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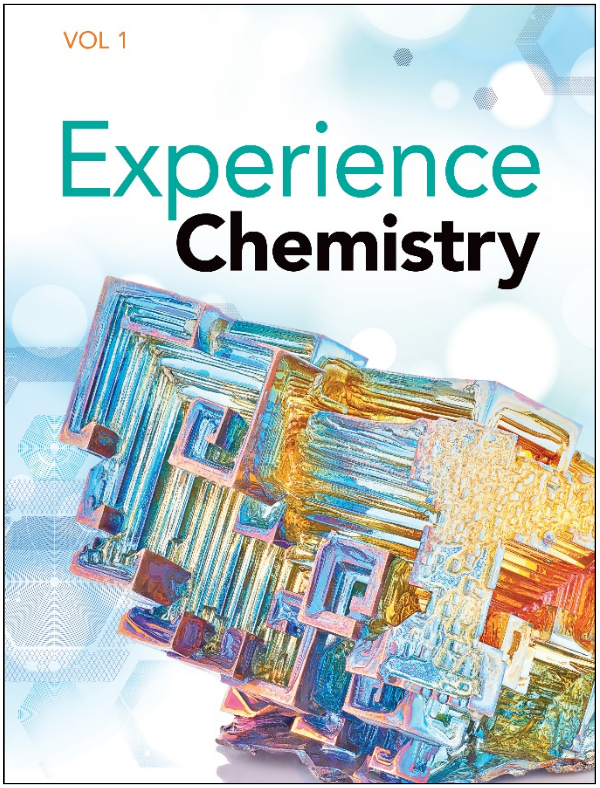

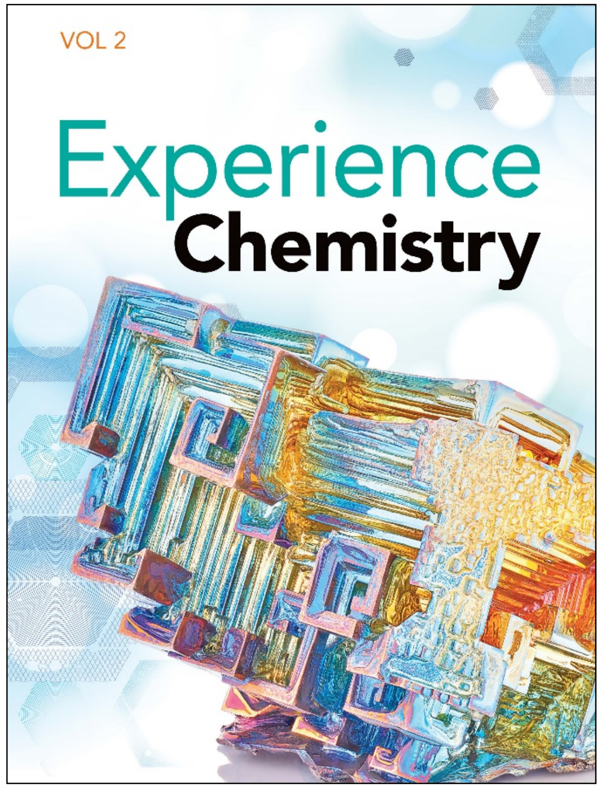

To the

Massachusetts 2016 Science and Technology/Engineering Standards

High School Chemistry

Prepared by Savvas Learning Company LLC, formerly Pearson K-12 Learning.

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Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry

Introduction

This document demonstrates how **Experience Chemistry ©2021** supports Massachusetts' 2016 Science and Technology/Engineering Standards for Chemistry**.** Correlation references include the Experience Notebook (Vol. 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.

