Advanced Placement Chemistry – Syllabus
Van Buren High School
Van Buren, Arkansas
Leslie Brodie

School Profile

City: Van Buren is located in west-central Arkansas, five miles from the Oklahoma border. The city has a rapidly growing population of 21,000 (an increase of 25% in ten years). It is the county seat and is situated just across the river from Fort Smith with a population of over 80,000.

Economics: Thirty-three percent of the students receive free lunch, and eight percent receive reduced lunch. Only twelve percent of the adult population have a bachelor's degree or higher. Of high school graduates, 50% pursue a bachelor's degree, and 20% pursue an associate's degree.

Demographics: The school district has a total of 5,800 students. Twenty-two percent of the students are minorities; the largest group is Hispanic with eleven percent of the population. Eight percent are identified as gifted and talented.

High School: There is only one high school in the city. It has 1,280 students in grades 10-12, and it is one of the top sixteen high schools in the state by size. The high school offers sixteen AP courses, and (by state law) a 1.0 weighted credit is given to grades of students who take the AP course and the AP exam.

AP Program

Van Buren High School currently offers one class of AP Chemistry. The class meets ninety minutes a day, five days a week. We accept both first- and second-year chemistry students', but demand that they have a strong background in math. Most AP Chemistry students are juniors or seniors who have had a minimum of Trig/Pre-Calculus. Van Buren High School has offered Advanced Placement Chemistry since 1997. Students taking the AP Chemistry course during the 1997-1998 school year were on a 4x4 block schedule and only had the course for one semester; therefore, no student attempted the AP exam during that year. Students began taking the AP exam during the 1998-1999 school year. During the 2004-2005 school year, students were required by the Arkansas State Department of Education to take the exam in order to earn weighted credit for the course. The State Department of Education paid for each student testing.

Test Results

1998-1999: 75% scored a 3 or better (4 students took the exam)
2000-2001: 100% scored a 3 or better (5 students took the exam)
2001-2002: 44% scored a 3 or better (9 students took the exam)
2002-2003: 80% scored a 3 or better (5 students took the exam)
2003-2004: 50% scored a 3 or better (12 students took the exam)
2004-2005: 25% scored a 3 or better (12 students took the exam)

2005-2006: 44% scored a 3 or better (25 students took the exam)

Overall results:
AP Score 5: 5.5%
4: 9.7%
3: 33.3%
2: 31.9%
1: 19.4%

The Course

The AP Chemistry course is designed to be the equivalent of the general chemistry course usually taken during the first college year. For some students, this course enables them to undertake, in their freshman year, second-year work in the chemistry sequence at their institution or to register in courses in other field where general chemistry is a prerequisite. For other students, the AP Chemistry course fulfills the laboratory science requirement and frees time for other courses.

AP Chemistry should meet the objectives of a good general chemistry course. Students in such a course should attain a depth of understanding of fundamentals and a reasonable competence in dealing with chemical problems. The course should contribute to the development of the students' abilities to think clearly and to express their ideas, orally and in writing, with clarity and logic. The college course in general chemistry differs qualitatively from the usual first secondary school course in chemistry with respect to the kind of textbook used, the topics covered, the emphasis on chemical calculations and the mathematical formulation of principles, and the kind of laboratory work done by students. Quantitative differences appear in the number of topics treated, the time spent on the course by students, and the nature and the variety of experiments done in the laboratory.

Prerequisites

The AP Chemistry course is designed to be taken only after the successful completion of a first course in high school chemistry. Surveys of students who take the AP Chemistry Exam indicate that the probability of achieving a grade of 3 or higher is significantly greater for students who successfully complete a first course in high school chemistry prior to undertaking the AP course. *Thus, it is strongly recommended that credit in a first-year high school chemistry course be a prerequisite for enrollment in an AP Chemistry class. In addition, the recommended mathematics prerequisite for an AP Chemistry class is the successful completion of a second-year algebra course.*

The advanced work in chemistry should not displace any other part of the student's science curriculum. It is high desirable that a student has a course in secondary school physics and a four-year college preparatory program in mathematics.

Assessment

Grades are weighted in Advanced Placement Chemistry by categories. Homework counts for ten percent of their overall grade, while laboratory reports count as twenty-five percent of their overall grade. Tests and quizzes count for the final sixty-five percent of their overall grade.

