STRATFORD PUBLIC SCHOOLS

Stratford, Connecticut

"Tantum eruditi sunt liberi"
Only The Educated Are Free

AP Chemistry

Revised and Edited by
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Reviewed by
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Peter Bowe and Patricia DeCoster

Adopted by the Board of Education – April 2014

Dr. Janet Robinson
Superintendent of Schools
Superintendent

Elaine Watson
Assistant

Stratford Public Schools AP Chemistry Unit 1

Unit Name: Introduction to Chemistry (1) **Early September/ 2 weeks**

Synopsis: 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.

- Connects prior learning in honors chemistry to greater depth in topics such as separation science, measurement, density and significant figures.

STUDENT LEARNING GOALS

21st Century Skills

1. Use real-world digital and other research tools to access, evaluate, and effectively apply information appropriate for authentic tasks.

2. Work independently and collaboratively to solve problems and accomplish goals.

3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

5. Effectively apply the analysis, synthesis, and evaluative processes that enable productive problem solving.

6. Value and demonstrate personal responsibility, character, cultural understanding, and ethical behavior

Common Core Literacy Standards for Science. (See Appendix)

CCSS.ELA-LITERACY.RST.11-12.1
CCSS.ELA-LITERACY.RST.11-12.2
CCSS.ELA-LITERACY.RST.11-12.3
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CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Density, Element, Compound, Distillation, Chromatography, Homogeneous Mixture, Heterogeneous Mixture, Significant Figures, Intensive vs. Extensive Properties, Unsaturated/Saturated/Supersaturated

Enduring Understandings	**Essential Questions**

--All matter is made of atoms. There are limited number and types of atoms; these are the elements --Atoms of each element have unique structures arising from interactions between electrons and nuclei --Elements display periodicity --Atoms are too small to study directly so atomic models are used to explain experimental data --Atoms are conserved in physical and chemical processes	➢ Is the average mass of any large number of atoms of a given element always the same for that given element? ➢ What is the relationship between chemical and physical change? ➢ How is expressing mass in amu useful to a chemist? ➢ Describe the differences between intensive and extensive properties.

Learning Objectives / Grade Level Expectations

Students will be able to:

- Understand and apply the scientific method
- Classify matter based on physical properties
- Mixtures can be separated using specific techniques
- Distinguish between physical and chemical properties
- Relate temperature and density changes to each other
- Identify and locate elements by their properties on the periodic table
- Evaluate the number of significant figures in a calculated value
- Utilize dimensional analysis to determine the appropriate units for an answer

ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
1. Chapter Test *2.* Performance Based Lab : Separation of Components of a Homogeneous Mixture Using Simple Distillation and Column Chromatography Use of volumetric glassware Use of ground glassware Methods of separation science Chromatography	Activity: Students determine the identity of an unknown solution using physical characteristics Activity: Determine alternate method of recording temperature Activity: Students are given the opportunity to make observations on many different elements on the periodic table and based on their physical characteristics, determine periodic tendencies. Students research the properties using the

	internet. Each lab group member gives a short 5-minute presentation on an element. Resource: www.ptable.com. Lab: Determination of Bunsen Burner Flame Temperature Using Thermocouple Wire and a Voltage Conversion Chart Unit conversions High temperature recording methods Types of burners Seebeck effect and thermocouple wire Voltage concept Use of voltmeters

LEARNING PLAN COMPONENTS

Texts

Brown, Theodore L., H. Eugene LeMay, and Bruce Edward Bursten. (2014). *Chemistry: The central science* (13th ed.). New Jersey: Pearson Education. **[CR1]**

Online Reading and Assignments

www.pwista.com/

Laboratory Manuals

Ehrenkranz, David and John J. Mauch. *Chemistry in Microscale*. Jack Randall, *Advanced Chemistry with Vernier* College Board, *AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices Teacher Manual*

Demonstration Resources

- Shakhashiri, Bassam. *Chemical Demonstrations: A Handbook for Teachers of Chemistry.*

Stratford Public Schools AP Chemistry Unit 2

Unit Name: Nuclear and Atomic Structure **Est. # of Weeks:** 3 weeks

Synopsis:

Students synthesize prior learning in subatomic particles, historical perspectives of atomic structure, and quantum theory in context driven problems such as element identification and radiometric dating.

STUDENT LEARNING GOALS

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  CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Protons, neutrons, electrons, Aufbau principal, Pauli Exclusion principal, Hunds Rule, groups/periods, isotopes, metals/nonmetals, electrolyte/nonelectrolyte

Enduring Understandings	**Essential Questions**
--All matter is made of atoms. There are limited number and types of atoms; these are the elements --Atoms of each element have unique structures arising from interactions between electrons and nuclei --Elements display periodicity --Atoms are too small to study directly so atomic models are used to explain experimental data --Atoms are conserved in physical and chemical processes	➢ What is radiometric dating and how is radiometric dating related to isotopic abundance? ➢ How does Rutherford's gold foil experiment exemplify ingenuity and proper use of the scientific method? ➢ What parts of Bohr's planetary model are utilized in the quantum model and why? ➢ What properties of a cathode-ray told Thompson that subatomic particles exist?

Learning Objectives / Grade Level Expectations

Students will be able to:

-describe the types of Subatomic Particles

-describe the structure and stability of the nucleus

-explain the use of mass spectroscopy and isotopes

-describe how the Rutherford experiment helped to reveal the structure of the atom

- describe how the Cathode Ray experiment helped to reveal the structure of the atom

- list the atomic structure terms

-apply the electromagnetic spectrum to analyze energy changes within electron structure

- use PES data to analyze the position and energy associated with electrons

-describe the Bohr model of the atom

-explain the use of spectroscopy to examine the structure of atoms

• Orbital Model of Atom

• Aufbau Diagram

• Paramagnetism

• Quantum Model

ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
Performance Based Assessment: Spectroscopy of gases using discharge tube Determine the emission spectrum of various known gases from given gas discharge tubes Determine what elements are in a fluorescent light bulb Determine energy of emission ➢ *Chapter Test*	**Guided-Inquiry:** Determination of Paramagnetism Using Electron Configuration and Magnetic Attractions Students design method of correlating electron configuration and paramagnetism. Flame Test of Salt Solutions Emission spectroscopy and electronic transition Predict the color of the flame produced when each of your test solutions is heated in a bunsen burner

LEARNING PLAN COMPONENTS

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Stratford Public Schools AP Chemistry Unit 3

Unit Name: Periodicity and Introduction to Bonding **Est. # of Weeks:** 2-3 weeks

Synopsis: Students begin with fragmented pieces of information regarding the properties of substances and the chemical bonds that hold these substances together. Class time is spent connecting initially disparate pieces of information regarding chemical bonding and resulting properties into and organized and structured system that can be utilized throughout the rest of the cource..

