SPRING GROVE AREA SCHOOL DISTRICT

PLANNED COURSE OVERVIEW

Course Title: Chemistry Honors	**Length of Course:** Full Year
Grade Level(s): Grades 10 - 12	**Periods Per Cycle:** 6
Units of Credit: 1	**Length of Period:** 40 Minutes
Classification: Core	**Total Instructional Time:** 120 Hours

Course Description

Chemistry is the scientific study of matter, energy, and the changes they undergo. Students will examine the structure, properties, and transformations of matter, along with their interactions with energy, on an atomic and molecular level. Throughout the course, students will participate in a mix of hands on and virtual lab activities to observe the properties and behavior of matter and energy, while honing valuable real world critical thinking and problem-solving skills around experimental design and data analysis.

Instructional Strategies, Learning Practices, Activities, and Experiences

- Inquiry Based Wet or Dry Lab Activities
- Direct Instruction
- Guided Notes from Videos, Readings, or PowerPoints
- Remedial Videos, Examples, and Practice
- Analogies
- Summarization
- Problem Solving
- Guided Practice
- Homework Assignments
- Graphic Organizers
- Cooperative Learning Activities
- Discovery Learning Activities
- Teacher Demonstration
- Models and Manipulatives
- Review Games

Assessments

Formative Assessments: Student Created Summaries, Homework Problems, Teacher Questioning, Post Lab Questions, Lesson/Topic Quizzes
Summative Assessments: Written Unit Exams, Lab Reports, Project Reports, Final Exam (or Midterm/Final Exam Combo).

Materials/Resources

Textbook: Chemistry 2e OpenStax, Teacher Constructed Handouts, Chemistry Laboratory Equipment and Chemicals (determined by staff as needed), Safety Equipment, Technology Equipment and Software

Adopted: 4/12/89
Revised: 9/3/91, 11/19/97, 11/15/01, 8/20/07, 5/15/17 (overview only), 5/22/23
https://springgroveareascho.sharepoint.com/sites/PrivateSGASD/Shared Documents/AASG/NEWCURR/SCIENCE/2023/Grade 11/Chemistry 1 Honors/Chemistry Honors_Overview.docx

Unit 1: Safety and Scientific Skills	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Introduction to Chemistry Lab Safety Lab Equipment Experimental Design/Scientific Method	<u>Objectives</u> 1) I can define the major branches of chemistry and identify applications of chemistry in modern life. 2) I can follow safety precautions in a chemistry lab setting. 3) I can identify common chemistry lab equipment. 4) I can correctly use common chemistry lab equipment in chemistry investigations. 5) I can observe a problem and generate a question to investigate. 6) I can design an experiment to gather data to test a question. 7) I can communicate my findings to others effectively. 8) I can read, understand, and summarize the methods and findings of a chosen article published in a peer reviewed scientific journal. 9) I can offer reasonable critique of the methods, findings, or other key aspects of a chosen article published in a peer reviewed scientific journal. <u>Standards:</u> CC.2.4.HS.B.2: Summarize, represent, and interpret data on two categorical and quantitative variables. CC.2.4.HS.B.4: Recognize and evaluate random processes underlying statistical experiments. CC.2.4.HS.B.5: Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. Science Practices 9-12: Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. Science Practices 9-12: Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Science Practices 9-12: Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. Science Practices 9-12: Select appropriate tools to collect, record, analyze, and evaluate data. Science Practices 9-12: Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Unit 2: Measurement and Unit Analysis	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Qualitative vs. Quantitative Data Correct measurement techniques with chemistry specific lab equipment. Accuracy vs. Precision Significant Figures in Calculations Unit Conversion with the Dimensional Analysis Grid	Objectives 1) I can distinguish between qualitative and quantitative data, and discuss some uses for each in scientific investigation. 2) I can record measurements to the correct units and decimal places using common chemistry lab equipment. 3) I can distinguish between accuracy and precision, and identify times when higher or lower levels of each may be needed in scientific investigation. 4) I can carry the correct number of significant figures on mathematical calculations involving measured values. 5) I can convert between various metric and non-metric units of measurement using a dimensional analysis grid. 6) I can offer reasonable critique or justification for the level of accuracy, precision, or a significant figure limitation of a chosen article published in a peer reviewed scientific journal. Standards: CC.2.4.HS.B.2: Summarize, represent, and interpret data on two categorical and quantitative variables. CC.2.4.HS.B.4: Recognize and evaluate random processes underlying statistical experiments. CC.2.4.HS.B.5: Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. Science Practices 9-12: Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

