AP CHEMISTRY
SYLLABUS
PHS 2017-2018

AP Chemistry Course Description:
The AP Chemistry course is designed to be the equivalent of a first-year college general chemistry course. The general concepts, equations and principles learned in first year high school chemistry are explored in greater detail and are applied to more advanced topics including solutions, thermodynamics, chemical equilibrium, and kinetics. The class includes student designed, guided inquiry format laboratory activities, hands-on teacher-directed laboratory activities, advanced manipulation of equations, and independent research and study of material. The laboratory activities will be performed at least one and a half periods per week (out of a total of 240 instructional minutes) which will allow for a minimum of 25 percent of the instructional time to be dedicated to hands-on lab activities.

Textbooks and Lab Books

Brown, LeMay, Bursten, Murphy, Woodward, and Stoltzfus. *Chemistry the Central Science 13th* Edition. Boston: Pearson Education, 2015.
Vonderbrink, Sally A. *Laboratory Experiments for Advanced Placement Chemistry*, 2ed. Flinn Scientific, 2006. (VB)
The College Board. *AP Chemistry Guided Inquiry Experiments: Applying the Science Practices*, 1ed. 2013. (CB)
Randall, Jack. *Advanced Chemistry with Vernier*. Oregon: Vernier Software and Technology, 2013. (ACV)

Required Materials
Laboratory notebook, 100 pages, chemical splash goggles, scientific calculator

Course Structure:
This course is structured around the six big ideas and seven science practices as designated by the College Board. The big ideas are:
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.
Big Idea 3: Changes in matter involve the rearrangement and/or recognition of atoms and/or transfer of electrons.
Big Idea 4: Rates of chemical reactions are determined by 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.
Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in dynamic competition, sensitive to initial conditions and external perturbations.

In addition, the course will incorporate the science practices for AP Chemistry. This will allow students to think and act like scientists. The science practices are:
Science Practice 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.
Science Practice 2: The student can use mathematics appropriately.
Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
Science Practice 4: The student can plan and implement data collection strategies in relation to a particular scientific question.
Science Practice 5: The student can perform data analysis and evaluation of evidence.
Science Practice 6: The student can work with scientific explanations and theories.
Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

Course Content:

First Semester

Unit	Chapters/Topics/Timeline	Laboratory
1	Chapters 1-3, Review of First Year (3 weeks) ● Big Ideas 1 and 2 ● L.O. 1.1, 1.2, 1.3, 1.4, 1.5, 1.13, 1.14, 1.17, 1.18, 2.1, 2.17, 3.1, 3.2 ● Uncertainty in measurements, significant figures, common lab measurements, basic atomic structure, average atomic mass and mass spectrometry, nomenclature ● The mole and Avogadro's number, molar mass, empirical vs. molecular formulas, chemical reactions and balanced chemical equations, stoichiometric calculations, law of conservation of mass ● Activity: Modeling Limiting and Excess Reagents with Colored Paper Clips - Students will use bags of colored paper clips to "make" compounds in specific ratios in order to identify limiting reagents, excess reagents and relate this to masses, L.O. 1.4, S.P. 1 ● Summer Problem Set and Chapter 3 Problem Set ● Quizzes on Nomenclature ● Test C1-3	● Density of Common Substances – students will develop a procedure to determine density graphically and compare it to a standard density determination (inquiry lab), S.P. 4 and 5 ● Exp. #5 Finding Ratio of Moles of Reactants in a Chemical Reaction (VB) L.O. 3.3, S.P. 5 ● Exp. #2 Analysis of Silver in an Alloy (VB) L.O. 3.5, 3.6, S.P. 2 ● Exp. #3 Gravimetric Analysis of a Metal Carbonate (VB) L.O. 3.3, S.P. 2 ● Exp #1 Determination of a Chemical Formula (ACV) L.O. 3.3, S.P. 2, S.P. 5.1