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STUDENT LEARNING GOALS

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Key Vocabulary

- Lattice energy, energy of formation, potential energy, oxidation states, metals, nonmetals, metalloids, ionic/covalent/metallic bonding, periodic law

Enduring Understandings	**Essential Questions**
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 --All matter is made of atoms. There are limited number and types of atoms; these are the elements --Atoms of each element have unique structures arising from interactions between electrons and nuclei --Elements display periodicity --Atoms are too small to study directly so atomic models are used to explain experimental data --Atoms are conserved in physical and chemical processes	➢ Spark a meaningful connection in the minds of students (connections to prior learning, accessible language, sentence structure) ➢ Genuine inquiry (not a predetermined, fixed answer) ➢ Encourages transfer across a range of learning experiences ➢ Number of essential questions is limited to what can be functionally sustained by the students as they work to make meaning throughout the unit (typically 1-5 for a unit)

Learning Objectives / Grade Level Expectations

1. Atomic Properties
2. Periodic Law
3. Elemental Properties
4. Types of Bonds
5. Metallic Bonding
6. Properties of Group One
7. Properties of Period Two
8. Metals vs. Non Metals
9. Multiple Oxidation States of Transition Metals
10. Ionic Bonding
11. Ionic Bonding and Potential Energy Diagrams
12. Energy of Formation of Ionic Compounds
13. Lattice energy

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
➢ PBA: **Guided-Inquiry:** Determination of Type of Bonding in Solids	

➢ Chapter Test	**Students use graphical representations and diagrams to construct their own understanding of the dominant type of bonding present in ionic compounds, covalent compounds, metals, polar molecules and nonpolar molecules** **Student Activity** - Students enter data and construct graphs using Microsoft Excel to predict, demonstrate, and identify periodic trends. Students will use graphs and data to justify exceptions to identified trends and present such information in a class discussion

Texts

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Stratford Public Schools AP Chemistry Unit 4

Unit Name: Covalent Bonding and Molecules **Est. # of Weeks:** 2-3 weeks

Synopsis: Chemical and physical properties of materials can be explained by the structure and arrangement of atoms, ions, or molecules and the forces between them. Physical properties of a substance generally depend on the spacing between the particles that make up the substance and the forces of attraction among them.

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CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Polar/nonpolar covalent bonds, Lewis Acids, Lewis Bases, Lewis Structures, Resonance, Hybridization, Molecular Geometry, Isomerism, Dipole Moment, Dielectric Constants,

Enduring Understandings	**Essential Questions**
➢ Matter can be described by its physical properties. The physical properties. The physical properties of a substance generally depend on the spacing between the particles (atoms, molecules, and ions) that make up the substance and the forces of attraction among them. ➢ Forces of attraction between particles (including noble gases and also different parts of some larger molecules) are important in determining many macroscopic properties of a substance, including how the observable physical state changes with temperature. ➢ The strong electrostatic forces of attraction holding atoms together in a unit are called chemical bonds. ➢ The type of bonding in the solid state can be deduced from the properties of the solid state.	➢ How do polar or nonpolar bonds relate to the chemical behavior of a substance? ➢ Explain how resonance relates to Lewis Structures. ➢ What is a functional group? How do interactions amongst functional groups relate to chemical change?

Learning Objectives

1. Types of Covalent Bonds
2. Nonpolar Covalent Bonds
3. Polar Covalent Bonds
4. Coordinate Covalent Bonds - Lewis Acids and Lewis Bases
5. Lewis Structures
6. Resonance
7. Hybridization
8. Molecular Geometry
9. Energy Effects on Molecules
10. Isomerism
11. Functional Groups
12. Interactions of Functional Groups
13. Classification of Molecules
14. Intermolecular Interactions
15. Dipole moments
16. Dielectric Constants
17. Types of Compounds
18. Properties of Metallic, Molecular, Macromolecular and Ionic Compounds

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
Performance Based Task: **Guided Inquiry:** Molecular Interactions Students will make observations with various solutions to determine the connection between: Random miscibility and solubility of given solutes and solvents Relationship of structure to solubility IMF effects, and solubility. Chapter Test	**Student Activity** - Students are given structures of various compounds and must explain why they differ in physical state at various temperatures; then predict the type(s) of bonding present based on the atom's position on the periodic table Molecular Modeling Using Foam Balls and Sticks Predict the shapes of molecules by building a model of the molecule with a molecular modeling kit and applying the Valence Shell Electron Pair Repulsion theory. **Guided-Inquiry:** Intermolecular Attractions Lab Students will make observations with various solutions to determine the connection between: molecular structure and polarity hydrogen bonding and structure capillary action to polarity Angle of curvature relationship to IMF Drop size and IMF

LEARNING PLAN COMPONENTS

Texts

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Stratford Public Schools AP Chemistry Unit 5

Unit Name: **Organic Chemistry**

Est. # of Weeks: 2 weeks

Synopsis: Students explore the properties and bonding of carbon in compounds including hydrocarbons, IUPAC nomenclature, and other organic compounds with relevance to industry and everyday life.

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CCSS.ELA-LITERACY.RST.11-12.8
CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

➢ Organic Chemistry, Saponification, Esterification, Polymerization, Acid, Ketone, Aldehyde, Alcohol, Isomers, IUPAC Nomenclature, Alkyl Groups, Hydrocarbons, Fractional Distillation

Enduring Understandings	**Essential Questions**
➢ Matter can be described by its physical properties. The physical properties. The physical properties of a substance generally depend on the spacing between the particles (atoms, molecules, and ions) that make up the substance and the forces of attraction among them. ➢ Forces of attraction between particles (including noble gases and also different parts of some larger molecules) are important in determining many macroscopic properties of a substance, including how the observable physical state changes with temperature. ➢ The strong electrostatic forces of attraction holding atoms together in a unit are called chemical bonds. ➢ The type of bonding in the solid state can be deduced from the properties of the solid state. ➢	➢ How does modern hydraulic "fracking" relate to fractional distillation? ➢ Why was IUPAC nomenclature originally developed and what patterns exist in this naming system? ➢ Why do chemists pay particular attention to organic compounds and chemistry? ➢ What organic compounds are used in everyday life?

Properties and Bonding in Carbon Compounds
. Introduction to organic chemistry: hydrocarbons and functional groups (structure, nomenclature, chemical properties). Physical and chemical properties of simple organic compounds
Hydrocarbons
. Petroleum
. Fractional Distillation
. Cracking
. Alkanes
. Alkenes
. Alkynes
. Benzene Series
. General Formulas
. Structural Formulas
0. Saturated/unsaturated Compounds
Nomenclature
. Alkyl Groups
. IUPAC Nomenclature
. Isomers
Other Organic Compounds
. Alcohols
Primary, Secondary, and Tertiary Alcohols
Diols and Triols

. Aldehydes
. Ketones
. Acids
. Esters
. Ethers

. Amines
. Polymers
Addition Polymerization
Condensation Polymerization
Natural Polymers

E. Organic Reactions

ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
➢ Performance Based Task: Aspirin Synthesis and Analysis Students will perform an esterification synthesis and prove such synthesis with the following procedures and calculations: Thin layer chromatography Quantitative analysis Theoretical yield calculations Percent yield calculations IR spectroscopy *Chapter Test*	Saponification Students will use surfactants and develop a procedure to measure surface tension. Esterification (Banana oil and oil of wintergreen) Students will use a variety of solutions to go through the esterification process and will identify the completion of such a process through macroscopic observations. Polymerization and Polymer Identification Students will use a variety of solutions to go through the polymerization process and will identify the completion of such a process through macroscopic observations. ➢

NOTE: Common Assessments should be identified in the summative or formative assessment box. A common assessment, by definition, is a locally designated task that all students will complete within a specified timeframe so that teachers can collectively analyze student work and adjust instructional practices.

LEARNING PLAN COMPONENTS

Texts

Brown, Theodore L., H. Eugene LeMay, and Bruce Edward Bursten. (2014). *Chemistry: The central science* (13th ed.). New Jersey: Pearson Education. **[CR1]**

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Stratford Public Schools AP Chemistry Unit 6

Unit Name: Predicting Reactions

Est. # of Weeks: 3 weeks

Synopsis: Students will predict reactions based on reaction types and stability. These reactions include redox, acid/base, and organic reactions.

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STUDENT LEARNING GOALS

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CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Synthesis, decomposition, oxidation, reduction, oxidizing agent, reducing agent, double replacement reaction , single replacement reaction, organic functional group reactions, acid-base reactions. Arrhenius acid/base

Enduring Understandings	**Essential Questions**
Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.	➢ How does the law of conservation of mass relate to a balanced chemical equation? ➢ Compare and contrast molecular, ionic, and net-ionic equations ➢ What is the process of standardization and what is the importance of this process in the laboratory? ➢ What is amphoterism and what relevance does this concept have to chemical change?

