Course Title: AP Chemistry Little Chute Science: 11th and 12th

Course Overview: The Little Chute High School AP Chemistry course is the equivalent of a university general chemistry course. AP Chemistry is open to students who passed chemistry and algebra in good standing. Enrollment in physics, algebra 2, and pre-calculus is recommended.

Scope and Sequence

Timeframe	Unit	Instructional Topics
1st Semester 3 Weeks	**Unit 1:** Chemical Fundamentals	Scientific Measurement and Math Nature of Matter Stoichiometry and Beer's Law
2 Weeks	**Unit 2:** Quantum Theory	Electron Configuration Light and Waves Quantum Model of the Atom
3 Weeks	**Unit 3:** Chemical Bonding	Bonding and Electronegativity Lattice Energy Covalent Bonding, VSEPR Theory
3 Weeks	**Unit 4:** Chemical Equations	Types of Reactions Titrations Redox Reactions
2 Weeks	**Unit 5:** Gaw Laws	Gas Laws and KMT Partial Pressure Effusion and Diffusion
2 Weeks	**Unit 6:** Thermochemistry	Enthalpy of Bonds and Formation Hess' Law
2 Weeks	**Unit 7:** Liquids, Solids, and Solutions	Structure of Matter Colligative Properties Vapor Pressure
2nd Semester 2 Weeks	**Unit 8:** Kinetics and Rate Law	Rate Law Determination Integrated Rate Law Reaction Mechanisms
3 Weeks	**Unit 9:** Chemical Equilibrium	Equilibrium Constant and Problems Le Chatlier's Principle Solubility Equilibrium
3 Weeks	**Unit 10:** Acids and Bases	Acid and Base Solubility Acid/Base Properties of Salts Buffers and Titration Curves
2 Weeks	**Unit 11:** Thermodynamics	Entropy Free Energy, Work, and Equilibrium
2 Weeks	**Unit 12:** Electrochemistry	Galvanic Cells Cell Potential and Work Corrosion and Electrolysis

UNIT 1: Chemical Fundamentals

Duration of Unit: 3 Weeks

Description of Unit: A review of high school chemistry and advancing skills from the course. Atomic structure, nomenclature, mathematics, and stoichiometry will be reviewed and improved.

Essential Questions and/or Enduring Understandings: Applying appropriate significant figures in mathematics, stoichiometric procedures in calculating chemical quantities, and using spectroscopy to determine unknown concentration.

ESSENTIAL Standards	Learning Targets
SPQ–2: Chemical formulas identify substances by their unique combination of atoms.	SPQ–2.A: Explain the quantitative relationship between the elemental composition by mass and the empirical formula of a pure substance. SPQ–2.B: Explain the quantitative relationship between the elemental composition by mass and the composition of substances in a mixture.
SPQ–1: The mole allows different units to be compared.	SPQ–1.A: Calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept. SPQ–1.B: Explain the quantitative relationship between the mass spectrum of an element and the masses of the element's isotopes.
SPQ–4: When a substance changes into a new substance, or when its properties change, no mass is lost or gained.	SPQ–4.A: Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process. SPQ–4.B: Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.
SAP–8: Spectroscopy can determine the structure and concentration in a mixture of a chemical species.	SAP–8.C: Explain the amount of light absorbed by a solution of molecules or ions in relationship to the concentration, path length, and molar absorptivity.

UNIT 2: Quantum Theory

Duration of Unit: 2 Weeks

Description of Unit: The Bohr model of the atom will be explored in greater detail.

Essential Questions and/or Enduring Understandings: Relationships between light and electron energy, positional probability of electrons, emission spectra, and photoelectron spectroscopy.

ESSENTIAL Standards	Learning Targets
SAP–1: Atoms and molecules can be identified by their electron distribution and energy.	SAP–1.A: Represent the electron configuration of an element or ions of an element using the Aufbau principle. SAP–1.B: Explain the relationship between the photoelectron spectrum of an atom or ion and– a. The electron configuration of the species. b. The interactions between the electrons and the nucleus.
SAP–2: The periodic table shows patterns in electronic structure and trends in atomic properties.	SAP–2.A: Explain the relationship between trends in atomic properties of elements and electronic structure and periodicity. SAP–2.B: Explain the relationship between trends in the reactivity of elements and periodicity.
SAP–8: Spectroscopy can determine the structure and concentration in a mixture of a chemical species.	SAP–8.A: Explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region. SAP–8.B: Explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule.

UNIT 3: Chemical Bonding

Duration of Unit: 3 Weeks

Description of Unit: Properties of ionic and covalent bonds will be explored in deeper detail. New topics include VSEPR theory and orbital hybridization and their connection to molecular geometry, lattice energy, and formal charge.

