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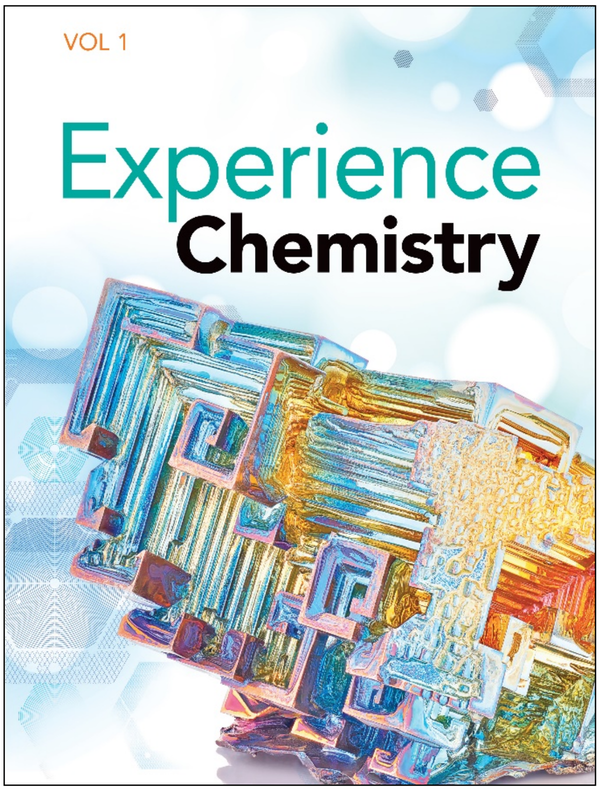

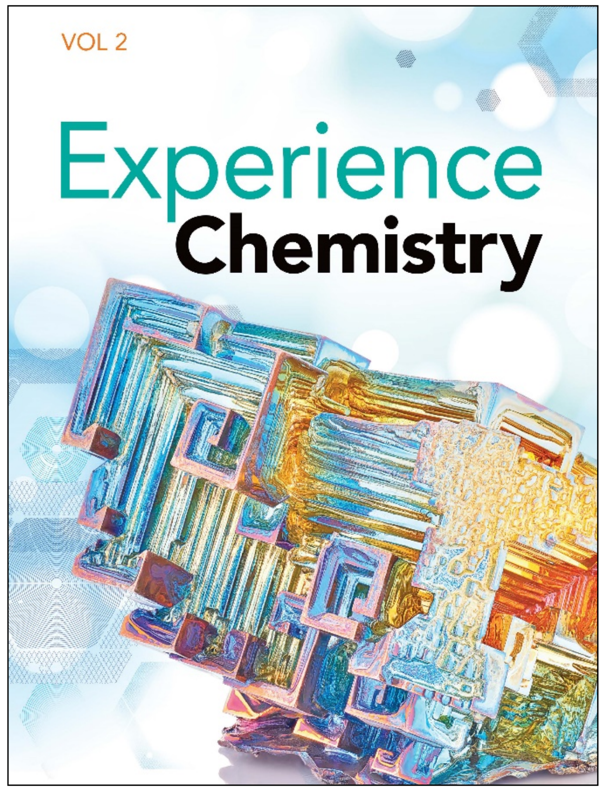

To the

Minnesota
2019 Academic Standards in Science
High School Chemistry

Prepared by Savvas Learning Company, formerly Pearson K12 Learning

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Introduction

This document demonstrates how **Experience Chemistry ©2021** supports Minnesota Academic Standards in Science for High School Chemistry (2019). Correlation references include the Experience Notebook (Volumes 1 and 2), Teacher Guide, and online digital assets.

Savvas Learning Company is excited to introduce **Experience Chemistry!** From climate change, water quality, and the newest energy sources, to the foods we grow and eat, your students will experience chemistry like never before. The program uses cool, weird, and amazing phenomena to engage students in 3-D science. Give students an up-close, first-hand experience they'll never forget.

Be the first to *Experience It!*

Storylines are organized around a real-world Anchoring Phenomena that sparks student curiosity, gives a purpose to learning and connects chemistry concepts through a unifying unique occurrence. Students encounter everyday phenomena through Claims-Evidence Reasoning Exercises, Authentic Readings, STEM Projects, and Engineering Performance Tasks.

Explore Phenomena with Flinn Scientific!