2	Chapter 4 Reactions in Aqueous Solution (3.5 weeks) ● Big Ideas 1, 2, and 3 ● L.O. 1.19, 2.1, 2.2, 3.1, 3.2, 3.4, 3.7, 3.8, 3.10 ● Solution composition, strong vs. weak electrolytes, expressing solution concentration in molarity ● Types of reactions - precipitation, acid-base, oxidation-reduction, balancing redox equations, reaction predictions and writing net ionic equations ● Activity: Writing Molecular, Complete and Net Ionic Equations from Demonstrations of Chemical Reactions – Student observe demos and videos of chemical reactions to write equations, L.O. 3.2, S.P. 1 ● Activity: Online Simulation: Using Solubility Rules to Predict Precipitation (http://www.wisc-online.com/Objects/ViewObject.aspx?ID=GCH2904) - Students will apply solubility and nomenclature rules to complete animations and write equations for precipitation reactions L.O. 3.1, S.P. 1 ● Problem Sets I-IV ● Quizzes on Problem Sets ● Test C4	● Inv #3 What Makes Water Hard? – In the written report conclusions, students are asked to write a letter on behalf of their company to a client in order to identify the best location to purchase a house based on water hardness (CB, inquiry lab) L.O. 1.19, 3.3, S.P. 2, 4, 5 and 6 ● Inv #4 How Much Acid is in Fruit Juice and Soft Drinks? (CB, inquiry lab) L.O. 1.20, S.P. 4, 5 and 6
3	Chapters 14, 15 Kinetics and Equilibrium (5 weeks) ● Big Ideas 4 and 6 ● L.O. 3.4, 4.2, 4.3, 4.4, 4.5 4.6, 4.7, 4.8, 4.9, 5.16, 5.17, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.21, 6.22 ● Reaction rates, rate laws, method of initial rates, half-life, reaction mechanisms and rate determining step, collision model, energy profile of an elementary reaction, temperature dependence of reaction rate, activation energy, intermediates vs. catalysts ● Characteristics of chemical equilibrium, expressions of equilibrium constant (K_c & K_p), reaction quotient, (Q), ICE tables to solve equilibrium problems, Le Châtelier's principle, solubility equilibria (K_{sp})	● Exp. #12 Kinetics of a Reaction (VB) L.O. 4.1, 4.2, 4.6, S.P. 1 and 2 ● Exp. #10 The Determination of an Equilibrium Constant(ACV) S.P. 2 ● Exp #23 Determining the Ksp of Calcium Hydroxide (ACV), S.P. 2 ● Exp #25 The Rate and Order of a Chemical Reaction(ACV), S.P. 2

	• Activity: Identifying Factors that Affect Reaction Rates - Students will observe the "Elephant Toothpaste" demo at different concentrations to write the reaction, identify/explain factors that affected the rate, i.e. concentration and catalyst, and draw the energy profile of catalyzed vs. uncatalyzed reactions. L.O. 4.5, 4.8, S.P. 1 and 6 • Activity: Analyzing Data to Determine Rates of Reaction - Students will be divided into groups with a set of time vs. concentration data to determine rate order for the reaction and rate constants with appropriate units and then report back orally to the class their findings, L.O. 4.2, S.P. 2 and 5 • Activity: Using LeChatelier's Principle – Students will observe the equilibrium of $CoCl_2$ system and use LeChateliers to predict and explain shift in equilibrium (Flinn Scientific Chem Fax, Pink and Blue: A Colorful Balancing Act), L.O. 6.8, S.P. 1 and • Problem Sets on both chapters • Chapter 12 partner quiz based on AP Exam problems • Test C14-15	
4	Chapters 16, 17 Acids and Bases their Equilibria (5.5 weeks) • Big Idea 2, 3 and 6 • L.O. 2.2, 3.7, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20, 6.21, 6.22, 6.23 • Nature and definitions of acids and bases, pH scale and strong/weak acid/base calculations, percent dissociation, K_a and K_b, acid-base properties of salts and oxides • Buffered solutions calculations, titrations and pH curves, acid-base indicators, ionic compound (K_{sp}) solubility • Activity: Evaluating Buffers – In small groups, students consider pairs of substance to determine if they are a buffer system, identify the components of the buffer, and	• Exp. #14 Determination of K_a for Weak Acids (VB), S.P. 1 and 2 • Exp #19 Buffers (ACV) L.O. 1.20, 6.13, S.P. 2 and 6

	both qualitatively and quantitatively describe the effects on the pH of the system with the addition of an acid or base, L.O. 6.20, S. P. 6 ● Problem Sets on both chapters ● Chapter 16-17 Test	
	Semester One Exam: Chapters 1-4, 14-17	

