Chemistry 1

Course Competencies/Objectives with Activities and Labs

Course Code: 3231

Course Description

Chemistry 1 is not to be considered a repeat of information covered in physical science. It will, instead, build on concepts already established in the minds of students. The purpose of this college preparatory course, therefore, is to allow the students to discover and work with the relationships that are fundamental to chemical reactions and the structure of matter. It will provide the students with the tools needed to function as chemically-literate citizens and to be prepared for the challenge of the more rigorous chemical principles typical of college and university courses. The lab experience will provide opportunities to master concepts, use problem-solving skills, and to apply those skills to real-world situations. Topics studied will include dimensional analysis, writing and balancing chemical equations, stoichiometric calculations, gas laws, atomic theory, the periodic system, chemical bonding, solutions and solubility, calorimetry and acid-base chemistry. Investigative, hands-on lab activities that address the high school inquiry standards are an integral part of this course.

Recommended Prerequisites: Has earned a unit in physical science and a unit in Algebra 1 or Mathematics for the Technologies 1 and 2.

Note on Safety Requirement

A required safety program must be implemented for students prior to initial lab activity. Safety should be addressed throughout the course in every unit of study.

Note on Activities

There are many videos, laser discs and computer programs that can be used to introduce and/or reinforce performance objectives.

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Note on standards: The numbering system for standards in this document (ie IVB2c) is based on the numbering system in the grades 9-12 Physical Science section of the Science Curriculum Standards 2000 document. Since the Science Curriculum Standards 2000 document represents basic scientific literacy for all children, many standards were expanded to include the more advanced topics normally addressed in a Chemistry I course.

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Topic: Chemical Safety

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-based Labs
Inquiry **Chemistry:** **IV.C.1.c.** Explain the sources and environmental effects of some inorganic and organic toxic substances, such as heavy metals and PCBs. (P)	• Include safety hazards as a part of every chemical operation. • Define, interpret, and apply classifications of flammability, toxicity, health, and reactivity. • Be able to read and interpret the Material Safety Data Sheet (MSDS) for a particular material. • Wear or use personal protection equipment (e.g., gloves, hoods, goggles). • Locate and operate emergency equipment (e.g., shower, eyewash, fire alarm, fire extinguisher, fire blanket). • Be able to take appropriate measures should an accident or injury occur. • Dispose of waste in a safe and environmentally correct manner.	• Safety video (ACS, ITV, or other comparable). • Safety contract and safety test. • Cow eye demo • Egg with sulfuric acid demo • Contact lens demo • Student generated posters on safety • Role play appropriate response to safety issues in the lab.

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Topic: Atomic Structure

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-based Labs
Chemistry: **IV.A.1.a.** Trace the historical development of the model of the atom including the contributions of Dalton, Thomson, Rutherford, and Bohr. (H, N) **IV.A.1.b.** Cite the physical and chemical evidences for the existence and structure of atoms. **IV.B.3.a.** Trace the historical development of the systematic approach to the study of matter by including the contributions of Lavoisier (Law of Conservation of Matter) and Dalton (atomic theory). (H, N) **IV.C.2.d.** Conclude from experimental evidence that mass is neither created nor destroyed based on mass measurements. (N)	• Interpret Dalton's atomic theory in terms of the Laws of Conservation of Mass, Constant Composition, and Multiple Proportions. • Compare and contrast the contributions of Dalton, Thomson, Rutherford, Bohr, Planck and Schodinger to the development of the current atomic model. • Describe and give evidence of the wave-particle duality of matter. • Based on the quantum theory, write electron configurations and orbital notation for the representative elements. • Use Bohr's model of the atom to explain the bright line spectrum in terms of electrons moving between energy levels. • Describe and identify the regions of the electromagnetic spectrum in terms of frequency, wavelength and energy. • Calculate and apply the equation E=hv and	• Conservation of mass lab. • Flame test lab. • Spectra emission demo and lab.