Experience Chemistry and Flinn Scientific partner to deliver high-quality inquiry opportunities to chemistry classrooms. Lab Experiments, Engineering Challenges, Performance Tasks, Virtual Reality Simulations, and Lab Videos by Flinn Scientific immerse students in hands-on chemistry.

Hands-On Labs
• Assign student-friendly labs focused on real-world phenomena in every learning experience.
• Customize your lessons with four versions of every lab including Open-Ended, Guided, Shortened, and Advanced.

Lab Videos
• Background videos, demo videos and summary videos engage and connect students to the phenomena, prepare students and instructors for set-up and revisit concepts before assessments.

Design Challenges and Performance Tasks
• Students mimic the real-world activities of engineers as they define and solve problems and design, test and evaluate solutions.
• Students demonstrate mastery of three-dimensional learning at the end of every Investigation with a Performance-Based assessment.

Lab Kits
• Simplify lab set-up and solution preparation with time-saving lab kits.

Virtual Reality
• Immerse your students in 360º simulations that bring chemistry to life.

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(1.0) Exploring phenomena or engineering problems	
(1.1) Asking questions and defining problems	
(9C.1.1.1.1) Ask questions about the impact of greenhouse gases on the Earth's climate, by analyzing their molecular structure and responses during energy absorption (P: 1, CC: 5, CI: PS1) **Emphasis** should include natural and human-made sources. Structures should include molecular shape.	**Experience Notebook, Volume 2:** **Investigation 10** Long-Term Changes in Sunlight, 77 Past Climates, 78 Volcanic Activity and CO_2, 81 Erosion and Carbon Dioxide, 82 Continent Distributions and Ocean Currents, 83-84 Cycles within Cycles, 85-87 Ocean/Atmosphere Circulation Changes, 88 Variations in Solar Output, 89-90 Volcanic Eruptions, 91-92 Climate and Humans, 93-95 Revisit Investigative Phenomenon, 96 Assessment, 97 **Investigation 11** Melting Ice and Rising Sea Levels, 109 Ice Cores and Human History, 110 Medieval Climate Anomaly and Little Ice Age, 113-114 Carbon Dioxide and Temperature, 115 Greenhouse Gas Release, 116 **Teacher Guide:** **Inquiry Labs:** How Melting Ice Affects Sea Level; Carbon Dioxide and Its Role in Climate; How Nature Records Changes in Climate; Human Activity and Carbon Emissions **Digital Activities:** Energy In and Out of Earth's Atmosphere; Sampling the Past; Milankovitch Cycles; Evaluate Milankovitch Cycles; Solar Output; Flow of Energy and Greenhouse Gases; Can Volcanoes Change the Climate?
(1.2) Planning and carrying out investigations	
(9C.1.2.1.1) Plan and conduct an investigation to gather evidence to compare the structure of substances and infer the strength of electrical forces between particles. (P: 3, CC: 1, CI: PS1) **Emphasis** is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). **Examples** of particles may include ions, atoms, molecules, and networked materials (such as graphite). **Examples** of collected evidence may include the melting point and boiling point, vapor pressure, and surface tension.	**Experience Notebook, Volume 1:** **Investigation 4** Ductility and Malleability, 142 **Teacher Guide:** **Inquiry Labs:** Correlate Material Properties and Bond Type; Melt Ionic and Covalent Compounds **Digital Activities:** Intermolecular Forces in Liquids; Tough Tools **Performance Based Assessment:** Qualitative Analysis and Chemical Bonding; Identify Evidence of Chemical Reactions