Teaching Strategies

Content lecture is a vital and necessary part of the AP curriculum. Students must have the material presented in a manner that will aide them in their understanding of complex ideas. This is accomplished using a variety of techniques that will appeal to all learning types (auditory, visual, and kinesthetic). Lecture will aide in enhancing the understanding of an auditory learner.

Demonstrations are performed to aide in the understanding of content for the visual learner. The instructor will provide many different demonstrations throughout the year.

To help the kinesthetic learner, many laboratory experiments will be performed throughout the year. Additionally, the classroom is set up as a scientific company we have named Spectrum Inc. The company is divided into scientific teams that are sub-contracted to solve problems presented to them throughout the year. Students are given jobs for the year, and they are paid based on their performance. The goal here is to have students act as scientists to perform inquiry based experiments that might be performed in the real world of science. Students are required within their scientific teams to formulate a plan of action, purchase materials required to perform their jobs, and present their findings to their peers using various forms of technology.

Periodic testing and quizzes are required to assess student learning. In order to prepare students for the AP test in May, formal tests are designed in a format similar to the AP test. Additionally, the tests are lengthy in order to help prepare students to work quickly and accurately in preparation for the rigor of the AP test.

In order to adequately prepare students for the AP exam, students are given additional preparation time after school and during Saturday tutorial sessions. The frequency of these tutorials increase significantly as the AP test date approaches each year.

Classroom Resources

Text

Brown, T. L., H. E. LeMay, Jr., and B. E. Bursten. 2003. *Chemistry: The Central Science.* 9th ed. Upper Saddle River, J.J.: Prentice Hall.

Laboratory Manuals

We do not use a lab manual but rather a collection of labs from various sources. These include:

Hall, James F. 1993. *Experimental Chemistry.* 3RD ed. D.C. Heath and Company.

Brown, T. L., H. E. LeMay, Jr., and B. E. Bursten. 2003. *Laboratory Experiments. Chemistry: The Central Science.* 9th ed. Upper Saddle River, J.J.: Prentice Hall.

AP Test Preparation Manuals

Demmin, Peter E. 1996. *Multiple Choice Questions in Preparation for the AP Chemistry Examination.* D&S Marketing Systems, Inc.

Barker, Brett. 2003. *Master the AP Chemistry Test.* 9th ed. Peterson's a division of Thomson Learning, Inc.

Moore, John and Richard Langley. 2004. *Five Steps to a Five.* McGraw-Hill Companies, Inc.

Freeman, Dana and Seyed Aijaz and Richard Bleil and Walter Voland. 2003. *AP Success: Chemistry*. 3rd ed. Peterson's a Division of Thomson Learning, Inc.

Additional Materials

TI-83 Plus Calculator
Student Carbonless Lab Notebook
Reaction binder (created by instructor)
Classroom computers shared by students – Graphical Analysis programs, Microsoft office programs and LCD projector for classroom presentations

Advanced Placement Chemistry Course Outline

First Quarter (40 days: 8 weeks)

Unit 1: Calculations and Uncertainty (1 week)

Content:

- Classification and Properties of Matter
- Scientific Measurement
- Scientific Units and Conversions

Objectives:

- Students shall explain the changes of *matter* using *physical properties* and *chemical properties.*
- Students shall demonstrate an understanding that science is a way of knowing.
- Students shall design and safely conduct a scientific inquiry.
- Students shall demonstrate an understanding of current theories in chemistry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.
- Students shall describe various careers in chemistry and the training required for the selected career.