Essential Questions and/or Enduring Understandings: The mechanisms, energy favorability, and positions of how atoms bond together.

ESSENTIAL Standards	Learning Targets
SAP–3: Atoms or ions bond due to interactions between them, forming molecules.	SAP–3.A: Explain the relationship between the type of bonding and the properties of the elements participating in the bond. SAP–3.B: Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength. SAP–3.C: Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions. SAP–3.D: Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.
SAP–4: Molecular compounds are arranged based on Lewis diagrams and Valence Shell Electron Pair Repulsion (VSEPR) theory.	SAP–4.A: Represent a molecule with a Lewis diagram. SAP–4.B: Represent a molecule with a Lewis diagram that accounts for resonance between equivalent structures or that uses formal charge to select between nonequivalent structures. SAP–4.C: Based on the relationship between Lewis diagrams, VSEPR theory, bond orders, and bond polarities– a. Explain structural properties of molecules. b. Explain electron properties of molecules.

UNIT 4: Chemical Equations

Duration of Unit: 3 Weeks

Description of Unit: The chemical equations unit will expand upon the knowledge of reaction types and predicting products. New topics will include balancing redox reactions, writing ionic equations, and titration laboratory technique.

Essential Questions and/or Enduring Understandings: Writing and predicting the likelihood of a chemical reaction. Determine the concentration of an analyte. Balance redox reactions under various conditions.

ESSENTIAL Standards	Learning Targets
TRA–1: A substance that changes its properties, or that changes into a different substance, can be represented by chemical equations.	TRA–1.A: Identify evidence of chemical and physical changes in matter. TRA–1.B: Represent changes in matter with a balanced chemical or net ionic equation– a. For physical changes. b. For given information about the identity of the reactants and/or product. c. For ions in a given chemical reaction. TRA–1.C: Represent a given chemical reaction or physical process with a consistent particulate model. TRA–1.D: Explain the relationship between macroscopic characteristics and bond interactions for– a. Chemical processes. b. Physical processes.
TRA–2: A substance can change into another substance through different processes, and the change itself can be classified by the sort of processes that produced it.	TRA–2.A: Identify a reaction as acid–base, oxidation–reduction, or precipitation. TRA–2.C: Represent a balanced redox reaction equation using half–reactions.

UNIT 5: Gas Laws	
Duration of Unit: 2 Weeks	
Description of Unit: Gas Laws will go into deeper detail of the properties of gases and the gas laws. New topics covered include partial pressure, Raoult's Law, Graham's Law, and effusion and diffusion.	
Essential Questions and/or Enduring Understandings: Advanced calculations of gas systems and deviations from the ideal gas law.	
ESSENTIAL Standards	**Learning Targets**
SAP–7: Gas properties are explained macroscopically—using the relationships among pressure, volume, temperature, moles, gas constant—and molecularly by the motion of the gas.	SAP–7.A: Explain the relationship between the macroscopic properties of a sample of gas or mixture of gases using the ideal gas law. SAP–7.B: Explain the relationship between the motion of particles and the macroscopic properties of gases with– a. The kinetic molecular theory (KMT). b. A particulate model. c. A graphical representation. SAP–7.C: Explain the relationship among non–ideal behaviors of gases, interparticle forces, and/or volumes.

UNIT 6: Thermochemistry

Duration of Unit: 2 Weeks

Description of Unit: Thermochemistry will review and go deeper into enthalpy, formation and bond energy, and Hess' Law.

Essential Questions and/or Enduring Understandings: Writing and applying standard enthalpy values to predict the thermochemical properties of a reaction. Laboratory calculations in determining the enthalpy of a chemical reaction.

ESSENTIAL Standards	Learning Targets
ENE–2: Changes in a substance's properties or change into a different substance requires an exchange of energy.	ENE–2.A: Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation. ENE–2.B: Represent a chemical or physical transformation with an energy diagram. ENE–2.C: Explain the relationship between the transfer of thermal energy and molecular collisions. ENE–2.D: Calculate the heat q absorbed or released by a system undergoing heating/cooling based on the amount of the substance, the heat capacity, and the change in temperature. ENE–2.E: Explain changes in the heat q absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition. ENE–2.F: Calculate the heat q absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction.
ENE–3: The energy exchanged in a chemical transformation is required to break and form bonds.	ENE–3.A: Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction. ENE–3.B: Calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation. ENE–3.C: Represent a chemical or physical process as a sequence of steps. ENE–3.D: Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.