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Physics: **IV.C.3.a.** Describe how the absorbing and releasing of energy by electrons produces light. **IV.C.3.b.** Explain that each element has its own configuration of electrons and has a unique line spectrum that can be used to identify that element.	$c=\lambda v$ to the electromagnetic spectrum.	

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Topic: Periodicity

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-based Labs
Chemistry: **IV.B.2.a.** Trace the historical development of the periodic table, including the contributions of Mendeleev. (H, N) **IV.B.2.b.** Explain the arrangement of elements within a group on the periodic table based on similar physical and chemical properties. **IV.B.2.c.** Explain that property trends on the periodic table are a function of the elements' atomic structures.	• Compare and contrast the contributions of Mendeleev and Mosley toward the development of the periodic table • Relate the position of an element on the periodic table to its electron configuration. • Identify trends of the periodic table (ionization energy, electronegativity, electron affinity, and relative size of atoms and ions). • Using the periodic trends, evaluate the element's position on the periodic table according to ionization energy, electronegativity, electron affinity, atomic and ionic size.	• Generate 3-D models showing periodic trends. • Graph trends and properties of the elements. • Create periodic table based selected properties. • Use element cards (element stats), element balls, element cubes to assimilate information on a given element. (atomic number, mass number, name, origin of name, physical and chemical properties, uses, etc.)

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Topic: Chemical Bonding

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.B.1.a.** Predict the charge a representative element will acquire based on its outer electron arrangement. **IV.B.3.d.** Predict the ratio by which the representative elements combine to form ionic compounds, expressing that ratio in a chemical formula. **IV.B.4.a.** Relate the physical properties of compounds to their type of bonding. **IV.B.4.b.** Analyze the physical properties of water as they relate to water's bonding and molecular shape. **IV.B.4.d.** Analyze the behavior of polar and nonpolar substances in	• Draw Lewis dot structures for simple molecules. • Relate electronegativity and ionization energy to the type of bonding an element is likely to undergo. • Describe hybridization of simple molecules. • Predict the shape of simple molecules and their polarity. • Identify the types of intermolecular forces present in a molecule based on its geometry and polarity. • Explain how intermolecular forces affect the physical properties of compounds (water). • Compare and contrast molecular and ionic compounds according to their properties. • Identify substances as molecular or ionic	• Cation/anion puzzle activities • Molecular model lab.[1] • Compare evaporation rates and compare to intermolecular forces (acetone, water, alcohol, etc.). • Use marbles to show viscosity differences. • Surface tension activities (float paper clips, use soap with a boat) • Electrolyte activities (pickle, conductivities) • Cooperative learning nomenclature games. • Correlate chemical names with ingredient labels on household substances

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forming solutions.	compounds. • Identify oxidation numbers based on valence electrons. • Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain common polyatomic ions.	

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Topic: Chemical Reactions and Stoichiometry

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.C.2.b.** Recognize balanced chemical equations. **IV.C.3.b.** Examine the role of free radicals in atmospheric changes, cellular changes, and processes such as organic synthesis and burning. (N, P) **IV.C.1.a** Explain the process of rusting in terms of electron transfer and debate the economic impact of rusting.	• Predict, identify the products, and balance . synthesis, decomposition, single displacement, double displacement, and combustion reactions. • Use the mole concept to determine the number of particles, mass, and gaseous volume of substances in a chemical reaction. • Explain oxidation and reduction processes. • Identify reactants as being oxidized, reduced, the oxidizing agent and the reducing agent. • Cite examples of oxidation and reduction reactions. • Determine molar mass, percent compositions, empirical formulas, and molecular formulas. • Perform mass-mass, mass-volume, and volume-volume, and limiting reactant	• Lab investigation the types of reactions • Percent composition lab. • Empirical formula lab. • Stoichiometry lab (limiting reactant—smores,[2] etc.). • Percent yield lab. • Make a Christmas tree ornament that depicts a redox reaction. • Mole Day activities. • Research project or paper or debate on environmental issues related to chemical reactions. • Hydrate lab • .