Second Semester

Unit	Chapters/Topics	Laboratory
5	Chapter 5 & 10 Gases and Thermochemistry (3.5 weeks) ● Big Ideas 2, 3, and 5 ● L.O. 2.4, 2.5, 2.6, 2.12, 3.4, 3.11, 5.2, 5.3, 5.4, 5.5, 5.6, 5.8 ● Use of general gas laws to solve gas stoichiometry problems, Kinetic Molecular Theory to describe gases, Ideal Gas Law vs. van der Waals equation, Maxwell-Boltzmann distributions ● Nature of energy, enthalpy and calorimetry, Hess's Law calculations, standard enthalpies of formation calculations ● Demos: Crushing a Can with Atmospheric Pressure, Marshmallow Man and balloons in the Vacuum Chamber, Blowing Up Balloon by heating ● Activity: Molar Mass of an Unknown Gas - Students will watch a demo of gas collection over water and use AP equation sheets to determine the molar mass of butane gas from variable collected, L.O. 2.6, S.P. 2 ● Activity: Explaining the "Whoosh Bottle" and "Pop the Top" – Students observe demos to write the combustion equations associated with each, including using the internet to find and include the molar heat of combustion and make predictions about the signs and	● Exp. #5 The Molar Volume of a Gas (ACV), S.P. 2 and 5 ● Inv #10 How Long Will That Marble Statue Last? (CB, inquiry lab) - In the written report, students are asked in their conclusions to write a paragraph to explain the results of the lab and a paragraph describing the phenomena of acid rain and how this lab models the process, L.O. 4.1, S.P. 4 and 5 ● Inv #12 The Hand Warmer Design Challenge (CB, inquiry lab) – In the written report, students are asked to research current commercial hand warmers and link it to the results obtained in their investigation, L.O. 5.7, 6.24, S.P. 4, 5 and 7 ● Exp #34 Vapor Pressure and Heat of Vaporization (ACV) S.P. 2 and 5

	magnitude of ΔH, ΔS, ΔG, L.O. 5.8, 5.13, S.P. 2 and 7 ● Problem Sets on both chapters ● Chapter 5 partner quiz based on AP Exam problems ● Test C5 & 10	
6	Chapters 19 & 20 Thermodynamics & Electrochemistry (3.5 weeks) ● Big Ideas 3, 5 and 6 ● L.O. 3.8, 3.12, 5.12, 5.13, 5.14, 5.15, 5.18, 6.25 ● Spontaneity, entropy and 2nd law of thermodynamics, calculations involving Gibb's free energy, free energy and equilibrium, external sources of energy to drive reactions ● Galvanic cell descriptions, cell potential determination, cell potential and free energy, effects of concentration on cell potential ● Problem Sets on both chapters ● Chapter 17 partner quiz based on AP Exam problems ● Test C19 & 20	● Exp. #21 Analysis of Commercial Bleach: Oxidation-Reduction Titration (VB) L.O. 1.20, 3.3, 3.9, S.P. 2 and 7 ● Exp. #20 Electrochemical Voltaic Cells (ACV) L.O. 3.13 ● Exp #16 Conductimetric Titration and Gravimetric Determination of a Precipitate (ACV) L.O. 1.20, 3.3, 3.9, S.P. 2 and 7 ● Exp #8 An Oxidation-Reduction Titration: The Reaction of Fe^{+2} and Ce^{4+} (ACV) L.O. 1.20, 3.3, 3.9, S.P. 2 and 7 ● Exp #31 Determining Avogadro's Number (ACV) L.O. 1.20, 3.3, 3.9, S.P. 2 and 7
7	Chapter 6 & 7 Atomic Structure and Periodicity (2 weeks) ● Big Idea 1 ● L.O. 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.15 ● Electromagnetic spectrum, atomic spectrum of hydrogen, the quantum mechanical model of atom, orbital shapes and energies, electronic structure of the atoms using PES data, ionization energy data and Coloumb's law ● Periodic trends of atomic radius, ionic radius, ionization energies, electron affinities, electronegativity as based on electronic structure and laboratory evidence ● Activity: Comparing Periodic Trends (Jigsaw Activity): Students will be organized into groups and assigned to research a periodic	● Inv #1 What Is the Relationship between the Concentration of a Solution and the Amount of Transmitted Light through the Solution? (CB, inquiry lab) L.O. 1.15, 1.16, S.P. 2, 3, 4 and 5