Learning Objectives / Grade Level Expectations

1. Naming Compounds
2. Balancing Chemical Equations
3. Types of Chemical Equations
4. Types of Chemical Reactions
5. Predicting based on Stability
6. Predicting based on Type
7. Chemical reactivity and products of chemical reactions

Reaction types – Organic Functional Group Reactions, Acid-base reactions; concepts of Arrhenius, Brönsted- Lowry, and Lewis; coordination complexes; amphoterism Precipitation reactions, Oxidation-reduction reactions, Oxidation number, the role of the electron in oxidation reduction reactions

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
➢ PBA: Redox Titration Students will perform a redox standardization of H_2O_2 using potassium permanganate. *Chapter Test*	**Student Activity** - Students observe a series of chemical reactions using video demonstrations from websites. For each they will: 1. Classify the type of reaction, 2. Write a balanced net ionic chemical equation, 3. Write a brief description for each reaction, and 4. Determine the driving force towards thermodynamic favorability for the reaction. Chemical Reactions Using Crystal Growth **:**Students will be provided with several solutions to perform several reactions and predict what possible reactions can occur with such solutions. Students will use macroscopic observations to confirm predictions. Solubility Rule Development Students will predict double replacement reactions in solutions based on solubility rules.

LEARNING PLAN COMPONENTS

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Stratford Public Schools AP Chemistry Unit 7

Unit Name: Measurement and Stoichiometry

Est. # of Weeks: 3 weeks

Students apply concepts of conservation of mass and matter to stoichiometry skills in predicting limiting and excess reagents, as well as theoretical yield. Stoichiometry skills will also be used to determine the empirical formula of compounds in a variety of scenarios.

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STUDENT LEARNING GOALS

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CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

Density, stoichiometry, limiting reagent, excess reagent, moles, volume, mass, Law of Constant Composition, significant figures

Enduring Understandings	**Essential Questions**
➢ Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons. ➢ Chemical changes are represented by a balanced chemical equation that identifies the ratios with which reactants react and products form. ➢ Chemical reactions can be classified by considering what the reactants are, what the products are, or how they change from one into the other. Classes of chemical reactions include synthesis, decomposition, acid-base, and oxidation-reduction reactions. ➢ Chemical and physical transformations may be observed in several ways and typically involve a change in energy.	What is the relevance of density as a concept to a car battery? How can density of liquids be used to determine if a battery is in good working order? How can the Law of Constant Composition be used to make predictions? How are the terms limiting reagent and excess reagent related to stoichiometry? How are moles, grams and particles related?

Learning Objectives / Grade Level Expectations

1. Law of Constant Composition and Calculations based on Law
2. Using Moles to find a Quantity
3. Stoichiometry
4. Limiting Reagents
5. Using Density
6. Solution Terms
7. Stoichiometry - Solutions
➢

ASSESSMENT PLAN

Summative Assessment(s)	
Chapter Test Problem Based Assessments: 1) Molar Mass of Gas Students will use a prescribed procedure and series of calculations to determine the molecular mass of an unknown gas. 2) Standardization of an Acid Solution, Students will use a prescribed procedure and series of calculations to prepare solutions of standardized salicylic acid	**1)** **Student Activity** - Students determine optimum hydrocarbon fuel to oxygen ratio to achieve complete combustion in a 60 mL volume. **2)** Percent Oxygen In A Chlorate **SP 2.2, 6.1** **3)** Students will use a prescribed procedure and series of calculations to determine the percent of oxygen in a chlorate. **4)** Percent of Water in a Hydrate **SP 2.2, 6.1** **5)** Students will use a prescribed procedure and series of calculations to determine the percent of water and the formula of a hydrate. **6)** Empirical Formula Students will use a prescribed procedure and series of calculations to determine the empirical

	formula of manganese chloride. **7)** Atomic Mass Students will use a prescribed procedure and series of calculations to determine the atomic mass of aluminum.

LEARNING PLAN COMPONENTS

Texts

Brown, Theodore L., H. Eugene LeMay, and Bruce Edward Bursten. (2014). *Chemistry: The central science* (13th ed.). New Jersey: Pearson Education.

Online Reading and Assignments

www.pwista.com/

Laboratory Manuals

Ehrenkranz, David and John J. Mauch. *Chemistry in Microscale*. Jack Randall, *Advanced Chemistry with Vernier* College Board, *AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices Teacher Manual , Flinn Chemtopic lab series*

Demonstration Resources

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Stratford Public Schools AP Chemistry Unit 8

Unit Name: Thermochemistry

Est. # of Weeks: 2 weeks

Synopsis: Students apply conceptual understandings of the first two laws of thermodynamics to investigate and measure heat transfer during physical and chemical processes.

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STUDENT LEARNING GOALS

21st Century Skills

1. Use real-world digital and other research tools to access, evaluate, and effectively apply information appropriate for authentic tasks.

2. Work independently and collaboratively to solve problems and accomplish goals.

3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

5. Effectively apply the analysis, synthesis, and evaluative processes that enable productive problem solving.

6. Value and demonstrate personal responsibility, character, cultural understanding, and ethical behavior

Common Core Literacy Standards for Science. (See Appendix)

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  CCSS.ELA-LITERACY.RST.11-12.2
  CCSS.ELA-LITERACY.RST.11-12.3
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  CCSS.ELA-LITERACY.RST.11-12.9
  CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Thermochemistry, system, surroundings, heat capacity, specific heat, state function, calorimetry, joule, calorie, Calorie, potential energy, kinetic energy, Hess's Law, Gibbs free energy

Enduring Understandings	**Essential Questions**
➢ Two systems with different temperatures that are in thermal contact will exchange energy. The quantity of thermal energy transferred from one system to another is called heat. ➢ Energy is neither created nor destroyed, but only transformed from one form to another. ➢ Breaking bonds requires energy, and making bonds releases energy. ➢ Electrostatic forces exist between molecules as well as between atoms or ions, and breaking the resultant intermolecular interactions requires energy ➢ Chemical or physical processes are driven in enthalpy or an increase in entropy, or both	➢ What is the relationship between temperature and energy? ➢ How do changes of state affect the energy of the system> ➢ What does it mean when a reaction is said to be spontaneous? How can one determine if a reaction is spontaneous? ➢ How can one experimentally determine the amount of heat transferred within a chemical reaction? ➢ How are the breaking and formation of bonds related to the overall energy transfer in a reaction?

Learning Objectives / Grade Level Expectations

Thermochemistry

1. Introduction to thermodynamics
2. Conservation of energy
3. State Functions
4. Potential Energy
5. Kinetic Energy
6. Calorimetry
7. Heat of Fusion
8. Heat of Vaporization
9. Specific Heat
10. Heat of Dilution
11. Heat of Solution
12. Hess's Law—direct and indirect
13. Bond Dissociation Energies
14. Gibbs Free Energy Equation

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
1) Unit Test **2) Guided-Inquiry:** Stoichiometry Rockets Students will relate energy changes associated with a chemical reaction to the enthalpy of the reaction, and relate energy changes to PΔV work.	**1) Student Activity** - Pre Lab Activity: Students calculate the needed volume of oxygen to react with given volume of gases in a reaction, determine the heat of the reaction, and then determine the amount of work produced using the distance the rocket traveled and heat produced from the reaction. **2)** Heat of Neutralization

	Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of neutralization for that reaction. **3)** Heat of Dissolution Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of dissolution for that reaction. **4)** Heat of a Reaction Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of a reaction: Mg-HCl. Relate energy changes associated with a chemical reaction to the enthalpy of the reaction, and relate energy changes to PΔV work ➢

LEARNING PLAN COMPONENTS

Texts

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Stratford Public Schools AP Chemistry Unit 9

Unit Name: Solids, Liquids, and Gases **Est. # of Weeks:** 2 weeks

Synopsis: Students investigate the forces of attraction between molecules as well as kinetic theory and the energy requirements for phase change. Heating and cooling curves as well as triple-point diagrams are included in this unit.