Frameworks:

P.6.C.1	Compare and contrast *matter* based on uniformity of particles: • pure substances • *solutions* • heterogeneous mixtures
P.6.C.2	Distinguish between *extensive* and *intensive physical properties* of *matter*
P.6.C.3	Separate homogeneous mixtures using physical processes: • *chromatography*
P.6.C.4	Design experiments tracing the *energy* involved in *physical changes* and *chemical changes*
NS.32.C.1	Explain why science is limited to natural explanations of how the world works

NS.32.C.2	Compare and contrast *hypotheses*, *theories*, and *laws*
NS.32.C.3	Compare and contrast the criteria for the formation of scientific *theory* and scientific *law*
NS.32.C.4	Distinguish between a scientific *theory* and the term "*theory*" used in general conversation
NS.32.C.5	Summarize the guidelines of science: ▪ explanations are based on observations, evidence, and testing ▪ *hypotheses* must be testable ▪ understandings and/or conclusions may change with additional empirical data ▪ scientific knowledge must have peer review and verification before acceptance
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of *bias* that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without *bias*
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.34.C.1	Recognize that theories are scientific explanations that require empirical data, verification, and peer review
NS.34.C.2	Understand that scientific theories may be modified or expanded based on additional empirical data, verification, and peer review
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experiments:

Students performed several experiments that relate to the content of this section during their participation in Pre-AP Chemistry. These included but were not limited to: Density of unknown metals, using instrumentation to collect various data and explain percent error and understand significant figures, and a paper chromatography inquiry lab. Advanced Placement students will additionally perform a Thin-Layer chromatography lab.

Unit 2: Atoms, Molecules, and Ions (2 weeks)

Content:

- Atomic Theory of Matter
- Atomic Structure
- Periodic Table
- Molecular Compounds
- Ionic Compounds
- Naming Inorganic Compounds

Objectives:

- Students shall understand the historical development of the model of the atom.
- Students shall understand the structure of the atom.
- Students shall understand the significance of the Periodic Table and its historical development.
- Students shall name and write formulas for binary and ternary compounds. Students shall explain the changes of matter using its physical and chemical properties.
- Students shall use atomic mass or experimental data to calculate relationships among elements and compounds.

Frameworks:

AT.1.C.1	Summarize the discoveries of the *subatomic particles* • Rutherford's gold foil • Chadwick's discovery of the neutron • Thomson's cathode ray • Millikan's Oil Drop
AT.1.C.2	Explain the historical events that led to the development of the current *atomic theory*
AT.2.C.1	Analyze an atom's particle position, arrangement, and charge using: • proton • neutron • electron
AT.2.C.5	Determine the arrangement of *subatomic particles* in the *ion(s)* of an *atom*

P.5.C.1	Write formulas for *binary* and *ternary compounds:* • *IUPAC* system • Greek prefixes • polyatomic *ions*
P.5.C.2	Name *binary* and *ternary compounds*
P.5.C.3	Predict the name and symbol for newly discovered *elements* using the *IUPAC* system
P.7.C.1	Demonstrate an understanding of the *Law of Multiple Proportions*
B.8.C.2	Derive *formula units* based on the charges of *ions*
AB.20.C.1	Name and write formulas for *acids*, *bases* and *salts:* • *binary acids* • *ternary acids* • *ionic compounds*

Experiments:
None

Unit 3: Stoichiometry (2 weeks)

Content:

- Chemical Equations
- Patterns of Chemical Reactivity
- Atomic and Molecular Mass
- Chemical quantities and the mole
- Limiting Reactants

Objectives:

- Students shall understand the relationship between balanced chemical equations and mole relationships.
- Students shall understand the mole concept and Avogardro's Number
- Students shall predict the product(s) based upon the types of chemical reactions.
- Students shall design and safely conduct a scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

S.15.C.6	Identify the physical state for each substance in a reaction equation
S.13.C.1	Apply the *mole* concept to calculate the number of particles and the amount of substance: Avogadro's constant = 6.02×10^{23}
S.13.C.2	Determine the *empirical* and *molecular formulas* using the molar concept: • *molar mass* • *average atomic mass* • *molecular mass* • formula mass
S.12.C.1	Balance *chemical equations* when all *reactants* and *products* are given
S.12.C.2	Use balanced reaction equations to obtain information about the amounts of *reactants* and *products*
S.12.C.3	Distinguish between *limiting reactants* and *excess reactants* in balanced reaction equations
S.12.C.4	Calculate *stoichiometric* quantities and use these to determine theoretical yields
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and

	independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.34.C.1	Recognize that theories are scientific explanations that require empirical data, verification, and peer review
NS.34.C.2	Understand that scientific theories may be modified or expanded based on additional empirical data, verification, and peer review
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NS.35.C.3	Utilize technology to communicate research findings

Experiments:

Pre-AP Chemistry

- Determining the Percent Yield of Copper.
- Determining the Formula of a Hydrate

AP Chemistry

- What is the formula of Cobalt Hydroxide?

Unit 4: Aqueous Reactions and Solution Stoichiometry (2 weeks)

Content:

- General Properties of Aqueous Solutions
- Precipitation Reactions
- Acid-Base Reactions
- Oxidation-Reduction Reactions
- Concentrations of Solutions
- Solution Stoichiometry and Chemical Analysis

Objectives:

- Students shall predict products based upon the type of chemical reaction
- Students shall understand the composition of solutions, their formation, and their strengths expressed in various units.
- Students shall understand oxidation-reduction reactions to develop skills in balancing redox equations.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

S.14.C.1	Given the *products* and *reactants* predict *products* for the following types of *reactions:* • *synthesis* • *decomposition* • *single displacement* • *double displacement* • *combustion*
S.15.C.1	Distinguish between the terms *solute*, *solvent*, *solution* and *concentration*
S.15.C.3	Calculate the following concentration expressions involving the amount of *solute* and volume of solution: • *molarity* (M) • *molality (m)*

	• *percent composition* • *normality* (N)
S.15.C.4	Given the quantity of a *solution*, determine the quantity of another species in the reaction
ORR.25.C.1	Identify substances that are oxidized and substances that are reduced in a *chemical reaction*
ORR.25.C.2	Complete and balance redox reactions: • assign *oxidation numbers* • identify the *oxidizing agent* and *reducing agent* • write net ionic equations
S.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of *bias* that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without *bias*
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:

AP Chemistry

- Precipitation Reactions and Solubility Rules
- Determination of Iron by Redox Titration

Unit 5: Thermochemistry (1 week)

Content:

- Nature of Energy
- First Law of Thermodynamics
- Enthalpy
- Calorimetry
- Hess's Law

Objectives:

- Students shall understand enthalpy and its relationship to chemical reactions.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

S.15.C.5	Define *heat of solution*
KE.23.C.1	Define *enthalpy* and *entropy* and explain the relationship to exothermic and endothermic reactions: • $\Delta H < U$ = *exothermic reaction* • $\Delta H > U$ = *endothermic reaction*
KE.23.C.4	Define specific heat capacity and its relationship to calorimetric measurements: $q = m(\Delta T)C_p$
KE.23.C.5	Determine the *heat* of formation and the *heat* of reaction using *enthalpy* values and the Law of Conservation of Energy
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of *bias* that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics

NS.33.C.5	Formulate valid conclusions without *bias*
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables

Experimentations:

Pre-AP Chemistry

- Determination of an Unknown metal using density and specific heat.

AP Chemistry

- Student choice of various enthalpy lab selections with presentations including (Exploring Energy Changes, Measuring Energy Changes, Discovering Instant Cold Packs, Measuring Calories, Heats of reactions and Hess' law.)

SECOND QUARTER (40 days/ 8 weeks)

Unit 6: Atomic Structure (1 week)

Content:

- Wave Nature of Light and Photons
- Quantum Mechanics
- Atomic Orbitals
- Electron Configurations

Objectives:

- Students shall understand how the arrangement of electrons in atoms relates to the quantum model.
- Students shall explain the changes of *matter* using *physical properties* and *chemical properties.*
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

P.6.C.5	Predict the *chemical properties* of substances based on their electron configuration: • active • inactive • inert
AT.3.C.1	Correlate emissions of visible light with the arrangement of electrons in *atoms:* • quantum • $c = v\lambda$ Where $v =$ *frequency* ; $\lambda =$ *wavelength*
AT.3.C.2	Apply the following rules or principles to model electron arrangement in *atoms*: • *Aufbau Principle* (diagonal filling order) • *Hund's Rule*

	• *Pauli's Exclusion Principle*
AT.3.C.3	Predict the placement of *elements* on the Periodic Table and their properties using electron configuration
AT.3.C.4	Demonstrate electron placement in *atoms* using the following notations: • *orbital notations* • *electron configuration notation* • *Lewis electron dot structures*
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of *bias* that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without *bias*
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:
AP Chemistry