	trend. They will become experts and create a short presentation to take back to teach to a new group. (http://edtech2.boisestate.edu/kilnerr/502/jigsaw.html) L.O. 1.9, 1.10, S.P. 6 ● Problem Sets on chapter ● Test C6 & 7	
8	Chapters 8 & 9 Bonding and Molecular Structure (3 weeks) ● Big Ideas 2 and 5 ● L.O. 2.18, 2.19, 2.20, 2.21, 5.1, 5.9, 5.10, 5.11 ● Bond character and polarity, dipole moment, bond energies/lattice energy ● Localized electron bonding model, Lewis structures using the octet rule, VSEPR model and molecular geometry, hybridization of molecular orbitals in *sp*, sp^2 and sp^3, sigma and pi bonding, molecular polarity, basic molecular orbital theory expansions ● Activity: Balloon Models of hybridization of molecular orbitals ● Problem Sets on both chapters ● Test C8-9	● Inv #5 Sticky Question: How Do You Separate Molecules That Are Attracted to One Another? (CB, inquiry lab) L.O. 2.10, S.P. 3, 4, 5 and 6 ● Inv #6 What's In That Bottle? (CB, inquiry lab) L.O. 2.22, 2.24, S.P. 2, 3, 4, 5, 6, and 7
9	Chapters 11 & 13 Liquids, Solids and Solutions (3.5 weeks) ● Big Idea 2 ● L.O. 2.3, 2.7, 2.8, 2.9, 2.11, 2.13, 2.14. 2.15, 2.16, 2.23, 2.24, 2.25, 2.26, 2.27, 2.28, 2.29, 2.30, 2.31, 2.32 ● Intermolecular forces to explain states of matter and predict trends, types and properties of solids and alloys, vapor pressure and state changes, heating curves ● Solution composition and concentration, enthalpy of solution formation, vapor pressure of solutions and Raoult's law for ideal solutions and deviations from ideal ● Activity: Comparing the Properties of Water, Ammonia, Butane, Ethanol, and Acetone (Jigsaw Activity) - Students will be organized	· Exp. #3 The Molar Mass of Volatile Liquids (ACV), S.P. 2

	into groups and shown samples of each substance to research for molecular structure, IMF's and properties. They will become experts and be assigned to new groups to present to each other their findings. L.O. 2.11, 2.13, 2.16, S.P. 7 ● Problem Sets on both chapters ● Test C11 & 13	
10	Post AP Exam Celebrations No Semester Exam	● Chemistry of Ice Cream ● Chemistry of Tie Dye

Laboratory Period: In order for AP Chemistry to be comparable to a first-year college general chemistry course, laboratory work must be an integral part of the course. A certain level of proficiency in laboratory procedures and analysis of data and results is also necessary for successful completion of the AP Chemistry exam. Laboratory work will comprise at least 25% of the course content. Students will keep a separate lab notebook (carbonless, double-copy type) that will serve as a record of lab work. Many universities will want to see this notebook as evidence before assigning college credit, so students are expected to diligently follow lab report guidelines. If absent for a lab, students must make-up the data collection in order to receive full credit for their report. Students are allowed to miss one lab data collection period per year and obtain data from their partners with no penalty for the lab report. After one missed lab, if a student does not make up the data collection of the lab, but obtains the data from a partner, the lab report will then receive an automatic 15% reduction in grade. Each lab period will begin with a five point quiz based on the background, materials, safety and procedure as described in the lab manual or handout. Lab quizzes cannot be made up for any absence reason including illness or other excused absence; the lowest two scores of each semester will be dropped.

AP Chemistry Laboratory Notebook

A laboratory notebook should be used to explain laboratory procedures, record all laboratory data, show how calculations are made, discuss results of an experiment, and to explain the theories involved. A record of laboratory work is an important document which will show the quality of the laboratory work you have done. When you explain your work, list your data, calculate values and answer questions, be sure that the meaning will be obvious to anyone who reads your notebook.

