are STRONGLY urged to purchase an AP Exam review book such as "Cracking the AP Chemistry Exam" (current edition).

GRADING:
Grades will be determined using a total points system. Exams / quizzes will be worth a large part of your grade just as they would in a college course. No calculators will be allowed on the Multiple Choice portion of all exams (not quizzes) to prepare students for the requirements of the AP exam.

HOMEWORK:
Extra practice and review problems will be assigned nightly. These assignments will be randomly checked at the discretion of the instructor. You should be trying all assigned problems, as they will help you review and understand the course concepts. At this level, ALL homework should be completed nightly… NO EXCUSES! Additional problems will be assigned for each unit from the textbook as well. These problems will not be checked.

ABSENCES:
You are responsible for all missed assignments. It is very important that you make every effort to be in class each day. In the event that you miss class, try to get the missed work as soon as possible. Keep in mind that in class we cover a lot of important material and concepts that you CANNOT expect to simply make up by staying after school for a few minutes. You will need to put extra time in on your own to make up the missed work!

EXTRA HELP:
I am available AFTER school for extra help Tuesday – Friday. You should come with questions and be prepared to use after school time efficiently. You may email me at MrLittleScience@iCloud.com, contact me on Twitter using @MrLittleScience, or reply to any Remind message to create a one-on-one texting thread any time you need help.

AP Curriculum Content Map

Unit 1: Introduction and Background (Late August - Late September)

Unit 1 Section 1

<table>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Learning Objectives: 1.1, 1.2, 1.3, 1.9, 1.10, 1.11, 1.17, 1.18, 1.19, 2.1, 2.7, 2.17, 2.19, 5.10</td></tr>
<tr><td colspan="2">Textbook Chapters: 1, 2, and 7</td></tr>
<tr><td>Section Title: Matter, Measurement, Periodic Table, and Nomenclature</td><td>Lab activity title and science practice skills acquired</td></tr>
<tr><td>Topics Covered:
Scientific Method
Classification of matter
Separation techniques
Physical and chemical properties
Density
Math review - measurement, significant figures, statistical techniques
Dimensional analysis
Units of measurement
Uncertainty in measurements and significant figures
Periodic law
Elemental properties
Types of bonds
Properties of groups 1 and 2
Metals vs. nonmetals
Naming compounds</td><td>*Guided-Inquiry Lab:
The Formidable 14 Bottle Problem Lab (SP 3)
Students will identify the substance present in different unknown bottles using various types of physical and chemical analysis
Gravimetric Analysis of a Metal Carbonate (SP 2.2)
Using a prescribed procedure, students will determine the identity of a Group 1 metal carbonate compound by gravimetric analysis
Design Your Own Experiment - Qualitative Analysis of Unknown Solutions (SP 4)
Students will justify selection of kinds of data needed to determine identity of chemicals in household products
Design a plan for collecting the data
Collect the data to determine chemical identities and the identity of an unknown
Evaluate data sources to determine which was most useful in determining chemical identities</td></tr>
</table>

Unit 1 Section 2

<table>
<tr><td colspan="2">Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.</td></tr>
<tr><td colspan="2">Learning Objectives: 1.4, 3.2, 3.4, 3.5, 3.6</td></tr>
<tr><td colspan="2">Textbook Chapters: 3 and 4</td></tr>
<tr><td>Section Title: Reactions, Moles, and Stoichiometry</td><td>Lab activity title and science practice skills acquired</td></tr>
<tr><td>Topics Covered
Multiple oxidation states of transition metals
Writing balanced molecular equations
Types of chemical reactions
Stoichiometry
Limiting reagents
Solutions stoichiometry</td><td>An Activity Series (SP 5)
Students will observe patterns of reactivity to establish ranking in the activity series of several elements</td></tr>
</table>

Unit 1 Section 3

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.	
Learning Objectives: 1.5, 1.6, 1.7, 1.8, 1.12, 1.13, 1.14	
Textbook Chapters: 2 and 6	
Section Title: Atomic Structure	**Lab activity title and science practice skills acquired**
Topics Covered: • Subatomic particles • The nucleus and nuclear stability • Isotopes • Atomic structure & associated terms • Rutherford experiment • Cathode ray experiments • EMR • Quantum mechanics • Bohr atom • Spectroscopy • Orbital model of atom • Aufbau diagram • Paramagnetism	*Guided-Inquiry Lab: *Analysis of Food Dyes in Beverages* **(SP 2.2, 5.1, 4.1, 4.2, 6.4)** • Apply information from the graph to determine the molar concentration of a sports drink or other unknown concentration then determine the mass of the dye in the container • Discover which plot of transmittance vs. molar concentration will produce linear relationships • Design a procedure/data-collection strategy to determine the concentration of dye in a sports drink

Unit 2: Bonding and States of Matter (Early October - Late October)

Unit 2 Section 1

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.	
Learning Objectives: 2.14, 2.17, 2.19, 2.20, 2.21, 2.22, 2.23, 2.24, 2.25	
Textbook Chapters: 8 and 9	
Section Title: Bonding	**Lab activity title and science practice skills acquired**
Topics Covered • Types of bonds (ionic, metallic, covalent) • Energy of formation of ionic compounds • Lattice energy • Coulomb's law • Nonpolar and polar covalent bonds • Coordinate covalent bonds • Resonance • Hybridization • Molecular geometry • Energy effects on molecules • Types of compounds • Properties of metallic, molecular and ionic compounds • Lewis structures	*Lewis Structures and Molecular Geometry* **(SP 1.4)** • Practice constructing/drawing Lewis structures of molecules and to use the structures to predict molecular geometry • Study molecular models to visualize molecular shapes and sketch 3-D structures *Guided-Inquiry Lab: *Determination of Type of Bonding in Solids* **(SP 1.1, 1.4, 6.2, 6.4, 7.1)** • Test solubility, conductivity, and melting point for various solids and use data obtained to predict the type of bonding for unknown compounds

Unit 2 Section 2

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.	
Learning Objectives: 2.4, 2.5, 2.6, 2.12	
Textbook Chapter: 10	
Section Title: Gases	**Lab activity title and science practice skills acquired**
Topics Covered • Real gases vs. Ideal gases • Ideal gas equation • Derivations based on ideal gas law • Gases collected over water • Kinetic molecular theory • Van der Waals equation • Molecular speeds • Diffusion and effusion • Pressure • Gas density and molar mass • Dalton's law of partial pressure	*Molar Volume of a Gas* **(SP 7.1)** • Students use water displacement and series of calculations to determine the molar volume of hydrogen gas *Molar Mass of a Volatile Liquid* **(SP 1.3, 5.1, 6.4, 6.5, 7.2)** • Students use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the molecular mass of an unknown volatile liquid *Crash Test Dummies: Air Bag Lab* **(SP 2.1, 6.1)** • Determine the amount of baking soda and vinegar needed to generate the maximum amount of carbon dioxide gas that will completely fill an "airbag" without bursting Mini-Lab: *Cartesian Diver* **(SP 6.1, 6.3)** • Students determine the relationship between pressure and volume

Unit 2 Section 3

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.	
Learning Objectives: 2.3, 2,4, 2.16, 2.10, 2.11, 2.13, 2.16, 2.18, 2.19, 2.20, 2.26, 2.27, 2.28, 2.29, 2.30, 2.31, 2.32, 5.9	
Textbook Chapter: 11	
Section Title: Solids / Liquids / IMFs	**Lab activity title and science practice skills acquired**
Topics Covered • Intermolecular interactions • Dipole moments • Types of compounds • Surface tension • Capillary action • Viscosity • Types of solids/crystal structure • Bonding model for metals • Alloys • Vapor pressure • Changes of state/energy changes • Heating/cooling curves • Phase diagrams	*Properties of Liquids Lab* **(SP 7.1)** • Observe differences in volatility, surface tension, and capillary action of three liquids due to IMFs *Physical Properties of Two Solids* **(SP 5.2)** • Examines the physical properties of a molecular solid vs. an ionic solid *Guided-Inquiry Lab: *Kool-Aid Chromatography Lab* **(SP 4.1)** • Students utilize chromatography to separate a dye mixture and design an experiment to identify which dyes are present in a flavor of Kool-Aid

Unit 3: Solutions and Kinetics (Early November- Early December)

Unit 3 Section 1

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.	
Learning Objectives: 1.16, 2.8, 2.9	
Textbook Chapter: 13	
Section Title: Solutions	**Lab activity title and science practice skills acquired**
Topics Covered • Types of solutions • Hydration • Electrolytes • Miscibility/immisibility • Dissolution process • Types of chemical reactions • Stoichiometry of precipitation/acid-base reactions • Solubility rules • Solubility curves • Henry's law • Molarity, molality, %, mole fractions • Dilution • Raoult's law & deviations • Colligative properties • Colloids	*Determining Molar Mass by Freezing Point Depression* **(SP 1.1, 1.2, 1.4, 6.2, 6.4)** • Students use freezing point depression to find molecular weight of a given substance *Freezing Point Depression: Ice Cream Demo* **(SP 2.2, 2.3)** • Students make ice cream in a bag using salt to lower the freezing point of a solution