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STUDENT LEARNING GOALS

21st Century Skills

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3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

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CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Triple point, vapor pressure, critical point, kinetic theory, entropy, ideal gas, intermolecular forces, viscosity, surface tension, enthalpy, Gibbs Free energy

Enduring Understandings	Essential Questions
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. Matter can be described by its physical properties. The physical properties of a substance generally depend on the spacing between particles that make up the substance and the forces of attraction among them. Forces of attraction between particles are important in determining many macroscopic properties of a substance, including how the observable physical state changes with temperature. The strong electrostatic forces of attraction holding atoms together in a unit are called chemical bonds. The type of bonding in the solid state can be deduced from the properties of the solid state.	➢ Under what type of scenario does an ideal gas deviate from ideal behavior? ➢ What accounts for the changes in kinetic and potential energy in solids, liquids, and gases? ➢ How do entropy, enthalpy, and Gibbs Free Energy apply to stretching rubber band ? ➢ How do viscosity and surface tension relate to intermolecular forces and

Learning Objectives / Grade Level Expectations

Gas, Liquids and Solids

1. Real Gases versus Ideal Gases
2. Ideal Gas Equation
3. Derivations based on Ideal Gas Equation
4. Gases collected Over Water
5. Kinetic Molecular Theory
6. Van Der Waals Equation
7. Molecular Speeds
8. Diffusion and Effusion
9. Molecular Theory related to Phase
10. Phase Changes
11. Entropy
12. Heating and Cooling Curves
13. Interfaces
14. Pressure
15. Vapor Pressure

16. Boiling Point and Freezing Points
17. Vapor Pressure Curves

18. Phase Diagrams – Triple point, critical point
19. Energy change during phase changes
20. Viscosity
21. Surface Tension
22. Types of Solids and Crystal Structure

ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
Chapter Test Problem Based Assessment: Freezing Point of a Pure Material Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the freezing point of phenyl salicylate	Student Activities: Drawing a triple point diagram using distilled water as compared to a concentrated aqueous solution Molar Mass of a Gas : Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the molecular mass of butane.

LEARNING PLAN COMPONENTS

Texts

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Stratford Public Schools AP Chemistry Unit 10

Unit Name: Solutions

Est. # of Weeks: 2-3 weeks

Synopsis: Skills in stoichiometry, determination of ion concentration and naming chemical formulas are utilized in this unit to predict both qualitatively and quantitatively the effect of various solutes on solvent properties including freezing point, boiling point, and vapor pressure.

STUDENT LEARNING GOALS

21st Century Skills

1. Use real-world digital and other research tools to access, evaluate, and effectively apply information appropriate for authentic tasks.

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CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Solutions, electrolytes, nonelectrolytes, dissolution, ionization, miscibility, solubility, Van Hoff Factor, colligative properties, dilution, Henry's Law, osmosis, stoichiometry, saturated, unsaturated, supersaturated

Enduring Understandings	**Essential Questions**
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. Matter can be described by its physical properties. The physical properties of a substance generally depend on the spacing between the particles (atoms, molecules, ions) that make up the substance and the forces of attraction among them. Forces of attraction between particles are important in determining many macroscopic properties of a substance, including how the observable physical state changes with temperature. The strong electrostatic forces of attraction holding atoms together in a unit are called chemical bonds. The type of bonding in the solid state can be deduced from the properties of the solid state. ➢	Explain how colligative properties more related to physical change than chemical change. Evaluate and compare the effects of colligative properties on solvents such as water and acetone in terms of boiling point elevation, lowering of vapor pressure, and freezing point depression. Compare and contrast ionization and dissolution What is a solubility curve and what information can bet gleaned from the solubility curve of a chemical?

Learning Objectives / Grade Level Expectations

1. Types of Solutions
2. Electrolytes
3. Miscibility and Immiscibility
4. Process of Dissolution
5. Dissolution versus Ionization
6. Solubility Terms
7. Solubility Curves
8. Henry's Law
9. Concentration Terms – Molarity, Molality, % , mole fractions
10. Dilution Problems
11. Stoichiometry Problems with Solutions—Review
12. Raoult's Law
13. Freezing and Boiling points of Solutions—Colligative Properties
14. Van't Hoff factor

15. Osmosis
16. Deviation from Raoult's Law
17. Colloids

ASSESSMENT PLAN

Summative Assessment(s)

- Unit Test
- Problem Based Assessment:

Spectroscopic Determination of the Percent of Salicylic Acid in Aspirin

Students prepare standard salicylic acid solutions and use spectroscopy to determine % salicylic acid in expired aspirin tablets.

Given past methods of spectroscopy and preparation of standard solutions, students design an experiment to determine % salicylic acid in expired aspirin tablets.

Formative and Diagnostic Assessment(s)

1) Freezing-point Depression

Students will use freezing-point depression to find molecular weight of a given substance.

2) Spectrophotometry

Students will use spectrophotometry and Beer's law to determine the concentration of a given cobalt chloride solution

LEARNING PLAN COMPONENTS

Texts

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Stratford Public Schools AP Chemistry Unit 11

Unit Name: Chemical Kinetics **Est. # of Weeks:** 2-3

Synopsis: Students use prior understandings of energy, behavior of gases and liquids, and molarity to evaluate chemical reactions in terms of speed of reaction. Graphic representations of zero, first, and second order reactions are emphasized.

STUDENT LEARNING GOALS

21st Century Skills

1. Use real-world digital and other research tools to access, evaluate, and effectively apply information appropriate for authentic tasks.

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3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

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CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

Activation Energy, reaction mechanism, zero order, first order, second order, reaction step, overall reaction, activated complex, intermediate, potential energy

Enduring Understandings	**Essential Questions**
➢ Reaction Rates that depend on temperature and other environmental factors are determined by measuring changes in concentrations of reactants or products over time ➢ Elementary reactions are mediated by collisions between molecules. Only collisions having sufficient energy and proper relative orientation of reactants lead to products ➢ Many reactions proceed via a series of elementary reactions ➢ Reaction rates may be increased by the presence of a catalyst	➢ What influences the rate of a reaction and what is the influence? ➢ What is the rate law and what does it tell scientist? ➢ How does the process of a multistep reaction differ from a single step reaction? ➢ What is the function of a catalyst in a reaction and what does the addition of a catalyst do to the rate reaction?

Learning Objectives

Kinetics

1. Rates relationship to collisions
2. Reaction Mechanisms
3. Activation energy
4. Nature of Reactants and Interfacial Surface Area
5. Temperature and Pressure effects on Rates
6. Catalyst—Homogeneous and Heterogeneous
7. Potential Energy Diagrams—Review
8. Activated Complex and Intermediates
9. Arrhenius Equation
10. Maxwell- Boltzman Diagram
11. Average Rate
12. Rates relationship to Stoichiometry
13. Graphical determination of Instantaneous Rate
14. Rate Laws
15. Determination of Rate Laws
16. Determination of Mechanisms
17. Order of Reactions
18. Calculations based on Order

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
Unit Test Problem Based Assessment: The Kinetics of Bleach Reaction Students use results to determine the order of the reaction. Consider the bleach to be in excess, write a rate law for the reaction, substitute the appropriate digit for the value of x in the rate law. Calculate a value for the rate constant k	**1)Student Activity** - Students orally present the solution to a problem given a set of data of the change of concentration versus time to the class, indicating the order of the reaction and the rate constant with appropriate units 2) Kinetics of the Acid Decomposition of Thiosulfate Students will use a prescribed procedure to perform the acid decomposition of thiosulfate and use a series of calculations to determine the rate law of the reaction. Students will perform graphical determination of order.

