Maryland Science Grades 9-12
Contents Standards Mapping

CHEMISTRY	Boardworks High School Chemistry Presentation
1) Expectation: The student will explain that atoms have structure and this structure serves as the basis for the properties of elements and the bonds that they form.	
a) The student will analyze the structure of the atom and describe the characteristics of the particles found there.	
i) Subatomic particles (protons, neutrons, & electrons – not to include quantum mechanical details of electron configurations)	Atomic Structure Electron Configuration Introducing Atoms
ii) Nucleus & electron cloud (definition; no orbitals included)	Atomic Structure Introducing Atoms
iii) Atomic number, mass number, and isotopes (definitions; calculate numbers of protons, neutrons, and electrons; notations)	Atomic Number and Mass Number Isotopes
iv) Atomic mass (qualitative concept of weighted average only; atomic mass unit)	Atomic Number and Mass Number
v) Neutral atom	Atomic Structure
vi) Historical development and/or experimental evidence for the existence and structure of the atom (Democritus, Dalton, Thomson, Rutherford, Bohr, electron cloud model)	Introducing Atoms
b) The student will demonstrate that the arrangement and number of electrons and the properties of elements repeat in a periodic manner illustrated by their arrangement in the periodic table.	
i) Groups/families and periods/series (groups 1-18; Alkali Metals, Alkaline Earth Metals, Transition Metals, Halogens, Noble Gases; Periods 1-7; Lanthanide Series, Actinide Series)	Electron Structure and the Periodic Table Patterns of Behavior The Noble Gases The Periodic Table
ii) For the following assessment limits, use only elements in groups 1,2, & 13-18. How trends behave (valence electrons; atomic radius; ionization energy; relative chemical reactivity; metallic/nonmetallic properties)	Ionization Energy Patterns of Behavior The Noble Gases The Periodic Table
c) The student will explain how atoms interact with other atoms through the transfer and sharing of electrons in the formation of chemical bonds.	
i) Formation of ions (relate charge of ions to number of electrons gained or lost as determined by valence electrons / location of elements on Periodic Table; cation; anion)	Formation of Ions

ii) Bond (definition)	Comparing Bonding Covalent Bonding Ionic Bonding Metallic Bonding Why do Atoms Form Bonds?
iii) Formation of ionic bond (definition; metal-nonmetal; based on valence electrons / location of elements on the Periodic Table)	Ionic Bonding Ionic Compounds
iv) Formation of covalent bond (definition; nonmetal-nonmetal; based on valence electrons / location of elements on the Periodic Table; formation of single, double, and triple bonds)	Covalent Bonding
v) Bond polarity (concept only, no electronegativity calculations; common examples)	Comparing Bonding Covalent bonding Electronegativity Ionic bonding
vi) Metallic bond (definition)	Metallic Bonding
vii) Bond energy (compare ionic and covalent)	Bonds and Activation Energy Comparing Bonding Covalent Bonding Ionic Bonding
viii) Metallic, ionic, and molecular substances (melting point, boiling point, electrical conductivity)	Comparing Bonding Giant Covalent Structures Ionic Compounds Metallic Bonding
2) Expectation: The student will explain how the properties of compounds are related to the arrangement and type of atoms they contain.	
a) The student will explain how the properties of a molecule are determined by the atoms it contains and their arrangement.	
i) Polar and nonpolar molecules (“like dissolves like” and why; not to include prediction of polarity from shape)	Atoms and Elements Electronegativity
ii) Shapes of molecules (limited to linear, bent/angular, tetrahedral)	Shapes of Molecules
iii) Water (definition and explanation of shape and polarity of molecule, observed changes in density as phases change, use as a “universal” solvent; conceptual understanding of hydrogen bonding, high surface tension, high specific heat)	Water
b) The student will explain why organic compounds are so numerous and diverse.	
i) Inorganic and organic compounds (define in terms of carbon content; do not include CO, CO2, or carbonates as organic compounds; definition of hydrocarbons)	Compounds Naming Compounds
ii) Ability of carbon to form chains and make rings (recognize, but not produce structural formulas)	Hydrocarbons

c) The student will describe the properties of solutions and explain how they form.	
i) Solute, solvent, and solubility	Solubility Solutions
ii) Suspensions and colloids	–
iii) Alloys and gaseous solutions	–
iv) Concentration (relative: dilute, concentrated, unsaturated, saturated, supersaturated; molarity – conceptual only; interpretation of solubility curves)	Concentration, Pressure and Reaction Rates Solubility
v) Dissociation/ionization (basic description; factors that influence rate: surface area of solute, temperature, agitation)	Formation of Ions Ionization Energy Rates of Reaction
vi) Electrolytes (definition in terms of composition and properties)	–
d) The student will differentiate among acids, bases, and salts based on their properties.	
i) Arrhenius definition (H+ and OH-)	Properties of Acids and Alkalis
ii) Ability of water to act as either an acid or a base	–
iii) Neutralization (definition)	Neutralization
iv) Salts (definition)	Neutralization
v) Indicators (phenolphthalein)	pH and Indicators
vi) Function of buffers (conceptual only)	–
3) Expectation: The student will apply the basic concepts of thermodynamics (thermochemistry) to phases of matter and phase and chemical changes.	
a) The student will explain that thermal energy in a material consists of the ordered and disordered motions of its colliding particles.	
i) Thermal energy (differentiate between thermal energy and temperature)	Temperature and Reaction Rates
ii) Phase changes	Changing State
iii) Heating / cooling (temperature vs. time) curve (interpret the different parts of the curve in terms of motion / kinetic energy and organization of the particles; changes in particle motion and organization between phase changes; identify melting/freezing and boiling point; not to include potential energy or calculations of Q)	Temperature and Reaction Rates
b) The student will describe observed changes in pressure, volume, or temperature of a sample in terms of macroscopic changes and the behavior of particles.	
i) Constant temperature (effect of pressure or volume change to sample of solid, liquid, or gas)	Temperature and Reaction Rates
ii) Constant volume (effect of pressure or temperature change to sample of solid, liquid, or gas)	Concentration, Pressure and Reaction Rates Surface Area, Catalysts and Reaction Rates
iii) Constant pressure (effect of temperature or volume change to sample of solid, liquid, or gas)	Concentration, Pressure and Reaction Rates Ideal Gas Laws

c) The student will explain why the interactions among particles involve a change in the energy system.	
i) Exothermic change (bond formation; dissociation; thermal energy released; no predictions/calculations of ΔH)	Exothermic Reactions
ii) Endothermic change (bond breaking; dissociation; thermal energy absorbed; no predictions/calculations of ΔH)	Endothermic Reactions
4) Expectation: The student will explain how and why substances are represented by formulas.	
a) The student will illustrate that substances can be represented by formulas.	
i) Subscripts (determine the numbers of atoms represented by a given formula; describe the function of subscripts in a chemical formula)	Naming Compounds Reacting Masses Types of Formulae
ii) Use symbols to represent elements and polyatomic ions (limited to NH4+1,OH-1, NO3-1, NO2-1, ClO3-1,ClO2-1, HCO3-1, CO3-2, SO4-2, SO3-2, PO4-3, PO3-3; including diatomics – H2, O2, N2, Cl2, Br2, I2, F2; given periodic table and ion chart)	Atoms and Elements
iii) Acids (binary naming system; ternary/oxyacid naming system limited to polyatomic ions given above)	Carboxylic Acids
iv) Write formulas for compounds (given Periodic Table, ion chart of polyatomic ions and transition metals, and compound name; Stock System/Roman Numerals for ionic compounds; prefixes (up through hexa) for molecular compounds; no hydrates)	Naming Compounds Types of Formulae
v) Name compounds (given formula, Periodic Table, and ion chart of polyatomic ions and transition metals; Stock System/Roman Numerals for ionic compounds; prefixes (up through hexa) for molecular compounds; no hydrates)	Naming Compounds
b) The student will show that chemical reactions can be represented by symbolic or word equations that specify all reactants and products involved.	
i) Convert word equations to symbolic equations	Naming Compounds Reacting Masses
ii) Convert symbolic equations to word equations	Naming Compounds Reacting Masses
c) The student will use mole relationships.	
i) Mole and Avogadro's Number (definitions)	Gases and Moles Molar Mass What are Moles?
ii) Relationship between moles and mass	Molar Mass What are Moles?
iii) Relationship between moles and particles	Molar Mass What are Moles?

iv) Formula mass (calculate the formula mass of a compound given the periodic table; no hydrates)	Relative Atomic Mass Relative Formula Mass
v) Mass percent composition (calculate the mass percent composition of a compound given the formula, formula mass, and periodic table; no hydrates)	Percentage Composition by Mass
5) Expectation: The student will explain that matter undergoes transformations, resulting in products that are different from the reactants.	
a) The student will describe the general types of chemical reactions.	
i) Synthesis and decomposition (definition; identify type given balanced formula equation or written description)	Thermal Decomposition
ii) Combustion (definition; identify type given balanced formula equation or written description)	Combustion
iii) Single displacement (definition; identify type given balanced formula equation or written description; apply activity series to determine if reaction will occur)	Redox Reactions
iv) Double displacement (definition; identify type given balanced formula equation or written description; apply solubility rules to predict if a precipitate will form)	Neutralization
b) The student will balance simple equations (not to include redox reactions).	
i) Law of Conservation of Mass (apply to reactions to account for the same number of atoms of each type appearing in both the reactants and products)	Conservation of Mass
ii) Coefficients (define; use to balance symbolic equations; explain meaning in symbolic equations; differentiate between the use and meaning of coefficients and subscripts)	Reacting Masses
c) The student will demonstrate that adjusting quantities of reactants may affect the amounts of products formed.	
i) Use of coefficients in a balanced equation to predict amounts of reactants and products (at the molecular/mole level – no mass-mass calculations)	Reacting Masses
ii) Changing the amount of reactant(s) may change the amount of product(s) formed (no calculations)	Reacting Masses
d) The student will recognize that chemical reactions occur at different speeds.	
i) Reaction rate (in order for atoms to react they must collide with sufficient energy; reaction rate increases as frequency of molecular collisions increases)	Rates of Reaction
ii) Effects of surface area, temperature, and concentration on the frequency and energy of molecular collisions (no calculations or specific concentration units)	Concentration, Pressure and Reaction Rates Surface Area, Catalysts and Reaction Rates
iii) Catalysts (definition; conceptual understanding of behavior)	Surface Area, Catalysts and Reaction Rates