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(9C.1.2.1.2) Plan and conduct an investigation of acid-base reactions to test ideas about the concentrations of the hydronium ion in an aqueous solution (pH). (P:3, CC: 3, CI: PS1) **Emphasis** is on developing an understanding of pH scales and various ways to measure pH. Also included is understanding the relative strength of acidity based on periodic properties of elements, the electronegativity model of electron distribution, empirical dipole moments, and molecular geometry. **Examples** of investigations may include household chemicals and ocean acidification analogs.	**Experience Notebook, Volume 2:** **Investigation 13** Defining Acids and Bases, 195 Apply Concepts, 195 SEP Use Mathematics, 198 Calculating pH, 199-200 Sample Problem: Calculating pH from H30+ Concentration, 201 SEP Develop Models, 202 Sample Problem: Estimating pH of a Weak Acid Solution, 209 Strength vs. Concentration, 210 CCC Cause and Effect, 213 Sample Problem: Finding Moles Needed for Neutralization, 214 **Teacher Guide:** **Engineering Design Challenge:** Design a Natural pH Indicator
(2.0) Looking at data and empirical evidence to understand phenomena or solve problems	
(2.1) Analyzing and interpreting data	
(9C.2.1.1.1) Analyze patterns in air or water quality data to make claims about the causes and severity of a problem and the necessity to remediate or to recommend a treatment process. (P: 4, CC :2, CI: PS3) **Emphasis** is on the scale of the problem and appropriate use of concentration units. **Examples** of pollutant data may include ozone, lead, particulates, nitrates, or microorganisms. **Examples** of remediation may include physical, chemical or biological processes.	Supporting Content: **Experience Notebook, Volume 2:** **Investigation 14** Carbon Dioxide and Ocean pH, 230-231 LeChatlier's Principle and Future Ocean pH, 236-237 **Investigation 18** Sustainable Resource Management, 433 **Teacher Guide:** **Inquiry Labs:** Observe Air Pollution **Digital Activities:** Critique an Ecological Plan Simulation: Ocean pH; Reduce the Car Industry's Footprint; Paper Mill Wastewater Treatment **Engineering Design Challenge:** Water Purification **Performance Based Assessment:** Qualitative Analysis of Acid Rain

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(2.2) Using mathematics and computational thinking	
(9C.2.2.1.1) Develop a data simulation, based on observations and experimental data of how the pressure, volume, temperature, and mass of a gas are related to each other, to predict the effect on a system of changing one of those variables.** (P: 5, CC: 2, CI: PS1) **Emphasis** is on applying the kinetic molecular theory of gases to develop gas laws. Example systems may include balloons, tires, or syringes.	**Experience Notebook, Volume 2:** **Investigation 9** Boyle's Law, 11 Sample Problem: Using Boyle's Law, 12 Charles's Law, 13 Absolute Zero, 15-16 Sample Problem: Using the Combined Gas Law, 20 Sample Problem: Using the Ideal Gas Law, 24 Revisit Investigative Phenomenon, 30 **Teacher Guide:** **Inquiry Labs:** The Thermodynamics of Hand Warmers; Relationships Between Gas Variables; The Ideal Gas Law **Digital Activities:** Energy Changes in Changes of State; Model the Combined Gas Laws; Why Are There No Ideal Gases? **Engineering Design Challenges:** Flameless Heating Systems
Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. (P: 5, CC: 5, CI: PS1) **Emphasis** of the practice is on using mathematical ideas to communicate the proportional relationships between the masses of atoms in the reactants and products. **Emphasis** of the core idea is on the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale.	**Experience Notebook, Volume 1:** **Investigation 5** Percent Composition from Chemical Formulas, 194 **Investigation 6** Balancing Word Equations, 220-221 Sample Problem: Writing Chemical Equations for Combination and Decomposition Reactions, 230 Sample Problem: Writing Chemical Equations for Single-Replacement Reactions, 233 **Experience Notebook, Volume 2:** **Investigation 13** Acid-Base Neutralization Reactions, 212-213 **Investigation 15** Balancing by the Half-Reaction Method, 294-295 Standard Cell Potential, 301 Sample Problem: Writing the Cell Reaction, 302 **Teacher Guide:** **Inquiry Labs:** Evaluate Chemical Reactions; Identify Unknowns Through Stoichiometry; Determination of Reaction Output; Formation of Barium Iodate **Digital Activities:** Understanding Stoichiometry; Limiting Reagent **Performance Based Assessment:** Chemical Quantities; The Stoichiometry of Filling a Balloon **Engineering Design Challenges:** Build a Film Canister Rocket