Determine the rate of the reaction during the first ten seconds. Determine graphically the initial rate of reaction. Graphically determine the rate at 15 seconds	Students will use differential rate laws to determine order of reaction. Students will determine the rate constant from experimental data. 3) Kinetics of Decomposition of Hydrogen Carbonate Students will determine the variables that affect reaction rate: Nature of reactants Surface area effects Concentration effects

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LEARNING PLAN COMPONENTS

Texts

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Stratford Public Schools AP Chemistry Unit 12

Unit Name: **Equilibrium**

Est. # of Weeks: 3 weeks

Synopsis: Students will take prior learning regarding concentration chemical kinetics, and fractions and apply them to the concept of equilibrium and the formation of an equilibrium constant expression.

STUDENT LEARNING GOALS

21st Century Skills

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CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Spontaneous reaction, LeChatelier's Principal, Equilibrium Constant, Law of Mass Action, Reaction Quotient, Reversible and irreversible chemical change

Enduring Understandings	**Essential Questions**
➢ Chemical equilibrium is a dynamic, reversible state in which rates of opposing processes are equal ➢ Systems at equilibrium are responsive to external perturbations, with the response leading to a change in the composition of the system ➢ Chemical equilibrium plays an important role in acid-base chemistry and in solubility ➢ The equilibrium constant is related to temperature and the difference in Gibbs free energy between reactants and products	➢ What is equilibrium? ➢ What is the equilibrium constant and what can it tell us about the system? ➢ How is the equilibrium quotient related to the equilibrium constant? ➢ How do external stressors affect a system at equilibrium? ➢ How is solubility understood in terms of chemical equilibrium?

Learning Objectives / Grade Level Expectations

1. Reversible processes and Reactions
2. Types of systems
3. Kinetics relationship to Equilibrium
4. Equilibrium Expressions
5. Equilibrium Constants
6. LeChatelier's Principle
7. Equilibrium Stresses
8. Equilibrium Calculations
9. Molar Solubility
10. Common Ion Effects
11. Reaction Quotients

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
Unit 13 Test Problem Based Assessment: Students will 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: Combination indicators Micro-titration pH measurement Probe technology ➢	**Student Activity** - Students determine the concentration of species at equilibrium given the equilibrium constant and the concentration of other species in the reaction at equilibrium. Students will apply Le Chatelier's Principle quantitatively to equilibrium systems that are altered. Le Chatelier's Principle Using Cobalt Complexes and Chemical Equilibrium Lab Students will perform a variety of stresses on a given system in equilibrium to demonstrate Le Chatelier's Principle. Solubility Constant of Calcium Hydroxide Students will 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

LEARNING PLAN COMPONENTS

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Stratford Public Schools AP Chemistry Unit 13

Unit Name: **Acids, Bases and Salts**

Est. # of Weeks: 4 weeks

- This unit takes basic understandings of acid/base behavior and titration and adds weak acid/base theory, buffers, and equilibrium constants.

STUDENT LEARNING GOALS

21st Century Skills

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2. Work independently and collaboratively to solve problems and accomplish goals.

3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

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CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- Dissociation, ionization, Bronsted acid/base, binary acid, oxyacid, weak/strong acids and bases, buffer, titration, equilibrium constant, mass-action , pH, pOH

Enduring Understandings	**Essential Questions**
➢ Chemical equilibrium is a dynamic, reversible state in which rates of opposing processes are equal ➢ Systems at equilibrium are responsive to external perturbations, with the response leading to a change in the composition of the system ➢ Chemical equilibrium plays an important role in acid-base chemistry and in solubility ➢ The equilibrium constant is related to temperature and the difference in Gibbs free energy between reactants and products	➢ How can chemical reasoning be used to describe the proton-transfer reactions of acid-base chemistry? ➢ How does the pH/pOH of a solution relate to the equilibrium state of the system? ➢ How does equilibrium affect the strength of ion dissociation in an acid/base solution? ➢ What is the difference between dissociation and ionization

Learning Objectives

Acids, Bases and Salts

1. Dissociation versus Ionization
2. Preparation of Acids, Bases and Salts
3. Classification of Acids and Bases
4. Bronsted-Lowry Theory of Acids and Bases
5. Degree of Ionization
6. Equilibrium Constants for Acids and Bases
7. Weak Acids and Bases
8. Binary acids versus Oxyacids
9. Determination of Acid and Base properties based on structure
10. Ionization of Water
11. pH and pOH
12. Acid-Base Stoichiometry Problems— Review
13. Ionization calculations of Weak Acids and Bases
14. Henderson-Hasselbalch Equation
15. Titration Calculations
16. Indicators
17. Types of Salts
18. Dissociation of salts and Buffers

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ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
➢ Primary intent of summative assessments are to report student achievement as a result of the unit experiences to inform future performance. <u>These are graded based</u> on established, transparent scoring criteria. ➢ Students should receive criterion-referenced feedback and should be expected to reflect on that feedback to improve next attempt (either revision/retry of a summative assessment or future work in the next units). ➢ Performance tasks are the most desirable forms of summative assessment because they evaluate enduring understandings and learning objectives in	➢ Primary intent of formative are to provide students with immediate feedback to improve current performance ➢ Formative assessments <u>do not have to be</u> "graded" – intent is not to collect documentation of achievement and average the grade but instead to coach for improved achievement on the summative assessments ➢ Primary intent of diagnostic assessments are to find out where students are before teaching begins and after teaching is over to determine current level of knowledge, skill and understanding ➢ Diagnostic assessments <u>should never be</u>

authentic contexts.	"graded."

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LEARNING PLAN COMPONENTS

Texts

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Stratford Public Schools AP Chemistry Unit 14

Unit Name: Electrochemistry and Thermodynamics

Est. # of Weeks: 2-3 weeks

Synopsis: This unit investigates electrochemistry and the role of entropy and Gibbs free energy in electrochemical change. The unit builds on prior understanding of enthalpy and redox chemistry.

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STUDENT LEARNING GOALS

21st Century Skills

1. Use real-world digital and other research tools to access, evaluate, and effectively apply information appropriate for authentic tasks.

2. Work independently and collaboratively to solve problems and accomplish goals.

3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

5. Effectively apply the analysis, synthesis, and evaluative processes that enable productive problem solving.

6. Value and demonstrate personal responsibility, character, cultural understanding, and ethical behavior.

Common Core Literacy Standards for Science. (See Appendix)

CCSS.ELA-LITERACY.RST.11-12.1
CCSS.ELA-LITERACY.RST.11-12.2
CCSS.ELA-LITERACY.RST.11-12.3
CCSS.ELA-LITERACY.RST.11-12.4
CCSS.ELA-LITERACY.RST.11-12.5
CCSS.ELA-LITERACY.RST.11-12.6
CCSS.ELA-LITERACY.RST.11-12.7
CCSS.ELA-LITERACY.RST.11-12.8
CCSS.ELA-LITERACY.RST.11-12.9
CCSS.ELA-LITERACY.RST.11-12.10

Key Vocabulary

- NOTE: This vocabulary list is a guaranteed collective document (not open to individual teacher interpretation).
- Terminology that is non-negotiable students learn in order for them to be functional in the unit

Enduring Understandings	**Essential Questions**
➢ Chemical changes are represented by a balanced chemical equation that identifies the ratios with which reactants react and products form. ➢ Chemical reactions can be classified by considering what the reactants are, what the products are, or how they change from one into the other. Classes of chemical reactions include synthesis, decomposition, acid-base, and oxidation-reduction reactions. ➢ Chemical and physical transformations may be observed in several ways and typically involve a change in energy.	➢ What is occurring on the atomic level between elements in an oxidation-reduction reaction? ➢ Explain the general steps in balancing an oxidation-reduction reaction. ➢ What is the general structure of a voltaic cell? ➢ How does electrochemistry show the interconnection between chemical and electrical energy in galvanic and electrolytic cells?

