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Correlation with the

21st Century Science Content Standards and Objectives for West Virginia Schools

Grades 11-12

Effective July 1, 2010

Grade 11

Conceptual Chemistry

Standard 2: Content of Science

SC.S.C.2

Students will

- demonstrate knowledge, understanding, and applications of scientific facts, concepts, principles, theories, and models as delineated in the objectives.
- demonstrate an understanding of the interrelationships among physics, chemistry, biology, earth/environmental science, and astronomy.
- apply knowledge, understanding, and skills of science subject matter/concepts to daily life experiences.

Performance Descriptor

SC.PD.C.2

Conceptual chemistry students at the distinguished level

- design and conduct an investigation to compare the conductivity and malleability of metals, nonmetals and metalloids, to separate a mixture, and/or to identify an unknown pure substance using its chemical and physical properties
- predict the behavior of an ideal gas and compare the behaviors of ideal and real gas
- analyze the periodic table to produce and use electron configurations to predict the chemical properties of elements
- generate the correct molecular formula for binary and oxy-acids
- calculate the enthalpy of reactions from balanced equations
- generate complex mole conversions that require three or more conversion factors and perform all calculations that use the mole as a conversion factor
- construct models of organic molecules and apply electronegativity values and molecular shape to classify the molecules as polar or nonpolar

- determine experimentally the properties of solution and identify the intermolecular forces
- conduct a neutralization experiment to construct and interpret a titration curve
- write nuclear equations for fission and fusion reactions

Objectives

Students will

SC.O.C.2.1
classify pure substances by their chemical and physical properties

→ **LAB** *Chemical Matter* "Chemical and Physical Properties"

SC.O.C.2.2
classify examples of matter as pure substance or mixture

→ **LAB** *Chemical Matter* "Chemical and Physical Properties"

SC.O.C.2.4
use the kinetic molecular theory to explain states of matter

→ **LAB** *Chemical Matter* "Comparing the States of Matter"

→ **LAB** *Chemical Matter* "Side-by-Side Comparison of Solids, Liquids, and Gases"

SC.O.C.2.5
perform calculations using the combined gas laws

→ **LAB** *Gases* "The Pressure-Volume Relationship"

→ **LAB** *Gases* "The Pressure-Temperature Relationship"

→ **DEMONSTRATION** *Gases* "What is Avogadro's Law?"

→ **MISCELLANEOUS** *Gases* "The Universality of the Ideal Gas Law"

SC.O.C.2.6
produce and use electron configuration to explain chemical properties of elements

→ **DEMONSTRATION** *Atoms* "What does a hydrogen atom look like?"

→ **LAB** *Atoms* "Atomic Orbitals"

→ **DEMONSTRATION** *Atoms* "Is an s-orbital the same for all elements?"

→ **DEMONSTRATION** *Atoms* "How do p-orbitals differ from each other?"

→ **Lab** *Atoms* "d-Orbitals"

SC.O.C.2.7
generate the correct formula and/or name for ionic and molecular compounds

→ **Lab** *Chemical Matter* "Naming Molecular Compounds"

SC.O.C.2.8
predict the type of bonding that occurs between atoms and characterize the properties of the ionic, covalent, or metallic bond formed

→ **Lab** *Chemical Bonding* "Exploring Ionic Interactions"

→ **Lab** *Chemical Bonding* "Electron Sharing in Molecules"

→ **Lab** *Chemical Bonding* "Energetics of Covalent Bonding"

→ **Lab** *Liquids & Solids* "Bonding in Crystalline Solids"

SC.O.C.2.9
given the reactants, anticipate the products and create balanced equations for the five general types of chemical reactions:

- synthesis or combination
- decomposition
- single replacement
- double replacement
- combustion

→ **Demonstration** *Kinetics* "What does a chemical reaction look like at the molecular level?"

→ **Lab** *Kinetics* "Examining a Reaction Mechanism"

SC.O.C.2.10
analyze the periodic table to predict trends:

- atomic size
- ionic size
- electronegativity
- ionization energy
- electron affinity

→ **Miscellaneous** *Main Groups* "Alkali Metals"

→ **Miscellaneous** *Main Groups* "Alkaline Earth Metals"

→ **Miscellaneous** *Transition Metals* "Elements of the d- and f-Blocks"

→ **MISCELLANEOUS** *Main Groups* "Boron Group"

→ **MISCELLANEOUS** *Main Groups* "Carbon Group"

→ **MISCELLANEOUS** *Main Groups* "Nitrogen Group"

→ **MISCELLANEOUS** *Main Groups* "Oxygen Group"

→ **MISCELLANEOUS** *Main Groups* "Halogens"

→ **MISCELLANEOUS** *Main Groups* "Noble Gases"