A Correlation of Experience Chemistry ©2021
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Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry

Table of Contents

A Correlation of Experience Chemistry ©2021
to the
Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	**Experience Chemistry ©2021**
(HS-PS1) Matter and Its Interactions	
(HS-PS1-1) Use the periodic table as a model to predict the relative properties of main group elements, including ionization energy and relative sizes of atoms and ions, based on the patterns of electrons in the outermost energy level of each element. Use the patterns of valence electron configurations, core charge, and Coulomb's law to explain and predict general trends in ionization energies, relative sizes of atoms and ions, and reactivity of pure elements.	**Experience Notebook, Vol 1:** **Investigation 1** Types of Atoms, 13-14 Patterns in Electron Configurations, 36-38 Valence Electrons, 39 Revisit Investigative Phenomenon, 40 **Investigation 2** The Periodic Table as a Predictive Model, 50-51 Coulomb's Law, 52 The Shielding Effect and Effective Nuclear Charge, 53-55 Atomic Radius, 56-58 Ionization Energy, 59 Successive Ionization Energies, 60 Connecting the Trends, 63 Revisit Investigative Phenomenon, 64 **Teacher Guide:** **Inquiry Labs:** Develop a Periodic Table; Elemental Metals, Nonmetals, and Metalloids; Periodic Trends and Properties **Performance Based Assessment:** Evaluate Atomic Structure with Flame Tests; Gravimetric Analysis of Periodic Trends **Digital Activities:** Graphing Periodic Properties; Periodic Trends; Make a Claim About Periodic Trends; Size Trends and Shielding Effect; Predict Reactivity Using Periodic Trends
(HS-PS1-2) Use the periodic table model to predict and design simple reactions that result in two main classes of binary compounds, ionic and molecular. Develop an explanation based on given observational data and the electronegativity model about the relative strengths of ionic or covalent bonds.	**Experience Notebook, Volume 1:** **Investigation 3** Ions and the Octet Rule, 68-69 Ionic Bonds, 70-71 Ionic Compounds, 72-73 Revisit Investigative Phenomenon, 76, 90 The Octet Rule in Molecules, 82-83 Types of Covalent Bonds, 84 Electronegativity and Bonding, 86-87 **Investigation 6** Activity Series, 232 Predicting the Products of Reactions, 238-239 Revisit Investigative Phenomenon, 240 Ions in Aqueous Solution, 241-242 Predicting the Formation of a Precipitate, 246

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	**Experience Chemistry ©2021**
HS-PS1-2 Continued:	Continued: **Experience Notebook, Volume 2:** **Investigation 15** Redox vs. Non-redox Reactions, 284 **Teacher Guide:** **Inquiry Labs:** Characteristics of Ionic Bonds; Characteristics of Covalent Bonds; Evaluate Chemical Reactions; Types of Chemical Reactions; Predict Chemical Reactions; Metal Activity **Engineering Design Challenge:** Water Purification **Digital Activities:** Calculate Bond Polarity; Predicting Bond Type; Reactivity of Metals; Cation Meets Anion; Predict Whether a Precipitate Will Form
(HS-PS1-3) Cite evidence to relate physical properties of substances at the bulk scale to spatial arrangements, movement, and strength of electrostatic forces among ions, small molecules, or regions of large molecules in the substances. Make arguments to account for how compositional and structural differences in molecules result in different types of intermolecular or intramolecular interactions.	**Experience Notebook, Vol 1:** **Investigation 3** Ionic Bonds, 70-71 Ionic Compounds, 72-73 Properties of Ionic Compounds, 74-76 Properties of Metals, 78-80 Revisit Investigative Phenomenon, 80 The Octet Rule in Molecules, 82-83 Electronegativity and Bonding, 86-87 Geometry and Polar Molecules, 88-90 Revisit Investigative Phenomenon, 90 Van der Waals Forces, 91-92 Hydrogen Bonds, 93 Properties of Molecular Substances, 94-95 Revisit Investigative Phenomenon, 96 **Investigation 4** Liquids and Intermolecular Forces, 118-119 Solids and Attractive Force, 120-121 Properties of Ionic and Molecular Compounds, 138 Covalent Network Solids, 139-140 Revisit Investigative Phenomenon, 140, 147 Ductility and Malleability, 142 Crystalline Structure and Properties of Metals, 144 Water and Hydrogen Bonding, 148 Structure Affects Properties of Ice, 152-153 **Teacher Guide:** **Inquiry Labs:** Characteristics of Ionic Bonds; Characteristics of Covalent Bonds; Intermolecular Forces; Correlate Material Properties and Bond Type; Melt Ionic and Covalent Compounds **Performance Based Assessment:** Types of Chemical Bonds