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	calculations for chemical reactions. • Calculate percent yield in a chemical reaction. • Discuss the impact of chemical reactions that affect the environment (ozone, UV rays, hazardous materials, carcinogens, acid rain, radon).	

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Topic: Gases and Kinetic Molecular Theory

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.B.5.a.** Compare and contrast solids, liquids, and gases in terms of particle arrangement and the energy that binds them together. **Physics:** **IV.B.3.a.** Predict and measure the effects of varying the temperature, pressure, and volume of gases. (N)	• Compare and Contrast the particle arrangement of solids, liquids and gases. • Using the Kinetic Molecular Theory, explain the relationship between pressure, volume, temperature, and number of particles in a gas sample. • Explain the relationship between temperature and average kinetic energy. • Solve gas law problems concerning changes in gas pressure, volume, or temperature • Perform calculations using the ideal gas law. • Interpret Dalton's Law of Partial Pressures and use it to calculate partial pressures and total pressures. .	• PTV board or craft stick. • Boyle's and Charles's law labs. • Vapor density[3] lab. • Molar mass of a gas lab (butane). • Molar volume lab. • Dry ice and liquid nitrogen demos. • Bell jar and vacuum pump demo. • Marshmallow syringe activity. • Determine gas law constant lab with butane.

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Topic: Solutions

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.B.4.c.** Investigate how solubility varies among different solutes and for the same solute at different temperatures. **IV.B.4.e.** Identify factors that affect the rates at which substances dissolve. **IV.B.4.f.** Compare the amount of solute and solvent in concentrated and dilute mixtures.	• Describe the process by which solutes dissolve in solvents. • Discuss the affect of pressure and temperature on solubility. • Determine the factors that affect the rates of solution. • Describe the dynamic equilibrium that occurs in saturated solutions. • Use a solubility curve to determine saturation values at different temperatures and for different solutes. • Explain the concept of "like dissolves like" and cite examples. • Calculate concentration in terms of molarity, molality, and percent mass. • Calculate the freezing point depression and boiling point elevation of a solution.	• Demonstration of supersaturated solutions.. • Freezing point depression labs. • Investigate the solubility of substances in polar and nonpolar solvents. • Crystallization lab. • Students prepare solutions of a specified concentration. • Lab investigating factors that affect solution rate. • Precipitation lab or demo

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	• Write net ionic equations for precipitation reactions in aqueous solution.	

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Topic: Acids and Bases

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.C.3.a.1.** Identify the physical characteristics of acids and bases. **IV.C.3.a.2.** Identify acids and bases in terms of their pH. **IV.C.3.a.3.** Describe neutralization reactions. **IV.C.3.a.4.** Explain how acid rain is formed and discuss its effects on the environment. (P) **IV.C.3.a.5.** Evaluate the role pH plays in the development of consumer products. (N, P) **IV.C.3.a.6.** Analyze the color changes of some common indicators to distinguish among the ranges of acidic, basic, and neutral solutions.	• Recognize acids and bases in terms of the presence of hydronium and hydroxide ions and relate their concentrations to the pH scale. • Compare and contrast the physical and chemical properties (nature, behavior, concentration, and strength) of acids and bases. • Distinguish between strong and weak acids and bases. • Name and write the formulas for binary and oxy-acids. • Calculate the pH and pOH of aqueous solutions using the hydronium or hydroxide ion concentration. • Explain how indicators are used in titrations. • Perform a strong acid strong base titration to identify the equivalence point by color change.	• Indicators and pH labs. • Neutralization lab. • Electrical conductivity demo. • Titration lab. • Determination of pH of household products. • Research paper production project or debate about the environmental issues related to acids and bases • Guest speaker (EPA, agriculture, pharmacist, industrial chemist)

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	• Assess the role of pH in consumer product development.	