SC.O.C.2.13
perform the following "mole" calculations:

- molarity
- percentage composition
- empirical and molecular formulas
- formulas of hydrates
- theoretical yields

→ **LAB** *Solutions* "Concentration of a Dissolved Pesticide"

SC.O.C.2.14
construct models to explain the structure and geometry of organic and inorganic molecules and the lattice structures of crystals

→ **LAB** *Chemical Bonding* "VSEPR Theory"

→ **LAB** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

SC.O.C.2.15
determine experimentally the effects of temperature and concentration on solution properties:

- solubility
- conductivity
- density
- colligative properties

→ **MISCELLANEOUS** *Solutions* "Energetics of Solutions"

SC.O.C.2.16
compare methods of measuring pH:

- indicators
- indicator papers
- pH meters

→ **MISCELLANEOUS** *Acids & Bases* "pH Indicator"

SC.O.C.2.17
investigate and explain water's role as a solvent based upon principles of polarity of substances

→ **DEMONSTRATION** *Solutions* "How do salts dissolve in water?"

→ **MISCELLANEOUS** *Solutions* "Energetics of Solutions"

SC.O.C.2.18
compare and contrast the Arrhenius and Bronsted-Lowry definitions of acids and bases

→ **LAB** *Acids & Bases* "Strong Acids"

→ **LAB** *Acids & Bases* "Structure and Acidity"

SC.O.C.2.19
classify reactions as exothermic and endothermic reactions by the direction of heat flow in a chemical reaction

→ **LAB** *Kinetics* "Reactive Collisions Between Molecules"

→ **LAB** *Kinetics* "Examining a Reaction Mechanism"

Grade 11
Chemistry

Standard 2: Content of Science

SC.S.C.2

Students will

- demonstrate knowledge, understanding, and applications of scientific facts, concepts, principles, theories, and models as delineated in the objectives.
- demonstrate an understanding of the interrelationships among physics, chemistry, biology, earth/environmental science, and astronomy.
- apply knowledge, understanding, and skills of science subject matter/concepts to daily life experiences.

Performance Descriptor

SC.PD.C.2

Chemistry students at the distinguished level

- quantitatively determine the identity of a substance using physical properties such as density, melting points, specific heat, etc.

- draw conclusions from historical development of the periodic table and atomic theory to validate modern theories of bonding
- create the correct molecular formula and communicate the correct name for the hydrocarbons
- construct the appropriate balanced equation for laboratory experiments
- explain from experimental data and appropriate stoichoimetric applications the limiting reactant, excess reactant, and theoretical yield
- determine experimentally the properties of solution
- perform gas stoichiometric calculations
- conduct a neutralization experiment to construct and interpret a titration curve
- design a properly working electrolytic cell based on redox principles
- predict and explain how shifts in equilibrium affect the solubility of a solid

Objectives

Students will

SC.O.C.2.1
classify pure substances by their chemical and physical properties

→ **LAB** *Chemical Matter* "Chemical and Physical Properties"

SC.O.C.2.2
research and evaluate contributions to the evolution of the atomic theory

→ **LAB** *Atoms* "Nuclei and Electrons"

SC.O.C.2.3
describe atoms using the Quantum Model

→ **LAB** *Atoms* "The Electron Cloud of an Argon Atom"

SC.O.C.2.4
produce electron configurations and orbital diagrams for any element on the periodic table and predict the chemical properties of the element from the electron configuration

→ **DEMONSTRATION** *Atoms* "What does a hydrogen atom look like?"

→ **LAB** *Atoms* "Atomic Orbitals"

→ **DEMONSTRATION** *Atoms* "Is an s-orbital the same for all elements?"

→ **DEMONSTRATION** *Atoms* "How do p-orbitals differ from each other?"

→ **LAB** *Atoms* "d-Orbitals"

SC.O.C.2.6
generate the correct formula and/or name for ionic and molecular compounds

→ **Lab** *Chemical Matter* "Naming Molecular Compounds"

SC.O.C.2.7
analyze periodic trends in atomic size, ionic size, electronegativity, ionization energy, and electron affinity

→ **Miscellaneous** *Main Groups* "Alkali Metals"

→ **Miscellaneous** *Main Groups* "Alkaline Earth Metals"

→ **Miscellaneous** *Transition Metals* "Elements of the d- and f-Blocks"

→ **Miscellaneous** *Main Groups* "Boron Group"

→ **Miscellaneous** *Main Groups* "Carbon Group"

→ **Miscellaneous** *Main Groups* "Nitrogen Group"

→ **Miscellaneous** *Main Groups* "Oxygen Group"

→ **Miscellaneous** *Main Groups* "Halogens"

→ **Miscellaneous** *Main Groups* "Noble Gases"