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	**Experience Chemistry ©2021**
HS-PS1-3 Continued:	Continued: **Digital Activities:** Ions and Electroplating; Formation of Ionic Compounds; Describe Ionic Bonding and Properties; Electron Dot Structures for Molecular Substances; Intermolecular Forces in Liquids; Water's Behavior on Earth; Relate Intermolecular Forces to States of Matter; Phase Changes and Intermolecular Forces; Tough Tools
(HS-PS1-4) Develop a model to illustrate the energy transferred during an exothermic or endothermic chemical reaction based on the bond energy difference between bonds broken (absorption of energy) and bonds formed (release of energy).	**Experience Notebook, Volume 1:** **Investigation 6** Energy of Reactions, 223-224 What Causes Reactions?, 225 Revisit Investigative Phenomenon, 226 Combination Reactions, 228 Decomposition Reactions, 229 **Investigation 8** Bond Enthalpy, 285-286 Activation Energy, 287 Representations of Enthalpy, 288 Revisit Investigative Phenomenon, 290, 298 Hess's Law, 291 Heat Summation, 292 Standard Enthalpy of Formation, 293 Standard Enthalpy of Reaction, 294 Enthalpy of Solution, 296-297 **Teacher Guide:** **Inquiry Labs:** The Thermodynamics of Hand Warmers; Hess's Law and the Combustion of a Metal **Engineering Design Challenge:** Flameless Heating Systems **Digital Activities:** Energy Changes in Reactions; Energy in Reactions; Bond Energy and Enthalpy

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Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry

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(HS-PS1-5) Construct an explanation based on kinetic molecular theory for why varying conditions influence the rate of a chemical reaction or a dissolving process. Design and test ways to slow down or accelerate rates of processes (chemical reactions or dissolving) by altering various conditions.	**Experience Notebook, Volume 2:** **Investigation 12** Collision Theory – a Review, 163 Effect of Concentration on Reaction Rates, 164 Effect of Temperature on Reaction Rates, 165 Effect of Particle Size on Reaction Rates, 166 Revisit Investigative Phenomenon, 167 One-Step and Multistep Reactions, 170 Lowering Activation Energy, 171-172 Assessment, 191 **Teacher Guide:** **Inquiry Labs:** Reaction Rates: Iodine Clock **Performance Based Assessment:** Reaction Rates and Equilibrium **Digital Activities:** Factors that Affect Reaction Rate; Reaction Rate and Molecular Collisions; Glow Sticks and Reaction Rate; Reaction Rates and Activation Energy
(HS-PS1-6) Design ways to control the extent of a reaction at equilibrium (relative amount of products to reactants) by altering various conditions using Le Chatelier's principle. Make arguments based on kinetic molecular theory to account for how altering conditions would affect the forward and reverse rates of the reaction until a new equilibrium is established.	**Experience Notebook, Volume 2:** **Investigation 12** Le Chatelier's Principle, 176 How Concentration Affects Equilibrium, 177 How Pressure Affects Equilibrium, 178 How Temperature Affects Equilibrium, 179 Revisit Investigative Phenomenon, 180 **Investigation 14** Le Chatelier's Principle and Future Ocean pH, 236-237 **Teacher Guide:** **Inquiry Labs:** Explore Chemical Equilibrium **Engineering Design Challenge:** Use Equilibrium for a Commercial Application **Performance Based Assessment:** Reaction Rates and Equilibrium **Digital Activities:** Equilibrium Shifting