Learning Objectives / Grade Level Expectations

Electrochemistry and Thermodynamics

1. Oxidation and Reduction
2. Substances gaining potential
3. Types of electrochemical cells
4. Voltaic cells
5. Cell Potentials
6. Concentration dependence of E
7. Nernst Equation
8. Cell potentials and Equilibrium
9. Metal Electrodes
10. Reference Electrodes
11. Indicator electrodes
12. Applications of Voltaic Cells
13. Electrolysis
14. Faraday's Law
15. Electrolytic Cells
16. Order of reduction
17. Applications of Electrolytic cells
18. Gibbs Free energy Equation (Free Work)
19. Relationship of Equilibrium and Q
20. Relationship to E

ASSESSMENT PLAN

Summative Assessment(s)	**Formative and Diagnostic Assessment(s)**
➢ Chapter 14 Test ➢ Problem Based Assessment: Electrolysis of Aqueous Solutions Lab Students will use a prescribed procedure to perform a series of redox chemical reactions for galvanic cells Students will use macroscopic	Sketch an electrochemical cell for all the cells created. Include each half-cell, the salt bridge, the electrodes and solutions, the voltmeter leads, the voltmeter, and a switch in your drawing. **Guided-Inquiry:** Electrolysis of Sodium Sulfate Using Micro Hoffman Apparatus

observations and calculations to generate a list of all the particles (ions and molecules) present in the U-tube before electrolysis Write a balanced oxidation half-reaction Write a balanced reduction half-reaction Determine the balanced net ionic equation for the chemical reaction Determine the ions present in the solution are oxidized and which are reduced Determine which electrode is the anode and which electrode in the cathode	Given experimental research using syringes to collect gases over water, atmospheric pressure, and room temperature: Students collect an unknown volume of gas generated Determine the system's net ionic equation, moles of gas, moles of electrons used to generate gas Determine amperes used in the experiment Copper Plating Lab Determine the number of faradays, coulombs, and current used to coat a leaf with copper.
LEARNING PLAN COMPONENTS	

Texts

Brown, Theodore L., H. Eugene LeMay, and Bruce Edward Bursten. (2014). *Chemistry: The central science* (13th ed.). New Jersey: Pearson Education. **[CR1]**

Online Reading and Assignments

www.pwista.com/

Laboratory Manuals

Ehrenkranz, David and John J. Mauch. *Chemistry in Microscale*. Jack Randall, *Advanced Chemistry with Vernier* College Board, *AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices Teacher Manual , Flinn Chemtopic lab series*

Demonstration Resources

Shakhashiri, Bassam. *Chemical Demonstrations: A Handbook for Teachers of Chemistry.*

Flinn Chemtopic lab series

Appendix A:
District Documents

DISTRICT MISSION

The mission of the Stratford Public Schools is to develop a community of learners in which students acquire the knowledge, skills and confidence to meet the challenges of a changing and increasingly diverse 21st century society.

DISTRICT CORE VALUES

Students will acquire content knowledge, strengthen higher-order thinking, and develop character in order to address 21st century challenges.

BUNNELL HIGH SCHOOL BELIEFS

We believe teachers must work collaboratively in support of student learning and to model collaboration as a social skill with students. We believe that a rigorous curriculum for all students, an acceptance of diversity, and a culture that actively welcomes all learners will contribute to a more knowledgeable community and society. We believe in the value of a strong education as a means of preparing students for work and life in the remainder of the 21st century.

STRATFORD HIGH SCHOOL BELIEFS

- a safe, positive school climate that embraces diversity is essential to ensure respect and opportunity for each individual
- students should understand the world beyond their community in order to contribute to a global society
- parents and students must share responsibility and work in partnership with the school in order to improve academic performance and to develop lifelong learners
- students should use technology effectively to acquire, process, and deliver information

BUNNELL HIGH SCHOOL and STRATFORD HIGH SCHOOL

LEARNING EXPECTATIONS

All students will…

- use real-world digital and other research tools to access, evaluate and effectively apply information appropriate for authentic tasks. (Academic)
- work independently and collaboratively to solve problems and accomplish goals. (Civic-Social)
- communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes. (Academic)
- demonstrate innovation, flexibility and adaptability in thinking patterns, work habits and working/learning conditions. (Academic)
- effectively apply the analysis, synthesis and evaluation processes that enable productive problem solving. (Academic)
- value and demonstrate personal responsibility, character, cultural understanding and

ethical behavior. (Civic-Social)

- show competence in all core academic subjects and other fields of interest, including the ability to clearly and effectively communicate content information in multiple formats. (Academic)

Stratford Information Literacy and Technology Standards

Standard 1: Information Strategies

Students determine their need for information and apply strategies to select, locate, and access information resources.

Essential Understanding:

Intelligent decision-making is based on recognizing the need and applying appropriate strategies for accessing information.

Standard 2: Information Use

Students evaluate, analyze, and synthesize information and data to solve problems, conduct research, and pursue personal interests.

Essential Understanding:

All information is not equal.

Standard 3: Information and Technology Application

Students use appropriate technologies to create written, visual, oral and multimedia products that communicate ideas and information.

Essential Understanding:

The effective communication of ideas and information is influenced by the use of appropriate formats.

Standard 4: Literacy and Literary Appreciation

Students extract meaning from fiction and non-fiction resources in a variety of formats. They demonstrate an enjoyment of reading, including an appreciation of literature and other creative expressions.

Essential Understanding:

Reading provides a variety of benefits and advantages.

Standard 5: Personal Management

Students display evidence of ethical, legal, and social responsibility in regard to information resources and project and self-management.

Essential Understanding:

Successful learning requires self-evaluation and discipline

21st Century Skills

1. Use real-world digital and other research tools to access, evaluate, and effectively apply information appropriate for authentic tasks.

2. Work independently and collaboratively to solve problems and accomplish goals.

3. Communicate information clearly and effectively using a variety of tools/media in varied contexts for a variety of purposes.

4. Demonstrate innovation, flexibility, and adaptability in thinking patterns, work habits, and working/learning conditions.

5. Effectively apply the analysis, synthesis, and evaluative processes that enable productive problem solving.

6. Value and demonstrate personal responsibility, character, cultural understanding, and ethical behavior.

Stratford Public Schools

Standards for Science

"What an exiting senior should be able to do in science."

Inquiry

1. Demonstrate an understanding and apply basic scientific concepts, principles and theories in biology, chemistry, physics and earth/space sciences relative to the science program completed by the student.
2. Identify and solve problems through scientific investigation, including: identification of the problem, student design of experiments, collection of relevant evidence or data, use of logical reasoning, appropriately analyzing quantitative and qualitative data from experiments, drawing conclusions and identifying the validity of an experiment.
3. Demonstrate various scientific inquiry skills including: formulating predictions, differentiating between observations and inferences, making generalizations from observations, relating an effect to its cause, identifying patterns or relationships, distinguishing between quantitative and qualitative observations, comparing, sorting and/or classifying objects or events.
4. Select and use appropriate technology, laboratory equipment and materials, including sensing devices to measure, calculate, organize and communicate data.
5. Demonstrate the ability to work independently and collaboratively in an organized fashion to complete a task.

Communication

6. Demonstrate the abilities associated with accurate and effective communication. These include writing, following written procedures, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, constructing a reasoned argument, and responding to critical comments.
7. Demonstrate the ability to create and/or interpret scientific information provided in graphs, tables, charts and illustrations.

STS – Science, Technology & Society

8. Distinguish between the role of science striving to understand the natural world and technology seeking solutions to human problems.

9. Analyze the possibilities and limits of science and technology in order to make and defend decisions about societal issues.

Safety In The Science Laboratory

Students and teachers must be aware of the potential for safety problems in the science classrooms and laboratories. Schools should review available safety resources and develop safety training for their teachers and students as well as safety rules for the classroom.

Teachers must choose safe labs that cover important concepts. Thought must be given to the chemicals purchased by schools. Which chemicals are the safest for the proposed labs, how much is needed, where will the chemicals be stored and in what arrangement? Are the storage areas locked and well ventilated?