Before arriving in the lab, the title, purpose, procedure and pre-lab questions must be completed. A data table should also be constructed, where data can be entered as it is collected. Before leaving the lab, all data and observations should be neatly recorded. Basic calculations should be completed. After lab, complete calculations should be performed and the conclusion, error analysis, and discussion of theory written.

General Formatting:
1. Use a carbon-less laboratory notebook with pages fastened in place.
2. Write your name and class on the front cover and inside the front cover.
3. In ink, number all the right-handed pages on the lower right corner if they are not already numbered.
4. Save the first two pages for a Table of Contents. This should be kept current as you proceed. Each time you write up a lab, place the title and page number where the lab report begins in the Table of Contents.
5. Write in ink. Use only the right hand pages. You may use the left-hand pages for preliminary notes or for a quick graph (to be done in pencil). The left-hand pages will not be graded.
6. If you make a mistake DO NOT ERASE. Just draw ONE LINE through your error, and continue with the new data. It is expected that some errors will occur. You cannot produce a perfect, error-free notebook.
7. Do not use the first person or include personal comments. 8. Label all sections with the headings below.

Notebook Laboratory Reports- Always include the following in each report:
Title The title should be descriptive. Experiment 5 is not a descriptive title.
Date This is the date (or dates) you performed the experiment.
Purpose A brief statement of what you are attempting to do. These are similar to the objectives or the Central Challenge in the AP Chemistry Lab Manual.
Procedure A brief description of the method you are using. You may refer to the lab manual for specific instructions. Do not include lengthy, detailed directions. A person who understands chemistry should be able to read this section and know what you are doing. Include all chemicals used and the major equipment.
Pre-lab Questions If there are any pre-lab questions include them here. Either rewrite the questions or answer in complete statements.

Results – Results are recorded in three parts:

Observations – General descriptions of visible appearances or changes that occur during the experiment, such as "table salt is a white, cube-shaped crystal which dissolves in water." (Qualitative) ***Data*** – Neatly arranged measured values listed in tabular form. The units of measurement MUST be included with the

numerical values. The accuracy of the measurement should also be included as a range (+/-). Always record all certain digits and one uncertain digit. Calculated answers that are derived by performing a simple mathematical operation can also be included in the data table. If graphs are included, make the graphs an appropriate size. Label all axes and give each graph a title. USE A RULER to make all data tables and graphs! (Quantitative)

Calculations – Show all calculations with formula and appropriate units on all numbers. Neatly demonstrate the math set-ups, including units. Label what is being calculated. – make it organized. Show precision and percent yield calculations where appropriate. If you can calculate percent error, do so and include it in this section. If experiments are qualitative, this section may be omitted.

Conclusions Make a simple statement that summarizes your findings. Refer back to the purpose of the lab to write this section. (i.e. How was the purpose of the experiment fulfilled?) Restate the final, averaged values obtained and the percent error or yield. For example, "The melting point of aluminum was determined to be 658°C, with a -0.3% error."

Experimental Sources of Error What are some specific sources of error, and how do they influence the data? Does the error make the values obtained larger or smaller than they should be? Which measurement was the least precise? If your calculated percent errors are significant, you must propose valid explanations here. Instrumental error and human error exist in all experiments, and should not be mentioned as a source of error unless they caused a significant fault. Significant digits and mistakes in calculations are NOT a valid source of error. In writing this section it is sometimes helpful to ask yourself what you would do differently if you were to repeat the experiment and wanted to obtain better precision and accuracy.

Discussion of Theory This section includes such information as: What theory was demonstrated in the experiment? Include all concepts used in the experiment. What do the calculations show? Why does (or doesn't) the experiment work? This section shows that you understand the concepts used in the lab. Be detailed and ask if you need help! Post-lab Questions Answer any questions included in the lab. Answer in such a way that the meaning of the question is obvious in your answer.

Formal Lab Reports

Several Lab reports each quarter will be a formal report. Formal Lab reports will follow a different format but will still include many of the sections already included in the Lab Notebook.

Formal Lab Reports will be divided into three sections: Introduction/ Abstract, Materials and Procedures and Results and Conclusion.