Unit 3: Atomic Arrangement in Matter	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
States of Matter Types of Matter Properties of Matter Changes in Matter Conservation of Mass Maxwell-Boltzmann Distributions	<u>Objectives</u> 1) I can distinguish between particle level representations of solids, liquids, and gasses, and list the general properties of each. 2) I can classify particle level drawings or formula representations of matter as elements, compounds, heterogeneous mixtures, or homogenous mixtures. 3) I can evaluate if a given property of matter is a physical or chemical property, and justify my response. 4) I can evaluate if a given property of matter is intensive or extensive, and justify my response. 5) I can classify changes in matter as physical or chemical, based on changes in a particle level drawing or formula representation. 6) I can create a reasonable particle level drawing or formula representation that depicts a given change in matter and demonstrates that mass is conserved. 7) I can create a reasonable particle level drawing of a complex material with the help of computer imaging software. 8) I can apply the concepts of a Maxwell-Boltzmann distribution to explain why some atoms in a sample may be in different states of matter at a given time compared to the bulk sample. <u>Standards</u> MS-PS1-1 Matter and its Interactions: Develop models to describe the atomic composition of simple molecules and extended structures. MS-PS1-2 Matter and its Interactions: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. MS-PS3-4 Energy: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS1-7 Matter and its Interactions: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Unit 4: Atomic Theory and Emissions	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
History of Atomic Models (Through Bohr Model) Constructing Bohr Models of Atoms Interactions in the Nucleus 1) Types of Radiation 2) Nuclear Reactions 3) Fission and Fusion Interactions in the Electron Cloud 1) Properties of Light 2) Interactions of Light and Electrons 3) Absorption and Emission Spectra Electron Configurations Orbital Diagrams Predicting Ions Using Atomic Models	<u>Objectives</u> 1) I can identify the key changes made to the model of the atom from Democritus to Bohr, with associated discoveries. 2) I can construct an accurate Bohr Model for an atom given a nuclide symbol or sentence description. 3) I can provide relevant details on the three major types of radiation. 4) I can interpret a nuclear reaction to classify the type of radiation being produced and process occurring. 5) I can distinguish between fusion and fission in nuclear processes. 6) I can compare and contrast nuclear reactors to nuclear weapons. 7) I can accurately apply the terms frequency, wavelength, and amplitude to describe and classify a photon of light. 8) I can use relevant equations to calculate the energy, frequency, or wavelength of light. 9) I can diagram the motion of an electron when atoms absorb or emit light. 10) I can explain how absorption and emission spectrum are generated, and why they can be used to identify elements. 11) I can create full or abbreviated electron configurations for an atom or ion. 12) I can create full or abbreviated orbital diagrams from an atom or ion. 13) I can use orbital diagrams to predict the likely charge of an ion, and justify my response. <u>Standards</u> HS-PS1-1 Matter and its Interactions: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-8 Matter and its Interactions: 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. HS-PS4-1 Waves and their Applications in Technologies of Information Transfer: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Unit 5: Periodic Table and Trends	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Periodic Table Basic Organization General Properties of Metals, Non-Metals, and Metalloids Periodic Properties Periodic Trends – Atomic Radius, Electronegativity Periodic Trends – Ionization Energy Photoelectron Spectroscopy	<u>Objectives</u> 1) I can apply relevant vocabulary to explain the shape and arrangement of the periodic table. 2) I can use the periodic table to classify a substance as a metal, non-metal, or metalloid, and predict likely physical and chemical properties. 3) I can apply knowledge of periodic properties to predict likely properties of atoms based on their group or period. 4) I can apply knowledge of Bohr Models and Coulomb's Law to explain trends in the size of atoms. 5) I can apply knowledge of Bohr Models and Coulomb's Law to explain trends in the electronegativity of atoms. 6) I can apply knowledge of Bohr Models and Coulomb's Law to explain trends in the ionization energy of atoms. 7) I can analyze Photo-Electron Spectroscopy data to provide evidence for predicted trends and the accuracy of the Orbital Model vs. Bohr Model. <u>Standards</u> HS-PS1-1-Matter and its Interactions: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-2 Matter and its Interactions: 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.