- Atomic Spectra and Atomic Structure

Unit 7: Periodicity (1 week)

Content:

- Development of the Periodic Table
- Size of Atoms
- Ionization Energy
- Electron Affinities
- Metals, Non-metals, and Metalloids
- Group Trends

Objectives:

- Students shall understand the process of ionic bonding
- Students shall understand the significance of the Periodic Table and its historical development

Frameworks:

B.8.C.1	Determine *ion* formation tendencies for groups on the Periodic Table: • *main group elements* • *transition elements*
P.4.C.1	Compare and contrast the historical events leading to the evolution of the Periodic Table
P.4.C.2	Describe the arrangement of the Periodic Table based on electron filling orders: • Groups • Periods
P.4.C.3	Interpret periodic trends: • *atomic radius* • *ionic radius* • *ionization energy* • *electron affinities* • *electronegativities*

Experimentations:

- None

Unit 8: Bonding (2 weeks)

Content:

- Lewis Symbols and the Octet Rule
- Ionic Bonding
- Covalent Bonding
- Polarity and Electronegativity
- Lewis Structures
- Resonance Structures
- Covalent Bond Strength

Objectives:

- Students shall understand the process of covalent bonding.
- Students shall understand the process of ionic bonding
- Students shall relate the physical properties as they relate to different types of bonding.

Frameworks:

B.8.C.3	Use the *electronegativitiy* chart to predict the *bonding* type of *compounds:* • *ionic* • *polar covalent* • *non-polar covalent*
B.9.C.1	Draw *Lewis structures* to show *valence electrons* for *covalent bonding*: • lone pairs • shared pairs • hybridization • resonance
B.9.C.2	Determine the properties of covalent *compounds* based upon double and triple bonding

Experimentations:

- None

Unit 9: Molecular Geometry (1 week)

Content:

- Molecular Shapes
- VSEPR Model
- Polarity of Polyatomic Molecules
- Covalent Bonding and Orbital Overlap
- Hybrid Orbitals
- Multiple Bonds
- Molecular Orbits

Objectives:

- Students shall understand the process of covalent bonding.

Frameworks:

B.9.C.3	Predict the polarity and geometry of a molecule based upon shared electron pairs and lone electron pairs: • *VSEPR Model*

Experimentations:
AP Chemistry

- Molecular Structures and Shapes.

Unit 10: Gases (1 week)

Content:

- Characteristics of Gases
- Pressure
- Gas Laws
- Ideal Gas Equation
- Gas Mixtures and Partial Pressure
- Kinetic Molecular Theory
- Molecular Effusion and Diffusion
- Real Gases

Objectives:

- Students shall apply the stoichiometric mass and volume relationships of gases in chemical reactions.
- Students shall understand the behavior of gas particles as it relates to the kinetic theory.
- Students shall understand the relationships between temperature, pressure, volume, and moles of a gas.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

GL.16.C.1	Demonstrate the relationship of the *kinetic theory* as it applies to *gas* particles: • *molecular motion* • *elastic collisions* • *temperature* • pressure • ideal gas
GL.16.C.2	Calculate the effects of *pressure*, *temperature*, and volume on the number of *moles* of *gas* particles in *chemical reactions*

<table>
<tr><td></td><td></td></tr>
<tr><td>GL.17.C.1</td><td>Calculate the effects of pressure, temperature, and volume to gases
<table>
<tr><th>Gas Law</th><th>Formula</th><th></th></tr>
<tr><td>Avogadro's Law</td><td>$V_2 = V_1 \frac{n_2}{n_1}$</td><td></td></tr>
<tr><td>Boyle's Law</td><td>$P_1V_1 = P_2V_2$</td><td></td></tr>
<tr><td>Charles' Law</td><td>$\frac{V_1}{T_1} = \frac{V_2}{T_2}$</td><td></td></tr>
<tr><td>Combined Law</td><td>$\frac{P_1V_1}{T_2} = \frac{P_2V_2}{T_1}$</td><td></td></tr>
<tr><td>Dalton's Law of Partial Pressure</td><td>$P_{Total} = P_1 + P_2 + P_3 \ldots$</td><td></td></tr>
<tr><td>Graham's Law of Effusion</td><td>$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}$</td><td></td></tr>
<tr><td>Guy-Lussac</td><td>$\frac{P_1}{T_1} = \frac{P_2}{T_2}$</td><td></td></tr>
<tr><td>Ideal Gas Law</td><td>$PV = nRT$</td><td></td></tr>
</table></td></tr>
<tr><td>GL.18.C.1</td><td>Calculate volume/mass relationships in balanced chemical reaction equations</td></tr>
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Experimentations:
Pre-AP Chemistry