Unit 3 Section 2

Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.	
Learning Objectives: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	
Textbook Chapter: 14	
Section Title: Kinetics	**Lab activity title and science practice skills acquired**
Topics Covered • Rates relationship to collisions • Reaction Mechanisms • Activation energy • Nature of Reactants and Interfacial Surface Area • Temperature and Pressure effects on Rates • Catalyst—Homogeneous and Heterogeneous • Potential Energy Diagrams • Arrhenius Equation • Average Rate • Rates relationship to Stoichiometry • Graphical determination of Instantaneous Rate • Rate Laws • Determination of Rate Laws • Determination of Mechanisms • Order of Reactions • Calculations based on Order	*Guided-Inquiry Lab: *Dyes Kinetics Lab* (**SP 2.1, 2.2, 4.2, 5.1, 6.5, 7.1)** • Students develop a procedure to determine the molar absorptivity constant for a reaction between sodium hydroxide and a common dye • Students develop a procedure to determine the order of the reaction with respect to the dye using spectroscopy and graphical analysis *Factors Affecting Reaction Rates* **(SP 5.1, 5.3)** • Students investigate the effects of concentration, surface area, temperature, and catalysts on various reactions

	Sudsy Kinetics Lab **(SP 2.1, 5.1)** • Students develop a procedure for testing the effect of concentration of hydrogen peroxide on the rate of reaction for elephant toothpaste *Kinetics to Dye For: Bleach and Food Dye Lab* **(SP 2.2, 2.3, 5.1, 5.2, 5.3)** • Students perform a reaction between bleach and blue food dye • Students use spectroscopy and graphical analysis to determine the order of the reaction with respect to the dye
Student Activity: *"Time of Death"*- In collaborative groups, students use kinetics and given data to determine when a victim was killed.	

Unit 4: Equilibrium and Acid/Base Chemistry (Early December- January)

Unit 4 Section 1

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.	
Learning Objectives: 5.16, 5.17, 5.18, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.21, 6.22, 6.23, 6.24, 6.25	
Textbook Chapters: 15 and 17 (parts)	
Section Title: Chemical Equilibrium	**Lab activity title and science practice skills acquired**
Topics Covered • Reversible processes and reactions • Types of systems • Kinetics relationship to equilibrium • Equilibrium Expressions • Equilibrium Constants • Le Chatelier's Principle • Equilibrium Stresses • Equilibrium Calculations • Molar Solubility • Common Ion Effects • Reaction Quotients	*Determine the Equilibrium Constant* (**SP 1.3, 2.2, 6.2, 7.2)** • Students use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the equilibrium constant for a system at equilibrium *Guided-Inquiry Lab: *Applications of Le Chatelier's Principle* **(SP 4.2)** • Students investigate six equilibrium systems to analyze patterns and trends in the principles, concepts, and definitions of equilibrium *Introduction to Equilibrium Straw Lab* **(SP 6.2)** • Students use straws, graduated cylinders, and water to represent how a reaction reaches equilibrium and how factors affect equilibrium *Determining the Solubility Product Constant of an Ionic Product* **(SP 2.1, 2.2, 2.3)** • Students use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the solubility constant of calcium hydroxide using micro-titration techniques

Unit 4 Section 2

<table>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Learning Objectives: 1.20, 3.7, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20</td></tr>
<tr><td colspan="2">Textbook Chapters: 16 and 17 (parts)</td></tr>
<tr><td>Section Title: Acids / Bases</td><td>Lab activity title and science practice skills acquired</td></tr>
<tr><td>Topics Covered
Dissociation versus Ionization
Preparation of Acids, Bases and Salts
Classification of Acids and Bases
Bronsted-Lowry Theory of Acids and Bases
Degree of Ionization
Equilibrium Constants for Acids and Bases
Weak Acids and Bases
Binary acids versus Oxyacids
Determination of Acid and Base properties based on structure
Ionization of Water
pH and pOH
Acid-Base Stoichiometry Problems— Review
Ionization calculations of Weak Acids and Bases
Henderson-Hasselbalch Equation
Titration Calculations
Indicators
Types of Salts
Dissociation of salts and Buffers</td><td>Introduction to Titrations Lab (SP 4.2, 5.1)
Standardize a solution of NaOH
Determine the molarity of an HCl solution
Use lab to get practice setting up and doing titrations
Determination of K_a Using Acid-Base Titrations (SP 2.2, 5.1, 6.4)
Use pH probes to determine the molecular weight and K_a of an unknown weak acid
Selecting Indicators for Acid-Base Titrations (SP 2.1, 5.1, 6.1)
Titration curves of pH versus volume of titrant are generated and used to verify appropriateness of selected indicators
*Guided-Inquiry Lab:
Designing a Buffer Solution (SP 2.3, 4.2, 6.4)
Determine the experimental value of K_a
Design a buffer with a desired pH
Predict by how much the pH will change when acid or base is added to the buffer
Acidity of Two Sodas (SP 1.3, 2.3, 6.2)
Students determine which clear soda has a greater concentration of citric acid by adding indicator and base to each</td></tr>
</table>