Unit 6: Ionic Bonding	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Formation of Ionic Bonds Predicting Ionic Compound Formulas Naming Ionic Compounds Structure of Ionic Compounds (Crystals) Lattice Energy	<u>Objectives</u> 1) I can detail the participants and forces involved in forming an ionic bond. 2) I can predict the formulas of chemical compounds formed from ionic bonds. 3) I can correctly name ionic compounds. 4) I can create a model showing how ionic compounds form 3D crystal structures. 5) I can rank the relative lattice energies of ionic compounds based on Coulomb's Law and periodic trends. <u>Standards</u> HS-PS1-2 Matter and its Interactions: 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. HS-PS2-4 Motion and Stability: Forces and Interactions: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS2-6 Motion and Stability: Forces and Interactions: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Unit 7: Covalent Bonding	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Formation of Covalent Bonds Covalent Compound Formulas Covalent Compound Nomenclature (Binary, Acids) Lewis Structures and Bond Strength VSEPR Polarity and IMF	<u>Objectives</u> 1) I can detail the participants and forces involved in forming a covalent bond. 2) I can translate covalent names into chemical formulas. 3) I can correctly name binary covalent compounds and acids. 4) I can draw reasonable Lewis Dot Structures for simple covalent compounds. 5) I can rank the relative strength of Covalent Bonds based on periodic trends and Coulomb's Law. 6) I can predict the polarity of simple covalent compounds. 7) I can translate 2D Lewis dot models into 3D VSEPR Models. 8) I can rank the relative IMF of covalent molecules. <u>Standards</u> HS-PS1-2 Matter and its Interactions: 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. HS-PS1-3-Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS2-4 Motion and Stability: Forces and Interactions: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS2-6 Motion and Stability: Forces and Interactions: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Unit 8: The Mole	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
The Mole and Avogadro's Number Average Atomic Mass Molar Mass of Compounds Grams to Particles Conversions Grams to Moles Conversions	<u>Objectives</u> 1) I can define a mole as Avogadro's Number of particles, and detail the uses of the mole in Chemistry. 2) I can calculate the average atomic mass of an element when given isotope abundances. 3) I can calculate the molar mass of a chemical compound. 4) I can determine the number of moles in a piece of matter given mass or particles. 5) I can determine the number of particles in a piece of matter given mass. 6) I can detail the experimental evidence justifying the use of Avogadro's Number for the number of particles in a mole. <u>Standards</u> HS-PS1-2 Matter and its Interactions: 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. HS-PS1-7 Matter and its Interactions: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Science Practices 9-12: Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

Unit 9: Stoichiometry of Matter	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Percent Composition Empirical/Molecular Formula Hydrate Formula Determination Combustion Analysis Percent Purity Solution Concentrations	<u>Objectives</u> 1) I can calculate the percent composition of elements in a compound. 2) I can determine the empirical and molecular formula of a chemical compound from given values. 3) I can calculate the empirical and molecular formula of a compound given combustion analysis data. 4) I can calculate the empirical and molecular formula of a hydrate from given data. 5) I can determine the percent purity of a substance from given data. 6) I can calculate the empirical and molecular formula of a compound given combustion analysis data. 7) I can calculate the empirical and molecular formula of a hydrate from experimental data. 8) I can determine the percent purity of a substance from experimental data. 9) I can calculate the concentration of substances dissolved in water. <u>Standards</u> HS-PS1-2 Matter and its Interactions: 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. HS-PS1-7 Matter and its Interactions: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Science Practices 9-12: Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