UNIT 7: Liquids, Solids, and Solutions

Duration of Unit: 2 Weeks

Description of Unit: New topics include the complex bonding patterns of solids, properties of liquids, and relationships between system changes and their effect on the physical properties of a pure substance or solution. Strength and properties of intermolecular forces will be explored in greater detail.

Essential Questions and/or Enduring Understandings: Identifying the type and properties of various solids. Calculations of shifts in physical properties of matter when changes in the system occur. Identify strength and type of intermolecular forces present in a pure substance or mixture. Predict the likelihood and strength of solubility based on intermolecular strength and the conditions of the system in which the solution resides.

ESSENTIAL Standards	Learning Targets
SAP–5: Intermolecular forces can explain the physical properties of a material.	SAP–5.A: Explain the relationship between the chemical structures of molecules and the relative strength of their intermolecular forces when– a. The molecules are of the same chemical species. b. The molecules are of two different chemical species. SAP–5.B: Explain the relationship among the macroscopic properties of a substance, the particulate–level structure of the substance, and the interactions between these particles.
SAP–6: Matter exists in three states: solid, liquid, and gas, and their differences are influenced by variances in spacing and motion of the molecules.	SAP–6.A: Represent the differences between solid, liquid, and gas phases using a particulate–level model.
SPQ–3: Interactions between intermolecular forces influence the solubility and separation of mixtures.	SPQ–3.A: Calculate the number of solute particles, volume, or molarity of solutions. SPQ–3.B: Using particulate models for mixtures– a. Represent interactions between components. b. Represent concentrations of components. SPQ–3.C: Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.

UNIT 8: Kinetics and Rate Law

Duration of Unit: 2 Weeks

Description of Unit: Kinetics covers the properties and mathematical functions of reaction speed.

Essential Questions and/or Enduring Understandings: Writing rate law functions from experimental data, graphical analysis of rate law data, identifying reaction mechanisms, and the influence of catalysts on a chemical reaction energy profile.

ESSENTIAL Standards	Learning Targets
TRA–3: Some reactions happen quickly, while others happen more slowly and depend on reactant concentrations and temperature.	TRA–3.A: Explain the relationship between the rate of a chemical reaction and experimental parameters. TRA–3.B: Represent experimental data with a consistent rate law expression. TRA–3.C: Identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time.
TRA–4: There is a relationship between the speed of a reaction and the collision frequency of particle collisions.	TRA–4.A: Represent an elementary reaction as a rate law expression using stoichiometry. TRA–4.B: Explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of molecular collisions.TRA–4.C: Represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile.
TRA–5: Many chemical reactions occur through a series of elementary reactions. These elementary reactions when combined form a chemical equation.	TRA–5.A: Identify the components of a reaction mechanism. TRA–5.B: Identify the rate law for a reaction from a mechanism in which the first step is rate limiting. TRA–5.C: Identify the rate law for a reaction from a mechanism in which the first step is not rate limiting. TRA–5.D: Represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile.
ENE–1: The speed at which a reaction occurs can be influenced by a catalyst.	ENE–1.A: Explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism.

UNIT 9: Equilibrium

Duration of Unit: 3 Weeks

Description of Unit: The equilibrium unit covers the direction and position of a chemical reaction. Topics covered include calculation of the equilibrium constant and the factors that can influence the direction and position of a chemical reaction.

Essential Questions and/or Enduring Understandings: Calculations of equilibrium constant, reaction quotient, and product solubility. Predict the direction of a chemical reaction and solubility based on influencing variables.

ESSENTIAL Standards	Learning Targets
TRA–6: Some reactions can occur in both forward and reverse directions, sometimes proceeding in each direction simultaneously.	TRA–6.A: Explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations. TRA–6.B: Explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions.
TRA–7: A system at equilibrium depends on the relationships between concentrations, partial pressures of chemical species, and equilibrium constant K.	TRA–7.A: Represent the reaction quotient Qc or Qp, for a reversible reaction, and the corresponding equilibrium expressions Kc = Qc or Kp = Qp. TRA–7.B Calculate Kc or Kp based on experimental observations of concentrations or pressures at equilibrium. TRA–7.C: Explain the relationship between very large or very small values of K and the relative concentrations of chemical species at equilibrium. TRA–7.D: Represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction. TRA–7.E: Identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant. TRA–7.F: Represent a system undergoing a reversible reaction with a particulate model.
TRA–8: Systems at equilibrium respond to external stresses to offset the effect of the stress.	TRA–8.A: Identify the response of a system at equilibrium to an external stress, using Le Châtelier's principle. TRA–8.B: Explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium.
SPQ–5: The dissolution of a salt is a reversible process that can be influenced by environmental factors such as pH or other dissolved ions.	SPQ–5.A: Calculate the solubility of a salt based on the value of Ksp for the salt. SPQ–5.B: Identify the solubility of a salt, and/or the value of Ksp for the salt, based on the concentration of a common ion already present in solution. SPQ–5.C: Identify the qualitative effect of changes in pH on the solubility of a salt. SPQ–5.D: Explain the relationship between the solubility of a salt and changes in the enthalpy and entropy that occur in the dissolution process.