SC.O.C.2.8
predict the type of bonding that occurs between atoms and characterize the properties of the ionic, covalent or metallic substances

→ **Lab** *Chemical Bonding* "Exploring Ionic Interactions"

→ **Lab** *Chemical Bonding* "Electron Sharing in Molecules"

→ **Lab** *Chemical Bonding* "Energetics of Covalent Bonding"

→ **Lab** *Liquids & Solids* "Bonding in Crystalline Solids"

SC.O.C.2.10
construct models to explain the structure and geometry of organic and inorganic molecules

→ **Lab** *Chemical Bonding* "VSEPR Theory"

→ **Lab** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

SC.O.C.2.11
given the reactants, anticipate the products and create balanced equations for the five general types of chemical reactions:

- synthesis or combination
- decomposition
- single replacement
- double replacement
- combustion

⟶ **Demonstration** *Kinetics* "What does a chemical reaction look like at the molecular level?"

⟶ **Lab** *Kinetics* "Examining a Reaction Mechanism"

SC.O.C.2.12
determine experimentally the effects of temperature and concentration on solution properties:

- solubility
- conductivity
- density
- colligative properties

⟶ **Miscellaneous** *Solutions* "Energetics of Solutions"

SC.O.C.2.13
classify reactions as exothermic and endothermic reactions by the direction of heat flow in a chemical reaction

⟶ **Lab** *Kinetics* "Reactive Collisions Between Molecules"

⟶ **Lab** *Kinetics* "Examining a Reaction Mechanism"

SC.O.C.2.14
explain the chemical and physical concepts involved in dynamic equilibrium

⟶ **Miscellaneous** *Equilibria* "The Dynamic Nature of Equilibria"

SC.O.C.2.15
generate mole conversions that demonstrate correct application of scientific notation and significant figures:

- mass to number of particles
- number of particles to volume
- volume to mass

⟶ **Lab** *Gases* "The Pressure-Volume Relationship"

⟶ **Lab** *Gases* "The Pressure-Temperature Relationship"

⟶ **Demonstration** *Gases* "What is Avogadro's Law?"

⟶ **Miscellaneous** *Gases* "The Universality of the Ideal Gas Law"

SC.O.C.2.17

perform the following "mole" calculations showing answers rounded to the correct number of significant figures:

- molarity
- percentage composition
- empirical formulas
- molecular formulas
- formulas of hydrates
- mole-mole and mass-mass stoichiometry
- determination of limiting reactant
- theoretical yield

→ **LAB** *Solutions* "Concentration of a Dissolved Pesticide"

SC.O.C.2.18
compare and contrast the Arrhenius and Bronsted-Lowry definitions of acids and bases

→ **LAB** *Acids & Bases* "Strong Acids"

→ **LAB** *Acids & Bases* "Structure and Acidity"

SC.O.C.2.19
compare methods of measuring pH:

- indicators
- indicator papers
- pH meters

→ **MISCELLANEOUS** *Acids & Bases* "pH Indicator"

SC.O.C.2.21
investigate and explain water's role as a solvent based upon principles of polarity of substances

→ **MISCELLANEOUS** *Solutions* "Energetics of Solutions"

Grade 12
Chemistry II

Standard 2: Content of Science

SC.S.CII.2

Students will

- demonstrate knowledge, understanding, and applications of scientific facts, concepts, principles, theories, and models as delineated in the objectives.
- demonstrate an understanding of the interrelationships among physics, chemistry, biology, earth/environmental science, and astronomy.

- apply knowledge, understanding, and skills of science subject matter/concepts to daily life experiences.

Performance Descriptor

SC.PD.CII.2

Chemistry II students at the distinguished level

- utilize VSEPR theory to make predictions about valence bonds that can be used to compare and contrast binding forces
- justify the ideal gas laws on the basis of the kinetic-molecular theory
- predict theoretical yield, limiting reactant, excess reactant, percent yield, and experimental error from a designed experiment that includes the appropriate stoichiometric applications
- design an experiment to illustrate the effect of changing concentration on the colligative properties of solutions, change of state, and molar mass
- evaluate systems based on the physical and chemical dynamic equilibrium concepts that include equilibrium constants and system directional change according to Le Chatelier's principle
- design an effective battery using the voltage calculated from the Nernst equation
- design and conduct experiments to collect and graphically analyze data to investigate reaction rate and predict reactant order
- design and conduct experiments to experimentally and mathematically demonstrate the first and second law of thermodynamics including the reaction spontaneity
- calculate and explain the relationships among weak acids, pH, pOH, pK, K_a, K_b, K_w, ionization constants, and percent ionization, K_{sp}
- prove the presence of specific cations and anions in an unknown mixture through experimental data
- solve complex problems involving radioactive decay and write nuclear equations for decay, fission, and fusion
- perform calculations involving the addition of a strong acid or base to a buffer; experimentally justify the hydrolysis of a salt and equivalence point of a titration curve
- evaluate organic structures and compounds based on functional groups.

Objectives

Students will

SC.O.CII.2.1

identify types of binding forces such as:

- ionic
- covalent
- metallic
- van der Waals forces (including London)

and relate binding forces to state, structure, and properties of matter

→ **LAB** *Chemical Bonding* "Exploring Ionic Interactions"

→ **LAB** *Chemical Bonding* "Electron Sharing in Molecules"

→ **LAB** *Liquids & Solids* "Intermolecular Forces"

SC.O.CII.2.2
investigate the valence bond including the concepts of

- hybridization of orbitals
- resonance
- formation of sigma and pi bonds

and demonstrate an understanding of the VSEPR theory

→ **LAB** *Chemical Bonding* "VSEPR Theory"

→ **LAB** *Chemical Bonding* "Energetics of Covalent Bonding"

→ **LAB** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

→ **LAB** *Chemical Bonding* "Probing Resonance: Ozone and Carbonate"

SC.O.CII.2.4
interpret the ideal gas laws on the basis of the kinetic-molecular theory

→ **LAB** *Gases* "The Pressure-Volume Relationship"

→ **LAB** *Gases* "The Pressure-Temperature Relationship"

→ **DEMONSTRATION** *Gases* "What is Boyle's Law?"

→ **DEMONSTRATION** *Gases* "What is Avogadro's Law?"

SC.O.CII.2.6
define changes of state, including critical temperatures and triple points, based on the kinetic molecular theory

→ **DEMONSTRATION** *Liquids & Solids* "How does temperature affect the vapor pressure?"

→ **LAB** *Liquids & Solids* "The Melting Transition"

→ **DEMONSTRATION** *Liquids & Solids* "How does temperature affect the vapor pressure?"

→ **DEMONSTRATION** *Chemical Matter* "Do physical changes affect the amount of matter?"

SC.O.CII.2.7
calculate concentration and explain the effect of changing concentration on the colligative properties of solutions

→ **LAB** *Solutions* "Concentration of a Dissolved Pesticide"

SC.O.CII.2.9
explain physical and chemical dynamic concepts; calculate equilibrium constants K_p, K_c, K_{sp}, K_a, and apply Le Chatelier's principle

→ **Miscellaneous** *Equilibria* "The Dynamic Nature of Equilibria"

→ **Lab** *Equilibria* "Equilibrium and Temperature"

→ **Lab** *Equilibria* "Equilibrium and Pressure"

SC.O.CII.2.10
use experimental data and graphical analysis to determine reactant order, rate constants, and reaction rate laws, calculate the rate of reaction, and explain the effect of temperature on rate changes

→ **Demonstration** *Kinetics* "What does a chemical reaction look like at the molecular level?"

→ **Lab** *Kinetics* "Reactive Collisions Between Molecules"

→ **Lab** *Kinetics* "Examining a Reaction Mechanism"

SC.O.CII.2.11
determine the heat of formation, heat of reaction, heat of vaporization and heat of fusion; apply Hess's Law

→ **Demonstration** *Liquids & Solids* "How does temperature affect the vapor pressure?"

→ **Lab** *Liquids & Solids* "The Melting Transition"

→ **Lab** *Kinetics* "Reactive Collisions Between Molecules"

→ **Lab** *Kinetics* "Examining a Reaction Mechanism"

SC.O.CII.2.12
using the second law of thermodynamics, calculate the free energy of formation, free energy of reaction, and the dependence of free energy on enthalpy and entropy changes

→ **Demonstration** *Chemical Thermodynamics* "Are gas expansions irreversible?"

→ **Lab** *Chemical Thermodynamics* "Entropy and the States of Matter"

SC.O.CII.2.13
perform all calculations with attention given to significant figures, precision of measured values, and the use of logarithmic and exponential relationships

→ *Many Labs*

SC.O.CII.2.15
experimentally determine the properties of acids:

- identify weak electrolytes
- define pH, pOH, pK, K_a, K_b, K_w, ionization constant, percent ionization, K_{sp}

- calculate pH and pOH
- measure pH with indicator papers and electronic meters
- recognize salts that undergo hydrolysis
- write a reaction for the ion with water
- interpret a titration curve to identify the equivalence point
- calculate the range of a buffer

→ **LAB** *Acids & Bases* "Strong Acids"

→ **LAB** *Acids & Bases* "Structure and Acidity"

SC.O.CII.2.17
recognize simple organic functional groups and classify simple organic compounds by name

→ **LAB** *Organic Chemistry* "Functional Groups"

→ **LAB** *Organic Chemistry* "Comparing and Identifying Organic Compounds"