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	Experience Chemistry ©2021
(HS-PS1-7) Use mathematical representations and provide experimental evidence to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Use the mole concept and proportional relationships to evaluate the quantities (masses or moles) of specific reactants needed in order to obtain a specific amount of product.	**Experience Notebook, Volume 1:** **Investigation 7** Interpreting Chemical Equations, 254 Sample Problem: Interpreting a Balanced Chemical Equation, 255 What Is Conserved?, 256 Proportionality of Reactants and Products, 257 Revisit Investigative Phenomenon, 258 Sample Problem: Using the Limiting Reagent to Find the Quantity of a Product, 273 **Teacher Guide:** **Inquiry Labs:** Identify Unknowns Through Stoichiometry; Determination of Reaction Output; Formation of Barium Iodate **Engineering Design Challenge:** Build a Film Canister Rocket **Performance Based Assessment:** The Stoichiometry of Filling a Balloon **Digital Activities:** Understanding Stoichiometry; Limiting Reagent
(HS-PS1-9(MA)) Relate the strength of an aqueous acidic or basic solution to the extent of an acid or base reacting with water as measured by the hydronium ion concentration (pH) of the solution. Make arguments about the relative strengths of two acids or bases with similar structure and composition.	**Experience Notebook, Volume 2:** **Investigation 13** Calculating pH, 199-200 Sample Problem: Calculating pH from H_3O^+ Concentration, 201 Strong Acids and Bases, 203 Weak Acids, 204-205 Weak Bases, 206-207 Calculating pH for Weak Acids and Bases, 208 Strength vs. Concentration, 210-211 **Investigation 14** Carbon Dioxide and Ocean pH, 230-231 **Teacher Guide:** **Inquiry Labs:** Measure Acid Strength **Digital Activities:** Exploring Acid Strength and Concentration; Compare Equilibrium Positions of Weak Acids

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	Experience Chemistry ©2021
(HS-PS1-10(MA)) Use an oxidation-reduction reaction model to predict products of reactions given the reactants, and to communicate the reaction models using a representation that shows electron transfer (redox). Use oxidation numbers to account for how electrons are redistributed in redox processes used in devices that generate electricity or systems that prevent corrosion.	**Experience Notebook, Vol 2:** **Investigation 15** Gaining and Losing Electrons, 276-277 Sample Problem: Identifying Oxidized and Reduced Reactants, 278 Oxidation Numbers in Reactions, 282 Sample Problem: Assigning Oxidation Numbers in Reactions, 283 Redox vs. Non-redox Reactions, 284 Sample Problem: Identifying Redox Reactions, 285 Revisit Investigative Phenomenon, 287 Balancing by the Oxidation-Number-Change Method, 292 Sample Problem: Balancing Redox Equations by Change in Oxidation Number, 293 Balancing by the Half-Reaction Method, 294-295 Revisit Investigative Phenomenon, 296 Voltaic Cells, 298-299 Sample Problem: Writing the Cell Reaction, 302 Revisit Investigative Phenomenon, 308 **Teacher Guide:** **Inquiry Labs:** Explore Iron Corrosion **Digital Activities:** Redox and Non-Redox Reactions; Oxidation and Reduction at the Atomic Scale; Track Electrons in Redox Reactions; Energy Transformation in a Battery
(HS-PS1-11(MA)) Design strategies to identify and separate the components of a mixture based on relevant chemical and physical properties.	For supporting content, please see: **Experience Notebook, Volume 1:** **Investigation 4** Colloids and Suspensions, 168-169 **Teacher Guide:** **Inquiry Lab**: Aqueous Solutions **Digital Activities:** Dissolution Rate; Solubility and Temperature.