Unit 10: Chemical Reactions	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Translation Between Word and Formula Equations Balancing Reactions Classifying Types of Reactions 1) Synthesis 2) Decomposition 3) Single Replacement 4) Double Replacement 5) Combustion Predicting Products/Reactants of Reactions Oxidation/Reduction Reactions	<u>Objectives</u> 1) I can translate between word and formula equations describing chemical processes. 2) I can balance chemical reactions. 3) I can identify common types of chemical reactions when given a word or formula equation. 4) I can predict the products or reactants of common chemical reactions. 5) I can predict if single replacement reactions will occur based on the activity series of metals. 6) I can predict if double replacement reactions will be observed based on solubility rules for common ionic compounds. 7) I can write half reactions for Oxidation-Reduction reactions. 8) I can give examples of important chemical reactions in real world industry. <u>Standards</u> HS-PS1-2 Matter and its Interactions: 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. HS-PS1-7 Matter and its Interactions: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Unit 11: Reaction Stoichiometry	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Mole Ratios Mass to Mass Stoichiometry Limiting/Excess Reactant Determination and Theoretical Yield Percent Yield	<u>Objectives</u> 1) I can identify the mole ratios between two chemicals in a balanced chemical reaction. 2) I can calculate the mass of any chemical needed to react with a given amount of any other chemical in a reaction. 3) I can determine the limiting and excess reactants in a chemical equation based on given values. 4) I can determine the theoretical yield of any product in a reaction based on given values. 5) I can determine the percent yield of a reaction. 6) I can carry out stoichiometric calculations for chemical reactions involving solutions. 7) I can use percent yield to evaluate the relative efficiency of chemical processes. 8) I can apply percent yield and theoretical yield in error analysis for chemical processes. <u>Standards</u> HS-PS1-2 Matter and its Interactions: 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. HS-PS1-7 Matter and its Interactions: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Science Practices 9-12: Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

Unit 12: Introduction to Thermodynamics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Types of Energy Conservation of Energy Endothermic vs Exothermic Processes Bond Energy Heat of Reaction Calorimetry Stoichiometry with Heat	<u>Objectives</u> 1) I can identify different forms of energy and explain how they are measured. 2) I can define the first law of thermodynamics and provide examples with justification. 3) I can classify processes as endothermic or exothermic. 4) I can describe why chemical bonds store energy. 5) I can use standard bond strengths to estimate the heat released or absorbed during a chemical reaction. 6) I can use a calorimeter to demonstrate conservation of energy using hot and cold water. 7) I can calculate how much heat will be produced or absorbed when a given amount of a chemical reacts using heat of reaction. <u>Standards</u> MS-PS3-2 Energy: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. MS-PS3-4 Energy: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. HS-PS3-1 Energy: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-4 Energy: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system.

Unit 13: Introduction to Kinetics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Rates of Reaction Estimating Rates Rates and Stoichiometry Collision Model 1) Temperature Impact 2) Geometry Impact 3) Concentration Impacts	<u>Objectives</u> 1) I can define the rate of a chemical reaction in my own words. 2) I can use graphical estimation to determine the rate of a reaction from a given set of data. 3) I can relate the rate of change of one chemical in a reaction to the rate of change in another chemical using reaction coefficients. 4) I can explain the role of temperature in determining if reactions occur or not when reactants collide. 5) I can explain the role of molecular geometry in determining if a reaction occurs or not when reactants collide. 6) I can explain the impact of concentration on the overall number of collisions in a given time during the reaction. 7) I can provide examples from industry or peer reviewed publications that demonstrate the impact of manipulating the kinetics of a reaction to make it faster or slower. <u>Standards</u> HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Unit 14: Introduction to Equilibrium	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Reversible Reactions Reactions at Equilibrium Le Chatelier's Principle Calculating K_{eq} Applications of Reaction Quotient	<u>Objectives</u> 1) I can explain how a reversible reaction is different from the chemical reactions previously studied in this course and apply correct notation. 2) I can write an equilibrium expression for a chemical reaction. 3) I can define the equilibrium constant, K_{eq}, and use it to classify reactions as favoring products or reactants. 4) I can use Le Chatelier's principle to qualitatively predict shifts in a reaction at equilibrium. 5) I can calculate K_{eq} for a reaction at equilibrium using known concentrations. 6) I can calculate reaction quotient, Q, and use it to predict the direction of reaction shifts. <u>Standards</u> HS-PS1-6 Matter and its Interactions: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.