- Graham's Law and Effusion

AP Chemistry

- Molar Mass of a Volatile Liquid or Gas

Unit 11: Intermolecular Forces, Solids and Liquids (2 weeks)

Content:

- Intermolecular Forces
- Properties of Liquids
- Phase Changes
- Vapor Pressure
- Phase Diagrams
- Structures of Solids
- Bonding in Solids

Objectives:

- Students shall relate the physical properties of solids to different types of bonding.
- Students shall understand the process of metallic bonding.
- Students shall understand the process of *covalent bonding.*

Frameworks:

B.9.C.4	Identify the strengths and effects of intermolecular forces (van der Waals): • *hydrogen bonding* • *dipole-dipole* • *dipole-induced dipole* • *dispersion forces* (London)
B.10.C.1	Explain the properties of metals due to delocalized electrons: • *molecular orbital model*
B.11.C.1	Distinguish between *amorphous* and *crystalline solids*
B.11.C.2	Compare and contrast the properties of *crystalline solids:* • ionic • covalent network • covalent molecular

	• metallic
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:
AP Chemistry:
Triple Point of Dry Ice

Third Quarter (47 days/9.5 weeks)
Unit 12: Properties of Solutions (2 weeks)

Content:

- Solution Process
- Saturated Solutions and Solubility
- Factors Affecting Solubility
- Concentrations of Solutions
- Colligative Properties
- Colloids

Objectives:

- Students shall understand the composition of solutions, their formation, and their strengths expressed in various units.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

S.15.C.1	Distinguish between the terms *solute*, *solvent*, *solution* and *concentration*
S.15.C.2	Give examples for the nine *solvent-solute* pairs
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:

AP Chemistry

- Freezing Point Depression and molar mass

Unit 13: Chemical Kinetics (2weeks)

Content:

- Reaction Rates
- Dependence of Rate on Concentration
- Change in Concentration vs. Time
- Temperature and Rate
- Reaction Mechanisms
- Catalysis

Objectives:

- Students shall determine the rate law and rates of various reactions.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

KE.23.C.6	Explain the role of *activation energy* and collision theory in *chemical reactions*
E.24.C.1	List and explain the factors which affect the rate of a reaction and the relationship of these factors to chemical equilibrium: • reversible reactions • reaction rate • nature of reactants • concentration • temperature • catalysis
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems

NS.35.C.3	Utilize technology to communicate research findings

Experimentations:
AP Chemistry:
Rates of Chemical Reactions: Rate order and Hydrogen Peroxide Decomposition

Unit 14: Chemical Equilibrium (2 weeks)

Content:

- Equilibrium Constant
- Heterogeneous Equilibria
- Calculating Equilibrium Constants
- Applications of Equilibrium Constants
- Le Chatelier's Principle

Objectives:

- Students shall determine the equilibrium constant from the law of mass action and determine how the reaction quotient relates to equilibrium.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

E.24.C.2	Solve problems developing an equilibrium constant or the *concentration* of a reactant or *product:* • $mA + nB \rightarrow sP + rQ$ mA + nB → sP + rQ • $K_{eq} = \frac{[P]^s[Q]^r}{[A]^m[B]^n}$
E.24.C.3	Explain the relationship of *LeChatelier's Principle* to equilibrium systems: • *temperature* • pressure • *concentration*
E.24.C.4	Describe the application of equilibrium and kinetic concepts to the Haber Process: • high *concentration* of hydrogen and nitrogen • removal of ammonia • precise *temperature* control • use of a contact *catalyst* • high *pressure*

NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:
AP Chemistry:

- Stresses Applied to the Equilibrium Constant

Unit 15: Acid/Base Equilibrium (2 weeks)

Content:

- Bronsted-Lowry Acids and Bases
- Autoionization of Water
- pH Scale
- Strong Acids and Bases
- Weak Acids and Bases
- Relationship between Ka and Kb
- Acid-Base Properties of Salt Solutions
- Acid-Base Behavior and Chemical Structure
- Lewis Acids and Bases

Objectives:

- Students shall apply rules of nomenclature to acids, bases, and salts.
- Students shall understand the historical development of the acid/base theories.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

AB.19.C.1	Compare and contrast the following acid/base theories: • Arrhenius Theory • Bronsted-Lowry Theory • Lewis Theory
AB.20.C.1	Name and write formulas for acids, bases and salts: • binary acids • ternary acids • ionic compounds
AB.21.C.1	Compare and contrast acid and base properties
AB.21.C.2	Describe the role that dissociation plays in the determination of strong and weak acids or bases

	Use acid-base equilibrium constants to develop and explain: • ionization constants • percent of ionization • common ion effect
AB.21.C.3	Explain the role of the pH scale as applied to acids and bases
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:
AP Chemistry:

- Hydrolysis of Salts and pH of Buffer Solutions

Unit 16: Additional Aspects of Equilibrium (1.5 weeks)

Content:

- Common-Ion Effect
- Buffered Solutions
- Acid-Base Titrations
- Solubility Equilibria
- Factors that Affect Solubility
- Precipitation and Separation of Ions
- Qualitative Analysis for Metallic Elements

Objectives:

- Students shall demonstrate an understanding of titration as a laboratory tool.
- Students shall understand the general properties of acids, bases and salts.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

AB.22.C.1	Perform a *titration* to solve for the *concentration* of an *acid* or *base*
AB.22.C.2	Use *indicators* in *neutralization* reactions
AB.22.C.3	Investigate the role of *buffers*
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

AB.21.C.2	Describe the role that dissociation plays in the determination of strong and weak acids or bases
	Use acid-base equilibrium constants to develop and explain: • ionization constants • percent of ionization • common ion effect
AB.21.C.3	Explain the role of the pH scale as applied to acids and bases

Experimentations:
AP Chemistry:

- Determination of the Dissociation Constant of a Weak Acid

Fourth Quarter (51 days/10.5 weeks 7.5 weeks prior to AP exam and 3 weeks after the AP exam.)

Unit 17: Chemical Thermodynamics (2 weeks)

Content:

- Spontaneous Processes
- Entropy and the Second Law of Thermodynamics
- Calculation of Entropy Changes
- Gibbs Free Energy
- Free Energy and Temperature
- Free Energy and the Equilibrium Constant

Objectives:

- Students shall understand enthalpy, entropy, and free energy and their relationship to chemical reactions.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

KE.23.C.2	Define *free energy* in terms of *enthalpy* and *entropy*: • $\Delta G = \Delta H - T\Delta S$ • $\Delta G < 0$ = spontaneous reaction • $\Delta S > 0$ = increase in disorder • $\Delta S < 0$ = decrease in disorder
KE.23.C.3	Calculate *entropy*, *enthalpy*, and *free energy* changes in *chemical reactions*: • $\Delta H^{\circ}_{(rxn)} = \Delta H^{\circ}_{f\,(products)} - \Delta H^{\circ}_{f\,(reactants)}$ • $\Delta G^{\circ}_{(rxn)} = \Delta G^{\circ}_{f\,(products)} - \Delta G^{\circ}_{f\,(reactants)}$

	• $\Delta S^{\circ}_{(rxn)} = \Delta S^{\circ}_{(products)} - \Delta S^{\circ}_{(reactants)}$
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations
NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:

- None

Unit 18: Electrochemistry (2 weeks)

Content:

- Oxidation-Reduction Reactions
- Balancing Oxidation-Reduction Reactions
- Voltaic Cells
- Cell EMF
- Spontaneity of Redox Reactions
- Effect of Concentration on Cell EMF
- Batteries
- Corrosion
- Electrolysis

Objectives:

- Students shall explain the role of oxidation-reduction reactions in the production of electricity in a voltaic cell.
- Students shall design and safely conduct scientific inquiry.
- Students shall use mathematics, science equipment, and technology as tools to communicate and solve problems in chemistry.