General Lab Safety Recommendations

1. Always perform an experiment or demonstration prior to allowing students to replicate the activity. Look for possible hazards. Alert students to potential dangers.
2. Safety instructions should be given orally and be posted each time an experiment is begun.
3. Constant surveillance and supervision of student activities are essential.
4. Never eat or drink in the laboratory or from laboratory equipment. Keep personal items off the lab tables.
5. Never use mouth suction in filling pipettes with chemical reagents. Use a suction bulb.

General Science Safety Checklist

The following is a suggested checklist of safety concerns in K-12 science laboratories.

1. Appropriate protective equipment for the science laboratory
2. Enforcement of safety procedures
3. All students and teachers know the location of all protective equipment
4. All students read and sign a lab safety contract.
5. Sufficient, accessible lab stations per number of students in each laboratory
6. All students must wear proper safety goggles whenever chemicals, glassware, or heat are used

No food products should be consumed by staff or students as part of a lesson, unit or related course work.

Appendix B:

Common Core Literacy Standards for Science

Key Ideas and Details:

CCSS.ELA-LITERACY.RST.11-12.1
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CCSS.ELA-LITERACY.RST.11-12.2
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Craft and Structure:

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

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

CCSS.ELA-LITERACY.RST.11-12.6
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.RST.11-12.7

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

CCSS.ELA-LITERACY.RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CCSS.ELA-LITERACY.RST.11-12.9

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

Range of Reading and Level of Text Complexity:

CCSS.ELA-LITERACY.RST.11-12.10

By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

Appendix C:
Sample Syllabus

Course Title: AP Chemistry
Textbook: Brown, Theodore L., H. Eugene LeMay, and Bruce Edward Bursten. (2014). *Chemistry: The Central Science* (13th Edition). New Jersey: Pearson Education.
Online Reading and Assignments
www.pwista.com/

Demonstration Resources
Shakhashiri, Bassam. *Chemical Demonstrations: A Handbook for Teachers of Chemistry.*

Description: This is an advanced placement course designed to prepare the student for the AP Chemistry exam. The course covers the equivalent of one full year of college level General Chemistry, comparable to a first year course at a college or university. The course is a rigorous math-based course (prerequisite: Algebra II), with a strong laboratory component. It is intended for students who have demonstrated a willingness to commit considerable time to studying and completing assignments outside of class, and who have successfully completed a prior course in chemistry during high school.

The course will develop the student's ability to incorporate mathematical skills in the solution of chemistry problems, both through the use of textbook problems and laboratory activities. Since part of the AP exam no longer allows the use of calculators, significant emphasis will be placed on developing the student's ability to solve problems through dimensional analysis and estimation.

Inquiry based laboratory work is an essential component of the course. Students work collaboratively with their peers to learn new physical manipulations (such as titrations and calorimetry) in order to test hypotheses, make observations, form conclusions based on the interpretation, analysis, and manipulation of data , and to improve their problem solving techniques. Students will be required to do extensive writing, and to keep a thorough and accurate ongoing laboratory notebook which will serve as a means of communication with their laboratory partners and as the basis of more structured laboratory reports to their teacher.

Since passing the AP exam may qualify the student to by-pass a first-year college chemistry course, AP Chemistry should not be considered "college prep." Rather, this is a college class, with college level expectations for behavior, participation and effort.

AP Chemistry meets for **43 minutes two days a week and 86 minutes three days a week**. At least one double period class each week will be devoted to laboratory experiments.

- **Problem sets follow each chapter-** Since the problems are given in advance, late homework will not be accepted. Homework is given on a regular basis and covers whatever was discussed in class on that particular day.
  Also, to count as a homework grade, students will be required to present AP released questions to the class.
- **Quizzes based on homework**
- **Tests** are given upon the completion of a chapter (some tests include multiple chapters). Each test consists of multiple choice questions, in which calculators are not permitted and a free response section- which come from old AP Released Exams when possible (calculators are permitted).
- **Laboratory reports are required.** On the day a lab is to be done in class, the Advanced Study Assignment, typed written purpose and step by step procedure are due. If the procedure is not written up, the lab cannot be done on that day and will have to be done after school within 5 school days. Labs are done with each chapter and they will be kept in a laboratory binder. This is mandatory and you will receive a lab notebook grade.

Grades are based on the following:

Tests: 60%
Laboratory: 20%
Homework/Quiz: 20%

Topic Outline:
1st Semester

Text Chapter	Topic	Approximate Time	Learning Objectives and laboratory experiments
1	Matter & Measurement	Summer	Students will be able to review concepts from 1st year chemistry including elements, compound and mixtures. Measurement, including significant figures and dimensional analysis. **Lab: The Densities of Liquids and Solids**
2	Atoms, Molecules and Ions	Summer	Students will be able to review concepts of atomic theory and subatomic particles. Also, organization of the periodic table and formula writing and nomenclature. **Lab: No suggested lab**
3	Stoichiometry	2 weeks	Students will learn how to solve problems with mass relations in chemistry. Specific quantitative calculations involve measuring molar mass, and moles, using Avogadro's number. Also, determination of empirical and molecular formulas of compounds. Emphasis will be placed on chemical equations and stoichiometric calculations using dimensional analysis. **Lab: Determination of a Chemical Formula, Properties of Hydrates, Analysis of an Unknown Chloride**
4	Reactions in Aqueous Solutions	2 weeks	Students will learn how to determine the concentrations of solutions. Net ionic equations, including precipitation, acid/base and redox reactions. Stoichiometric problems involving solution chemistry. **Lab: Determination of Iron by Reaction with Permanganate- A Redox Reaction**
5	Gases	2.5 weeks	Students will understand the kinetic molecular theory. Gas laws will be examined and students will be able to have solve stoichiometric relationships in a gaseous reaction. Nonideal gases will also be discussed with pressure and volume consequences. **Lab: Molar Mass of a Volatile Liquid, Analysis of an Aluminum-Zinc Alloy**

6	Electronic Structure and the Periodic Table	2 weeks	Students will learn about atomic spectra, Bohr atom, quantum numbers, atomic orbitals, electron configurations and trends in the periodic table in terms of chemical and physical properties. **Lab: No suggested lab**
7	Covalent Bonding	2 weeks	Students will understand Lewis structures, ionic bonding, bond character, covalent bonding ,VSEPR model, resonance structures and hybridization. **Lab: The Geometric Structure of Molecules**
8	Thermochemistry	2.5 weeks	Students will use thermochemical equations to solve for enthalpy, heats of formation, bond energies and heats of reaction. **Lab: Heat Effects and Calorimetry**
9	Liquids and Solids	1.5 weeks	Students will learn about liquid vapor equilibrium, how to read phase diagrams, intermolecular forces, network covalent, ionic and metallic solids. **Lab: No suggested lab**
10	Solutions	1.5 weeks	Students will learn about concentration measurements, principles of solubility and colligative properties of solutions. **Lab: Molar Mass Determination of Depression of the Freezing Point**
11	Rate of Reaction	3 weeks	Students will learn about reaction kinetics and how to solve rate law expressions, determination of half life. Also catalysts and energy of activation will be discussed along with reaction mechanisms. **Lab: Rates of Chemical Reactions, The Iodination of Acetone**

2nd Semester

Text Chapter	Topic	Approximate Time	Learning Objectives and laboratory experiments
12	Gaseous Chemical Equilibria	2 weeks	Students will be able to determine and solve for the equilibrium constant, Le Chateleir's principle and how equilibrium is shifted by temperature, concentration, etc. **Lab: Properties of Systems in Chemical Equilibrium- Le Chatelier's Principle, Determination of the Equilibrium Constant for a Chemical Reaction**