Topic: Equilibrium and Kinetics

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.C.4.a.** Describe how reaction rates are a function of the collisions among particles. **IV.C.4.b.** Analyze the effects of temperature, particle size, stirring, concentration, and catalysts on reaction rates. **IV.C.4.c.** Apply reaction rate concepts to real life applications such as food spoilage, storage of film and batteries, digestive aids, and catalytic converters. (P, T)	• Discuss the factors that affect the rate of a chemical reaction. • Explain rates of reaction in terms of collision frequency, energy of collisions, and orientation of colliding molecules. • Define the role of activation energy in a chemical reaction. • Analyze the effects of temperature, particle size, stirring, concentration, and catalysts on reaction rates. • Apply the concepts of reaction rates to phenomena encountered in everyday life (food spoilage, storage of film, batteries, and digestive aids). • Predict shifts in equilibrium using	• Blue bottle, clock reactions lab. • Elephant toothpaste demo. • Genie in a bottle demo. • Manipulation of reaction rate factors lab. • Collision theory demos • LeChatelier's Principle demos

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	LeChatelier's Principle.	

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Topic: Thermochemistry

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.C.2.c.** Classify reactions as energy-absorbing (endothermic) or energy-releasing (exothermic) based on temperature measurements.	• Apply the law of conservation of energy to analyze the energy changes involved in calorimetry. • Perform calculations using $q = mc\Delta T$	• Calorimetry lab. • Exothermic and endothermic demos.

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Topic: Organic Chemistry

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.B.6.a.** Analyze how carbon atoms bond to one another in a variety of structures. **IV.B.6.b.** Describe polymers as molecules bonded together. **IV.B.6.c.** Determine uses of aromatic compounds and polymers in everyday life. (P) **IV.B.6.d.** Explore, investigate, and list some common uses of petroleum products, including manufacturing and medical applications.	• Examine how carbon can single, double, or triple bond to form compounds. • Classify hydrocarbons as alkane, alkene or alkyne based on their structural formulas • Name and draw structural formulas of alkanes, alkenes, and alkynes. • Draw structural isomers for simple hydrocarbons. • Define polymers and give examples and uses. • Define and describe aromatic compounds and give examples and uses. • Catagorize organic compounds by their functional group.	• Nylon factory demo. • Slime. • Molecular model lab • Esters lab. • Synthesis of aspirin. • Textiles lab (Contact Clemson University, School of Textiles) • Guest speaker (industrial chemist) • Current events in chemistry (discussion, debate, reports, etc.)

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Topic: Nuclear Chemistry

S.C. Standard	Performance Objectives (Competencies)	Suggested Activities and Inquiry-Based Labs
Chemistry: **IV.A.3.a.** Explain why like charges are able to remain in close proximity in the nucleus.[4] **IV.A.3.b.** Contrast the energy released by nuclear reactions to that released by chemical reactions. **IV.A.4.a.** Explain that unstable isotopes undergo spontaneous nuclear decay, emitting energy or particles and energy. **IV.A.4.b.** Apply the predictable rate of nuclear decay to estimate the age of materials.	• Discuss the advancements in the nuclear model through the research of the Curies, Meitner, and Fermi. • Differentiate between alpha, beta, and gamma radiation • Recognize that some elements spontaneously break down into new elements through the process of radioactive decay. Write an equation for this process. • Explain the concept of half-life, and use it to determine age of materials. • Use general equations to compare energy changes in fission and fusion reactions. • Compare fission and fusion reactions and discuss real world examples and consequences of each.	• Half-life lab • Demo geiger counter • Guest speaker (navy nuclear specialist, nuclear power plant engineer, etc.) • Generate a flow chart of nuclear fuel production of energy. • Develop a Project, write a paper or debate the effects of nuclear applications. • View laserdisc or videos on Nuclear Chemistry.

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	• Based on E=mc2 compare energy changes released during nuclear reactions with that released during ordinary chemical reactions.	

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