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	Experience Chemistry ©2021
(HS-PS2) Motion and Stability: Forces and Interactions	
(HS-PS2-6) Communicate scientific and technical information about the molecular-level structures of polymers, ionic compounds, acids and bases, and metals to justify why these are useful in the functioning of designed materials.	**Experience Notebook, Volume 1:** **Investigation 4** Properties of Ionic and Molecular Compounds, 138 Revisit Investigative Phenomenon, 140, 147 Ductility and Malleability, 142 **Experience Notebook, Volume 2:** **Investigation 16** Ethers and Amines, 330 Organic Chemical Reactions, 335-336 Polymers, 337-339 **Teacher Guide:** **Inquiry Labs:** Investigate Different Hydrocarbons; Protein and Amino Acid Tests **Engineering Design Challenge:** Building a Better Bike; Polymers: Bouncy Balls **Digital Activities:** Tough Tools; Protein Structure and Food Design
(HS-PS2-7(MA)) Construct a model to explain how ions dissolve in polar solvents (particularly water). Analyze and compare solubility and conductivity data to determine the extent to which different ionic species dissolve.	**Experience Notebook, Volume 1:** **Investigation 3** Properties of Ionic Compounds, 74-75 **Investigation 4** Aqueous Solutions, 154-155 Electrolytes and Nonelectrolytes, 156-157 Solubility, 162 Solubility and Temperature, 163-164 **Investigation 6** Predicting the Formation of a Precipitate, 246 **Experience Notebook, Volume 2:** **Investigation 13** Strong Acids and Bases, 203 Weak Acids, 204-205 Weak Bases, 206-207 **Teacher Guide:** **Inquiry Labs:** Aqueous Solutions **Digital Activities:** Ions and Electroplating; Model Concentration's Effect on Conductivity; Conductivity of Strong and Weak Acids

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	**Experience Chemistry ©2021**
(HS-PS2-8(MA)) Use kinetic molecular theory to compare the strengths of electrostatic forces and the prevalence of interactions that occur between molecules in solids, liquids, and gases. Use the combined gas law to determine changes in pressure, volume, and temperature in gases.	**Experience Notebook, Volume 1:** **Investigation 4** Kinetic Theory and a Model for Gases, 112 Common Gases, 113 Kinetic Energy and Particle Motion in Solids, Liquids and Gases, 117 Liquids and Intermolecular Forces, 118-119 Solids and Attractive Force, 120-121 Phase Changes, 125-126 **Experience Notebook, Volume 2:** **Investigation 9** Compressibility, 6 Gas Pressure and Amount of Gas, 7 Gas Pressure and Volume, 8 Gas Pressure and Temperature, 9 Combined Gas Law, 19 Sample Problem: Using the Combined Gas Law, 20 Real Gases, 27-28 **Teacher Guide:** **Inquiry Labs:** Compressibility; Relationships Between Gas Variables **Digital Activities:** Relate Intermolecular Forces to States of Matter; Phase Changes and Intermolecular Forces; Explain Changes in Tire Pressure; Gas Volume and Temperature; Relate Gas Pressure and Temperature; Model the Combined Gas Laws

Massachusetts 2016 Science and Technology/Engineering Standards for Chemistry	Experience Chemistry ©2021
(HS-PS3) Energy	
(HS-PS3-4b) Provide evidence from informational text or available data to illustrate that the transfer of energy during a chemical reaction in a closed system involves changes in energy dispersal (enthalpy change) and heat content (entropy change) while assuming the overall energy in the system is conserved.	**Experience Notebook, Volume 1:** **Investigation 6** Energy of Reactions, 223-224 Revisit Investigative Phenomenon, 226 **Investigation 8** Systems and Surroundings, 283 Enthalpy, 284 Bond Enthalpy, 285-286 Activation Energy, 287 Revisit Investigative Phenomenon, 290 Heat Summation, 292 Standard Enthalpy of Reaction, 294 Enthalpy of Solution, 296-297 Revisit Investigative Phenomenon, 298 **Experience Notebook, Volume 2:** **Investigation 12** Entropy, 183-184 Enthalpy, Entropy, and Free Energy, 187-188 **Teacher Guide:** **Inquiry Labs:** The Thermodynamics of Hand Warmers; Supersaturation and Thermodynamics **Engineering Design Challenge:** Flameless Heating Systems **Performance Based Assessment:** Enthalpy of a Neutralization Reaction **Digital Activities:** Energy in Reactions; Bond Energy and Enthalpy; Energy Input for the Rusting of Iron