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(3.0) Developing possible explanations of phenomena or designing solutions to engineering problems	
(3.1) Developing and using models	
(9C.3.1.1.1) Use the periodic table as a model to predict the relative properties of elements based on the patterns of valence electrons. (P: 2, CC: 1, CI: PS1) **Emphasis** is on properties that could be predicted from patterns may include reactivity of metals, types of bonds formed (ionic versus covalent), and numbers of bonds formed.	**Experience Notebook, Volume 1:** **Investigation 1** Types of Atoms, 13-14 Patterns in Electron Configurations, 36-38 Valence Electrons, 39 Revisit Investigative Phenomenon, 40 **Teacher Guide:** **Inquiry Labs:** Develop a Periodic Table, Periodic Trends and Properties; Elemental Metals, Nonmetals, and Metalloids **Digital Activities:** Periodic Properties; Predict Reactivity Using Periodic Trends **Performance Based Assessment:** Evaluate Atomic Structure with Flame Tests; Gravimetric Analysis of Periodic Trends
(9C.3.1.1.2) Develop a model based on evidence to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (P: 2, CC: 5, CI: PS1) **Emphasis** of the practice is on illustrating the relationships between components of the system. **Emphasis** of the core idea is on how a chemical reaction is a system that affects the energy change. **Examples** of models may include molecular level drawings, diagrams, graphs showing the relative energies of reactants and products, and representations showing energy is conserved. Not included is the calculation of the total bond energy change during a chemical reaction from the bond energies of reactants and products.	**Experience Notebook, Volume 1:** **Investigation 6** Energy of Reactions, 223-224 Revisit Investigative Phenomenon, 226 Combination Reactions, 228 Decomposition Reactions, 229 Predicting the Products of Reactions, 238-239 **Investigation 8** Bond Enthalpy, 285-286 **Experience Notebook, Volume 2:** **Investigation 12** Effect of Concentration on Reaction Rates, 164 **Teacher Guide:** **Inquiry Labs:** Types of Chemical Reactions; Measure Energy Flow in Chemical Reactions; The Thermodynamics of Hand Warmers; Hess's Law and the Combustion of a Metal **Performance Based Assessment:** Enthalpy of a Neutralization Reaction

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(9C.3.1.1.3) Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (P: 2, CC: 5, CI: PS1) **Emphasis** is on simple qualitative models and on the scale of energy released in nuclear processes relative to other kinds of transformations. Not included is quantitative calculations of the energy released.	**Experience Notebook, Volume 2:** **Investigation 17** Strong and Weak Nuclear Forces, 361-364 Radioactive Decay Chains, 367 Revisit Investigative Phenomenon, 372 Nuclear Fission, 379 Nuclear Fusion, 380 Solar Fusion, 381 Fusion in Large Stars, 382 **Teacher Guide:** **Inquiry Labs:** Radioactive Decay; Nuclear Energy **Digital Activities:** What Happens When an Atom Decays? Energy From Nuclear Processes **Performance Based Assessment:** Natural Radiation
(3.2) Constructing explanations and designing solutions	
(9C.3.2.1.1) Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (P: 6, CC: 1, CI: PS1) **Examples** of chemical reactions may include synthesis, decomposition, or combustion.	**Experience Notebook, Volume 1:** **Investigation 2** The Periodic Table, 43 Connecting the Trends, 63 **Investigation 6** Activity Series, 232 Predicting the Products of Reactions, 238-239 Revisit Investigative Phenomenon, 240 **Experience Notebook, Volume 2:** **Investigation 15** Redox vs. Non-redox Reactions, 284 **Teacher Guide:** **Inquiry Labs:** Evaluate Chemical Reactions; Predict Chemical Reactions **Digital Activities:** Reactivity of Metals; Cation Meets Anion **Performance Based Assessment:** Identify Evidence of Chemical Reactions **Engineering Design Challenges:** Water Purification