Unit 5: Thermochemistry and Electrochemistry (Late January - February)

Unit 5 Section 1

<table>
<tr><td colspan="2">Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.</td></tr>
<tr><td colspan="2">Learning Objectives: 1.20, 3.7, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20</td></tr>
<tr><td colspan="2">Textbook Chapters: 5 and 19</td></tr>
<tr><td>Section Title: Thermochemistry and Thermodynamics</td><td>Lab activity title and science practice skills acquired</td></tr>
<tr><td>Topics Covered
Introduction to thermodynamics
Conservation of energy
State Functions
Potential Energy
Kinetic Energy
Calorimetry
Heat of Fusion
Heat of Vaporization
Specific Heat
Heat of Dilution
Heat of Solution
Hess’s Law—direct and indirect
Bond Dissociation Energies
Entropy
Gibbs Free Energy Equation</td><td>Enthalpy of Reaction and Hess’s Law Thermodynamics
(SP 1.1, 1.4, 7.2, 1.5, 4.4, 5.1)
Students use a prescribed set of procedures to verify Hess’s law using three acid-base reactions, calculating the heat change and enthalpy of reaction for each reaction, mathematically combining enthalpies of the first two reactions to determine the third and comparing this value to the measured enthalpy value of the third
Heat of Formation Lab (SP 7.1)
Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of formation for that reaction
*Guided-Inquiry Lab:
Designing a Hand Warmer (SP 4.2, 5.1)
Students investigate the energy changes accompanying the formations of solutions for common laboratory salts, and then apply the results to design a hand warmer that is reliable, safe, nontoxic, and inexpensive
Mini-Lab:
Heat of Fusion Ice Lab (SP 2.2, 2.3)
Students use a prescribed procedure to determine the heat of fusion of ice</td></tr>
</table>

Unit 5 Section 2

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.	
Learning Objectives: 3.12, 3.13, 5.14, 5.15, 6.25	
Textbook Chapter: 20	
Section Title: Electrochemistry	**Lab activity title and science practice skills acquired**
Topics Covered • Oxidation and Reduction • Substances gaining potential • Types of electrochemical cells • Voltaic cells • Cell Potentials • Concentration dependence of E • Nernst Equation • Cell potentials and Equilibrium • Metal Electrodes • Reference Electrodes • Indicator electrodes	*Guided-Inquiry Lab: *Electrochemical Cells Inquiry Lab* **(SP 2.2, 2.3, 5.1, 6.4)** • Determine the cell voltage for microscale cells • Use the Nernst equation to determine the voltage of a cell at nonstandard conditions • Determine the K_{sp} for AgCl *Citrus Battery Challenge* **(SP 4)** • Use various combinations of metal electrodes to construct a battery from citrus fruit and produce a battery that results in the greatest voltage *Penny Electrolysis: Electroplating Lab* **(SP 2.2, 2.3)** • Perform an electrolysis using a penny and nickel • Determine the average current applied

Unit 6: Organic Chemistry (Late February - Early March)

Unit 6 Section 1

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.	
Learning Objectives: 1.15, 1.19, 2.10, 2.11, 3.3, 5.11	
Textbook Chapter(s): 25, 12.6-12.7	
Section Title: Organic Chemistry	**Lab activity title and science practice skills acquired**
Topics Covered • Properties and Bonding in Carbon Compounds • Hydrocarbons • Nomenclature • Functional Groups	*Synthesis, Isolation, and Purification of an Ester* **(SP 5.1, 6.2, 6.4)** • Perform an esterification reaction to create an ester • Isolate the compound formed • Purify the compound using distillation
Student Activity: "*Functional Groups Mini Project*"- In collaborative groups, research a particular organic functional group including alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, and amides in order to explain and present properties, naming, formation, and real-world importance to the class.	