13	Acids and Bases	2 weeks	Students will be able to distinguish between various theories of acids and bases, determine pH and determine equilibrium expressions and solve for K_a, K_b, and K_w and to learn acid-base properties of salt solutions. **Lab: Standardization of a Basic Solution and the Determination of the Molar Mass of an Acid**
14	Equilibria in Acid-Base Solutions	3 weeks	Students will be able to understand how to calculate the pH of a buffer system, the effect of acids and bases on a buffered system and how to perform a titration and solve for the appropriate concentration. **Lab: pH Measurements- Buffers and Their Properties**
15	Complex Ions	1 week	Students will learn the composition of complex ions, their geometry, electronic structure and the formation of constants. **Lab: Synthesis and Analysis of a Coordination Compound**
16	Precipitation Equilibria	2 weeks	Students will learn about precipitation formation ad be able to solve the for solubility product constant. Students will also learn how to dissolve precipitates. **Lab: Development of a Scheme for Qualitative Analysis**
17	Spontaneity of Reaction	2 weeks	Students will learn the laws of thermodynamics; use Hess' Law to solve problems of energy, entropy and free energy and to determine the spontaneity of a reaction. **Lab: No Lab Suggested**
18	Electrochemistry	1 week	Students will review redox reactions and balancing. Be able to distinguish between a voltaic and galvanic cell, calculate cell voltages, solve problems using the Nernst Equation and Faraday's Laws. **Lab: No lab suggested.**
19	Nuclear Reactions	1 weeks	Students will learn about nuclear equation, half lives, nuclear particle emissions, fission and fusion and nuclear reactors. **Lab: No suggested lab**
22	Organic Chemistry	2 weeks	Students will learn organic chemistry nomenclature, functional groups and properties **Lab: Preparation of Aspirin**

Preparation for the AP Exam: For each chapter (starting with chapter 4), students will be given AP Free response questions and will be required to present these to the class routinely throughout the year. All of my exams are modeled after the AP Chemistry Test, including multiple choice questions and free response questions from old exams. Starting in the spring, review sessions will be held after school for any student taking the AP Test. At these sessions, practice tests will be given, which will be graded using the AP scoring rubric. Students are also responsible for taking practice exams on their own time in preparation for the exam in May. Considerable time will be spent going over each multiple choice and free response question to ensure understanding of the material and testing format.

AP Lab Experiments

Laboratory Manuals

Ehrenkranz, David and John J. Mauch. *Chemistry in Microscale*.

Jack Randall, *Advanced Chemistry with Vernier*

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

Experiments:

- **The Densities of Liquids and Solids**
  - **Purpose:** To determine the density of an unknown liquid and solid through calculations involving mass and volume and water displacement.
  - **Student conducted experiment.**
  - **Time:** 45 minutes

- **Resolution of Matter into Pure Substances. I. Paper Chromatography**
  - **Purpose:** To use paper chromatography to separate a mixture of metallic ions in solution and to determine the components of an unknown solution through calculation of R_f values.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **Resolution of Matter into Pure Substances. II. Fractional Crystallization**
  - **Purpose:** To separate two pure components from a mixture through solubility, temperature and filtration.
  - **Student conducted experiment.**
  - **Time:** 3 hours

- **Determination of a Chemical Formula**
  - **Purpose:** To determine the formula of a compound with the general formula $Cu_xCl_y \cdot zH_2O$, where the x, y and z are integers which, when known, establish the formula of the compound.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **Properties of Hydrates**
  - **Purpose:** To study the properties of hydrates and determine the amount of water lost by a sample of unknown hydrate on heating. From this amount, if given the formula or molar mass of the anhydrous sample, you will be able to calculate the formula of the hydrate itself.
  - **Student conducted experiment.**
  - **Time:** 3 hours

- **Molar Mass of a Volatile Liquid**
  - **Purpose:** To use the Ideal Gas Law in determining the molar mass of a volatile liquid.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **Analysis of an Aluminum-Zinc Alloy**
  - **Purpose:** To react a weighed sample of an aluminum-zinc alloy with an excess of acid and collect the hydrogen gas over water. Through use of the Ideal Gas Law and Dalton's Law, the percentage of Aluminum can be determined.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **Heat Effects and Calorimetry**
  - **Purpose:** Using a calorimeter, determine the specific heat of a metal and heat of solution.
  - **Student conducted experiment.**
  - **Time:** 90 minutes

- **The Geometric Structure of Molecules**
  - **Purpose:** Using molecular model kits, to predict the molecular geometries, polarity, isomers and resonance structures of common chemical species.
  - **Student conducted experiment.**
  - **Time:** 90 minutes

- **Molar Mass Determination of Depression of the Freezing Point**
  - **Purpose:** To estimate the molar mass of an unknown solute through use of tertiary butyl alcohol as a solvent. The freezing points will be obtained by studying the rate at which liquid tertiary butyl alcohol and some of its solutions containing the unknown cool in a water bath
  - **Student conducted experiment.**
  - **Time:** 90 minutes

- **Analysis of an Unknown Chloride**
  - **Purpose:** Weighed samples containing an unknown percentage of chloride will be titrated with a standardized solution of $AgNO_3$ to determine the percentage of chlorine.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **Rates of Chemical Reactions. The Iodination of Acetone**
  - **Purpose:** To study the kinetics of the reaction between acetone and iodine and

determine the order of the reaction and rate constant.
- **Student conducted experiment.**
- **Time:** 3 hours

- **Properties of Systems in Chemical Equilibrium- Le Chatelier's Pri**
  - **Purpose:** To interpret observations of altering an equilibrium system by changing temperature and concentrations.

- **Student conducted experiment.**
- **Time:** 2 hours

- **Determination of Iron by Reaction with Permanganate- A Redox Reaction**
  - **Purpose:** To determine the percentage of iron in an unknown containing iron (II) ammonium sulfate by using $KMnO_4$, a widely used oxidizing agent in volumetric analysis.
  - **Student conducted experiment.**
  - **Time:** 90 minutes

- **Standardization of a Basic Solution and the Determination of the Molar Mass of an Acid**
  - **Purpose:** To determine the molarity of OH^- ion in a NaOH solution by titrating that solution against a standardized solution of HCl. Then, you will you use the standardized NaOH solution to titrate a sample of a pure solid organic acid to determine its molar mass.
  - **Student conducted experiment.**
  - **Time:** 3 hours

- **Determination of the Equilibrium Constant for a Chemical Reaction**
  - **Purpose:** To study the equilibrium properties of the reaction between iron (III) ion and thiocyanate ion and to determine the equilibrium constant for the reaction.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **pH Measurements- Buffers and Their Properties**
  - **Purpose:** To determine the approximate pH of several solutions using acid-base indicators. Then you will find the pH of some other solutions with a pH meter. The rest of this experiment deals with the properties of buffer solutions by noting the effect on pH of changing the composition of the buffer and using the data to calculate K_a of the acid. The stability of the pH as we add small amounts of acid will be examined and the effect of dilution will be noted. The buffer will then be exhausted by adding excess acid or base. Finally, buffers will be prepared having specific pH values.
  - **Student conducted experiment.**
  - **Time:** 2 hours

- **Determination of the Solubility Product of PbI_2**
  - **Purpose:** To determine the solubility product of lead (II) iodide through stoichiometry.
  - **Student conducted experiment.**
  - **Time:** 3 hours

- **Development of a Scheme for Qualitative Analysis**
  - **Purpose:** To develop a scheme for the qualitative analysis of 4 cations.
  - **Student conducted experiment.**
  - **Time:** 90 minute

- **Synthesis and Analysis of a Coordination Compound**
  - **Purpose:** To synthesize $Co_x(NH_3)_yCl_z$ and analyze it using gravimetric procedure for the chloride ion, colorimetric method for the cobalt ion and a volumetric procedure for ammonia.
  - **Student conducted experiment.**
  - **Time:** 90 minutes

- **Preparation of Aspirin**
  - **Purpose:** To synthesize aspirin and determine its purity.
  - **Student conducted experiment.**
  - **Time:** 2 hours