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(9C.3.2.1.2) Apply scientific principles and evidence to provide an explanation about the effects of changing the surface area, agitation, temperature, and concentration of the reacting particles on the rate at which the reaction occurs. (P: 6, CC: 1, CI: PS1) **Emphasis** is on student reasoning that focuses on the number and energy of collisions between molecules and on simple reactions in which there are only two reactants. **Examples** of evidence may include temperature, concentration, and rate data; and qualitative relationships between rate and temperature.	**Experience Notebook, Volume 2:** **Investigation 12** Calculating Reaction Rates, 161 Effect of Concentration on Reaction Rates, 164 CCC Stability and Change, 179 How Temperature Affects Equilibrium, 179 Reaction Rate vs. Favorability, 182 Revisit Investigative Phenomenon, 190 Assessment, 191 **Teacher Guide:** **Inquiry Labs:** Reaction Rates: Iodine Clock **Digital Activities:** Reaction Rates and Activation Energy **Performance Based Assessment:** Reaction Rates and Equilibrium; Calcium Carbonate and Shell Production
(9C.3.2.1.3) Construct an explanation for the phenomenon of solution creation and identify from patterns how the properties of the resulting solution depend on the interactions between solute and solvent or on concentrations of solutes. (P: 6, CC: 1, CI: PS1) **Emphasis** is on polarity, solubility, boiling point elevation, freezing point depression, and osmosis. **Examples** may include salts dissolving to make water hard, road salt, antifreeze, oil spills, reverse osmosis water systems.	**Experience Notebook, Volume 1:** **Investigation 4** Aqueous Solutions, 154-155 SEP Develop a Model, 154 CCC Structure and Function, 155 Solubility, 162 Solubility and Temperature, 163-164 SEP Interpret Data, 163 Solubility and Pressure, 166 Sample Problem: Using Henry's Law, 167 Assessment, 171 **Teacher Guide:** **Inquiry Lab:** Aqueous Solutions
(9C.3.2.2.1) Evaluate the design and function of products and processes involving organic compounds to meet desired needs in relationship to the molecular structures and in particular, the functional groups involved.* (P: 6, CC: 6,CI: PS1, ETS1) **Examples** of desired needs are having flexible but durable materials made up of long-chained molecules (polymers and plastics), and having pharmaceuticals designed to interact with specific receptors.	Supporting Content only: **Experience Notebook, Volume 2:** **Investigation 16** Types of Organic Compounds, 327 Identifying Functional Groups, 323 Sample problem: Identifying Functional Groups, 323 Polymers, 337-339 **Teacher Guide:** **Performance Based Assessment:** Prepare and Characterize Biodiesel **Engineering Design Challenges:** Polymers: Bouncy Balls

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(4.0) Communicating reasons, arguments and ideas to others	
(4.2) Obtaining, evaluating and communicating information	
(9C.4.2.1.1) Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (P: 8, CC: 6, CI: PS1) **Emphasis** is on the attractive and repulsive forces that determine the functioning of the material. **Examples** may include why electrically conductive materials are often made of metal.	**Experience Notebook, Volume 1:** **Investigation 3** Properties of Metals, 78-79 **Experience Notebook, Volume 2:** **Investigation 16** Organic Chemical Reactions, 335-336 Revisit Investigative Phenomenon, 354 **Teacher Guide:** **Digital Activities:** Protein Structure and Food Design **Performance Based Assessment:** Prepare and Characterize Biodiesel **Engineering Design Challenges:** Polymers: Bouncy Balls
(9C.4.2.1.2) Review text and online sources to develop a series of questions regarding the chemistry, utility, and safety of nuclear fission. (P: 8, CC: 7,CI: PS1) **Emphasis** is on evaluating the argument and specific claims in the text including the validity of reasoning as well as the relevance and sufficiency of the evidence. **Examples** may include fission (nuclear power generation, nuclear weapons) and the use of fission by-products (nuclear medicine, food irradiation).	**Experience Notebook, Volume 2:** **Investigation 17** Strong and Weak Nuclear Forces, 361-364 Radioactive Decay Chains, 367 Nuclear Fission, 379 Radiation Penetration, 387 Radiation Hazards and Units, 388 Nuclear Fission Power, 392-393 Nuclear Accidents and Radioactive Waste, 394 **Teacher Guide** **Inquiry Labs:** Radioactive Decay; Nuclear Energy **Digital Activities:** What Happens When an Atom Decays? Energy From Nuclear Processes

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(9C.4.2.2.1) Communicate and evaluate claims by various stakeholders, including Minnesota American Indian Tribes and communities and other cultures, about the environmental impacts of various chemical processes on natural resources. (P: 8, CC: 2, CI: PS1) **Examples** of cultures may include those within the local context of the learning community and within the context of Minnesota. **Examples** of natural resources may include wild rice harvesting, mining of minerals, and access to clean air and water. **Examples** of chemical processes may include sulfate in water/soil, acid mine drainage, and air and water pollution.	Content specific to Minnesota's Native Americans is beyond the scope of ***Experience Chemistry*.** However, the environmental impacts of human activity and manmade chemical processes are discussed throughout. Please see: **Experience Notebook, Volume 2:** **Investigation 18** **Chemicals All Around Us,** 403-404 The Chemical Industry, 405-406 A Greener Vision for Chemistry, 415 Sustainable Energy Practices, 434 Sustainable Waste Management, 435 **Teacher Guide:** **Inquiry Labs:** Carbon Dioxide and Its Role in Climate; How to Recycle Polylactic Acid Plastics **Digital Activities:** Reduce the Car Industry's Footprint; Choices When Designing Chemical Processes; Discuss the Emergence of Green Chemistry; Consider Trade-Offs in Green Chemistry