UNIT 10: Acids and Bases	
Duration of Unit: 3 Weeks	
Description of Unit: Acids and bases discusses in great detail the properties of acids and bases in solution, pH of solutions, titration curves, effects of salt on the pH of a solution, and the function of buffers.	
Essential Questions and/or Enduring Understandings: Identify an acid, base, and their respective conjugates, the difference between a strong and weak acids, and the various parts of a titration curve. Calculation of pH given experimental data, titration curves, and designing of a buffering system to a specific pH.	
ESSENTIAL Standards	**Learning Targets**
TRA–2: A substance can change into another substance through different processes, and the change itself can be classified by the sort of processes that produced it.	TRA–2.B: Identify species as Brønsted–Lowry acids, bases, and/or conjugate acid–base pairs, based on proton–transfer involving those species.
SAP–9: The chemistry of acids and bases involves reversible proton–transfer reactions, with equilibrium concentrations being related to the strength of the acids and bases involved.	SAP–9.A: Calculate the values of pH and pOH, based on Kw and the concentration of all species present in a neutral solution of water. SAP–9.B: Calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base. SAP–9.C: Explain the relationship among pH, pOH, and concentrations of all species in a solution of a monoprotic weak acid or weak base. SAP–9.D: Explain the relationship among the concentrations of major species in a mixture of weak and strong acids and bases. SAP–9.E: Explain results from the titration of a mono– or polyprotic acid or base solution, in relation to the properties of the solution and its components. SAP–9.F: Explain the relationship between the strength of an acid or base and the structure of the molecule or ion.
SAP–10: A buffered solution resists changes to its pH when small amounts of acid or base are added.	SAP–10.A: Explain the relationship between the predominant form of a weak acid or base in solution at a given pH and the pKa of the conjugate acid or the pKb of the conjugate base. SAP–10.B: Explain the relationship between the ability of a buffer to stabilize pH and the reactions that occur when an acid or a base is added to a buffered solution. SAP–10.C: Identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid–base pair used to create the buffer. SAP–10.D: Explain the relationship between the buffer capacity of a solution and the relative concentrations of the conjugate acid and conjugate base components of the solution.

UNIT 11: Thermodynamics

Duration of Unit: 2 Weeks

Description of Unit: Thermodynamics covers the energy properties of chemical reaction favorability given thermodynamic data. The unit describes conditions at which reactions can happen naturally and the energy influences that must be made on a reaction to initiate it.

Essential Questions and/or Enduring Understandings: Prediction of the spontaneity of a chemical reaction. Understanding of entropy. Calculation of thermodynamic system data.

ESSENTIAL Standards	Learning Targets
ENE–4: Some chemical or physical processes cannot occur without intervention.	ENE–4.A: Identify the sign and relative magnitude of the entropy change associated with chemical or physical processes. ENE–4.B: Calculate the entropy change for a chemical or physical process based on the absolute entropies of the species involved in the process. ENE–4.C: Explain whether a physical or chemical process is thermodynamically favored based on an evaluation of $\Delta G°$. ENE–4.D: Explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate.
ENE–5: The relationship between $\Delta G°$ and K can be used to determine favorability of a chemical or physical transformation.	ENE–5.A: Explain whether a process is thermodynamically favored using the relationships between K, $\Delta G°$, and T. ENE–5.B: Explain the relationship between external sources of energy or coupled reactions and their ability to drive thermodynamically unfavorable processes.

UNIT 12: Electrochemistry	
Duration of Unit: 2 Weeks	
Description of Unit: Electrochemistry covers the electrical properties of chemical reactions. Topics include galvanic cells, reduction potential, electrolysis, and the thermodynamic favorability of electrochemical reactions.	
Essential Questions and/or Enduring Understandings: Designing a galvanic cell, predicting the direction of electron flow, voltage, and chemical species in a galvanic cell. Calculating the cell potential, concentrations of chemical species, and the products or charge associated with an electrolysis process.	
ESSENTIAL Standards	**Learning Targets**
ENE–6: Electrical energy can be generated by chemical reactions.	ENE–6.A: Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell. ENE–6.B: Explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half–reactions within the cell. ENE–6.C: Explain the relationship between deviations from standard cell conditions and changes in the cell potential. ENE–6.D: Calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell.