

Chemistry

Mastery Guide

Matter and Energy

Standard Number: 2.0 Matter and Energy

Standard: The student will investigate the characteristics of matter and the interaction of matter and energy.

Performance Indicators State: Mastered by end of 4th week of 1st nine Weeks

As documented through state assessment,

Level 1, the student is able to:

- * identify a pure substance as element or compound, when given its chemical name or formula.
- * distinguish among elements, compounds, solutions, colloids, and suspensions, given examples.
- * classify changes in matter as physical or chemical, given examples or scenarios.
- * classify properties of matter as physical or chemical when given examples or scenarios.
- * distinguish between heat content and temperature when given a unit, a definition and/or an example.

Level 2, the student is able to

- * distinguish among gases, liquids and solids in terms of particle spacing and relative movement, given a diagram or scenario.

- * predict the effect of changing one gas variable (volume, temperature or pressure) on one of the others, given a scenario.
- * demonstrate an understanding of the law of conservation of matter, given experimental data.
- * categorize a process as endothermic or exothermic, given an example or scenario.

Level 3, the student is able to

- * demonstrate an understanding of the law of conservation of energy by equating heat loss and heat gain in an interaction, given the formulas $-q=q$ and $q=mc\Delta t$, and the specific heat.

Performance Indicators Teacher:

As documented through teacher observation,

Level 1, the student is able to

- * estimate equivalent Fahrenheit and Celsius temperatures and convert between Celsius and Kelvin temperature scales.
- * measure the mass and volume of solids and liquids using appropriate equipment, methods and units.
- * determine the density of solids and liquids.
- * read a thermometer and express the temperature accurately.

Level 2, the student is able to

- * distinguish between accuracy and precision.
- * create data tables and graphs from experimental data.
- * analyze data by computing a percentage error.
- * record measurements and results of calculations using the correct number of significant figures.
- * characterize a relationship between two variables as directly or inversely proportional.

- * use conversion factors, dimensional analysis and/or ratio and proportion to convert between quantities.
- * express large and small numbers using scientific notation and perform calculations in scientific notation.
- * practice appropriate safety procedures when working in the laboratory.
- * research careers that relate to matter and energy such as, surveyor, carpenter, structural engineer, HVAC technician, pathologist, etc.

Level 3 , the student is able to

- * using a calorimeter, identify an unknown metal by determining its specific heat.

Atomic Structure

Standard Number: 1.0 Atomic Structure

Standard: The student will investigate atomic structure and its implications for physical and chemical properties.

Performance Indicators State: Mastered by the end of the first nine weeks

As documented through state assessment,

Level 1, the student is able to

- * categorize an element as a metal, metalloid, nonmetal or noble gas based on its position in the periodic table.

- * identify an element's atomic number and name or symbol, given the number of protons or electrons in a neutral atom using a periodic table.
- * identify protons, neutrons and electrons with regard to their relative mass, relative charge and/or location in an atom.

Level 2, the student is able to

- * identify the major characteristics of various models of the atom: Democritus, Thomson, Rutherford, Bohr, and the modern quantum mechanical model.
- * determine the number of protons, neutrons and/or electrons in an atom or ion, given the symbol of the atom or ion and a periodic table.
- * compare *s* and *p* orbitals in an energy level in terms of general shape, energy and/or numbers of electrons possible.
- * determine the Lewis electron-dot structure or number of valence electrons for an atom of any main group element (1, 2, 13-18), given its atomic number or its position in the periodic table.

Level 3, the student is able to

- * describe the trends present in the periodic table with respect to atomic size, ionization energy, electron affinity or electronegativity.

Performance Indicators Teacher:

As documented through teacher observation,

Level 1, the student is able to

- * identify an isotope when given the number of protons and neutrons.
- * draw Bohr models for the first 18 elements.

Level 2, the student is able to

- * write the arrangement of electrons in the following three ways:
 - * orbital notation
 - * electron configuration notation
 - * electron-dot notation
- * predict the charge of an ion usually formed by the main-group elements (1, 2, 13-18) using the periodic table.
- * organize atoms from the main- group elements (1, 2, 13-18) based on atomic radii.
- * support the existence of the atom using the Laws of Definite Composition, Conservation of Matter and Multiple Proportion
- * calculate the average atomic mass of an element from the percent distribution and masses of isotopes.
- * identify and/or explain the formation of anions and cations.
- * use the Bohr model to draw an electron moving from its ground state to an excited state, and/or represent the emission of energy as it returns from an excited state to a lower energy state.
- * recognize names of famous scientists and identify their major contributions: Neils Bohr, James Chadwick, John Dalton, Max Planck, Ernest Rutherford, J.J. Thomson.
- * describe the differences between the Bohr model of the atom and the quantum mechanical (QM) electron-cloud model of the atom.
- * calculate wavelength, frequency or energy of a photon of electromagnetic radiation, given the formula and constants.

* research careers that relate to atomic structure, such as astronomy, nuclear medical technician, research physicist, chemist, etc.

Level 3, the student is able to

- * compare *s*, *p*, *d*, and *f* orbitals in an energy level in terms of general shape, energy or number of electrons possible.
- * determine quantum numbers for elements given the electron configuration.
- * explain in a paragraph why some elements do not have the predicted electron configuration; for example, copper tends to have an electron configuration of [Ar] 4s¹3d¹⁰ instead of [Ar] 4s²3d⁹
- * justify the quark combinations that make protons and neutrons, given the charges of the up and down quarks.
- * write the nuclear equation involving alpha or beta particles, given the mass number of the parent isotope and complete symbols for alpha or beta emissions.

Interactions of Matter

Standard Number: 3.0 Interactions of Matter

Standard: The student will examine the interactions of matter.

Performance Indicators State: Mastered by the end of the 5th week of the 2nd 9wks

As documented through state assessment,

Level 1, the student is able to

- * distinguish between a chemical symbol and a chemical formula, given examples.

- * identify the parts (reactants or products) of a chemical reaction, given a balanced chemical equation.
- * identify the types of chemical reactions (composition, decomposition, double replacement, single replacement), given a balanced equation.
- * determine the number of atoms, formula units or molecules of a particular substance, given a balanced equation.

Level 2, the student is able to

- * distinguish between ionic and covalent compounds, given binary formulas.
- * identify the formula for a compound using a periodic table and a list of common ions, given the name of the compound
- * identify the name of compounds and common acids (sulfuric acid, nitric acid, hydrochloric acid, acetic acid, and phosphoric acid), using a periodic table and a list of common ions.
- * select a correctly balanced chemical equation, when given examples.
- * recognize a balanced chemical equation using appropriate symbols, given a word equation.
- * convert between any two of the following quantities of a substance: mass

number of moles

number of particles

molar volume (at STP)

- * determine molar ratios expressed in balanced chemical equations.
- * analyze percent composition of the elements in a compound, given the formula.

- * solve mass to mass stoichiometry problems

Level 3, the student is able to

- * identify and solve different types of stoichiometry problems (volume (at STP) to mass, moles to mass, etc...)

Performance Indicators Teacher:

Level 1, the student is able to

- * write a balanced equation and identify the reactants and products.

Level 2, the student is able to

- * draw models of atoms bonding ionically and covalently.
- * write the formulas for compounds, given the names of compounds.
- * write the names of compounds given examples of chemical formulas using the stock system.
- * write a balanced chemical equation and classify as to type, given a word description of a chemical reaction.
- * calculate and measure the actual molar mass of a substance and relate it to the number of particles.
- * predict the products of a single or double replacement chemical reaction, given an activity series and a solubility chart.
- * research careers that relate to interactions of matter, such as pharmacist technician, industrial chemist, chemical technician, chemical engineer, etc.

Level 3, the student is able to

- * draw shapes of molecules and label bond angles, bond polarity and molecule polarity, given a formula.
- * predict amounts of product given mole or mass amounts of reactants in an actual lab experience and compare actual yield to theoretical yield.
- * use percentage composition to determine the empirical or molecular formula of an unknown substance.

Solutions and Acids/Bases

Standard Number: 4.0 Solutions and Acids/Bases

Standard: The student will investigate the characteristics of solutions including solutions of acids and bases.

Performance Indicators State: Mastered by the end of the 2nd nine weeks

*As documented through state assessment,
Level 1, the student is able to*

- * classify substances as acid or base, given the formula of an inorganic acid or base.

Level 2, the student is able to

- * identify the solute and solvent in a solid, liquid or gaseous solution, given its composition.

- * classify a solution as saturated, unsaturated or supersaturated, given the composition of the solution and a solubility graph.
- * calculate the concentration of a solution in terms of molarity or mass percent, given mass of solute and mass or volume of solution.
- * classify a substance as an acid or a base, given at least two of the following properties: color of litmus, color of phenolphthalein, taste, pH and slippery or non-slippery.

Level 3, the student is able to

- * predict the products of a neutralization reaction involving inorganic acids and bases, given the reactants.

Performance Indicators Teacher:

As documented through teacher observation,

Level 1, the student is able to

- * demonstrate the factors (temperature, stirring, particle size and concentration) that affect the rate at which a solute dissolves.
- * investigate the acidity/basicity of substances by observing their effect on various indicators.

Level 2, the student is able to

- * describe how to prepare a dilute solution from a concentrated solution of known molarity.
- * perform a neutralization reaction.
- * research careers that relate to solutions, such as cosmetologist, environmental scientist, water quality control technician, artist, etc.

Level 3, the student is able to

- * investigate colligative properties, i.e. the effect on freezing point and boiling point when a solute is added to a solvent.
- * demonstrate knowledge of neutralization reactions by performing a titration.
- * calculate molality of solutions.
- * classify a solution as neutral, acidic, or basic, or calculate its pH, given the hydrogen ion concentration or hydroxide ion concentration.