Frameworks:

ORR.26.C.1	Write equations for the reactions occurring at the *cathode* and *anode* in electrolytic conduction
ORR.26.C.2	Build a voltaic cell and measure *cell potential:* • half-cells • *salt bridge*
ORR.26.C.3	Explain the process of obtaining electricity from a chemical voltaic cell: • line notation : *anode (oxidation)* ‖ *cathode (reduction)*
ORR.26.C.4	Calculate electric potential of a cell using redox potentials and predict *product*
ORR.26.C.5	Use redox potentials to predict electrolysis *products* and the electric potential of a cell
NS.33.C.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.33.C.2	Research and apply appropriate safety precautions (refer to Arkansas Safety Lab Guide) when designing and/or conducting scientific investigations

NS.33.C.3	Identify sources of bias that could affect experimental outcome
NS.33.C.4	Gather and analyze data using appropriate summary statistics
NS.33.C.5	Formulate valid conclusions without bias
NS.33.C.6	Communicate experimental results using appropriate reports, figures, and tables
NS.35.C.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.35.C.2	Use appropriate equipment and technology as tools for solving problems
NS.35.C.3	Utilize technology to communicate research findings

Experimentations:
AP Chemistry:

- Electrochemical Cells and Thermodynamics

Unit 19: Nuclear Chemistry (Saturday Session)

Content:

- Radioactivity
- Patterns of Nuclear Stability
- Nuclear Transmutations
- Rates of Radioactive Decay
- Detection of Radioactivity
- Energy Changes in Nuclear Reactions
- Nuclear Fission
- Nuclear Fusion
- Biological Effects of Radiation

Objectives:

- Students shall understand the process of transformations of nuclear radiation
- Students shall understand the current and historical ramifications of nuclear energy.

Frameworks:

NC.30.C.1	Describe the following radiation emissions: • alpha particles • beta particles • gamma rays • positron particles
NC.30.C.2	Write and balance nuclear reactions
NC.30.C.3	Compare and contrast *fission* and *fusion*
NC.30.C.4	Apply the concept of half life to *nuclear decay*
NC.31.C.1	Construct models of instruments used to study, control, and utilize radioactive materials and nuclear processes
NC.31.C.2	Research the role of nuclear reactions in society: • transmutation • nuclear power plants

	• Manhattan Project

Experimentations:

- None
- Students will watch and discuss the movie "Fat Man and Little Boy"

Unit 20: Organic Chemistry (Saturday Session)

Content:

- Introduction to Hydrocarbons
- Alkanes
- Unsaturated Hydrocarbons
- Functional Groups; Alcohols and Ethers
- Compounds with a Carbonyl Group
- Introduction to Biochemistry
- Chirality in Organic Chemistry
- Proteins
- Carbohydrates
- Nucleic Acids

Objectives:

- Students shall differentiate between aliphatic, cyclic, and aromatic hydrocarbons.
- Students shall describe the functional groups in organic chemistry.

Frameworks:

OC.27.C.1	Examine the bonding and structural differences of *organic compounds:* • *alkanes* C_nH_{2n+2} • *alkenes* C_nH_{2n} • *alkynes* C_nH_{2n-2} • *aromatic hydrocarbons* • *cyclic hydrocarbons*
OC.27.C.2	Differentiate between the role and importance of *aliphatic*, *cyclic*, and *aromatic hydrocarbons*
OC.27.C.3	Compare and contrast *isomers*

OC.28.C.1	Describe the functional groups in organic chemistry: • halohydrocarbons • alcohols • ethers • aldehydes • ketones • carboxylic acids • esters • amines • amides • amino acids • nitro compounds
OC.28.C.2	Name and write formulas for aliphatic, cyclic, and aromatic hydrocarbons
OC.29.C.1	Differentiate among the biochemical functions of proteins, carbohydrates, lipids, and nucleic acids
OC.29.C.2	Describe the manufacture of polymers derived from organic compounds: • polymerization • crosslinking

Experimentation:

- None

AP Review and Test Preparation (3.5 weeks) with approximately 6 after school sessions and 3 Saturday sessions.

Seniors are released a couple of days after the AP exam. Juniors have an additional 3 weeks of instruction. Additional laboratory activities are performed based on student interest.