CHEMISTRY Learning Objectives

INTRODUCTION TO CHEMISTRY

The learner will

- ☑ identify five traditional areas of study in chemistry.
- ☑ relate pure chemistry to applied chemistry.
- ☑ identify areas affected by chemistry research.

MATTER AND CHANGE

The learner will

- ☑ distinguish between macroscopic and microscopic views.
- ☑ differentiate among three states of matter.
- ☑ describe a physical change.
- ☑ distinguish between homogeneous and heterogeneous samples of matter.
- ☑ explain the difference between an element and a compound, a substance and a mixture.
- ☑ describe what happens during a chemical change and four possible clues that it has taken place.
- ☑ apply the law of conservation of mass to chemical reactions.

SCIENTIFIC MEASUREMENT

The learner will

- ☑ calculate density, convert between Celsius and Kelvin, convert measurements to scientific notation and distinguish between mass and weight.
- ☑ convert to scientific notation.
- ☑ distinguish among accuracy, precision and error of measurement.
- ☑ list the SI units
- ☑ convert complex units, using dimensional analysis.
- ☑ calculate the density of material.
- ☑ describe how density varies with temperature.

ATOMIC STRUCTURE

The learner will

- ☑ explain what makes elements and isotopes different from each other.
- ☑ calculate the number of neutrons and atomic number in each element.
- ☑ identify the subatomic particles, describe the structure of the atom, calculate the number of neutrons in an atom and calculate the atomic mass of an element.
- ☑ compare the different models of the atom.
- ☑ know Dalton's atomic theory.

ELECTRONS IN ATOMS

The learner will

- ☑ identify and interpret chemical formulae for several common compounds.
- ☑ describe the relationship between wavelength and frequency of light.
- ☑ identify the source of atomic emission spectra.
- ☑ distinguish between quantum mechanics and classical mechanics.
- ☑ identify Bohr and Rutherford models of the atom.
- ☑ describe how the shapes of orbitals related to different sub-levels differ.

THE PERIODIC TABLE

The learner will

- ☑ describe how to write the electron configuration for an atom and how to classify elements based on electron configuration.
- ☑ compare early and modern periodic tables.
- ☑ describe how the shapes of orbitals related to different sub-levels differ.
- ☑ classify elements based on their electron configuration.
- ☑ describe trends among the elements for atomic size.
- ☑ explain how ions form.
- ☑ describe periodic trends for first ionization energy, ionic size and electronegativity.
- ☑ describe the relationship between the three main parts of an atom.
- ☑ illustrate models of various common atoms.

IONIC AND METALLIC BONDING

The learner will

- ☑ determine the number of valence electrons in an atom of a representative element.
- ☑ explain how the octet rule applies to atoms of metallic and nonmetallic elements.
- ☑ describe how cations form.
- ☑ explain how anions form.
- ☑ explain the electrical charge of an ionic compound.
- ☑ describe three properties of ionic compounds.
- ☑ model the valence electrons of metal atoms.

COVALENT BONDING

The learner will

- ☑ distinguish between the melting points and boiling points of molecular and ionic compounds.
- ☑ describe the information a molecular formula provides.
- ☑ describe how electrons are shared to form covalent bonds and identify exceptions to the octet rule.
- ☑ demonstrate how electron dot structures represent shared electrons.
- ☑ describe how atoms form double or triple covalent bonds.
- ☑ distinguish between a covalent bond and a coordinate covalent bond and describe how the strength of a covalent bond is related to its bond dissociation energy.
- ☑ describe how oxygen atoms are bonded in ozone.
- ☑ describe the relationship between atomic and molecular orbitals.
- ☑ describe how electronegativity values determine the distribution of charge in a polar molecule.
- ☑ describe what happens to polar molecules when they are placed between oppositely charge metal plates.
- ☑ identify the reason why network solids have high melting points.

CHEMICAL NAMES AND FORMULAS

The learner will

- ☑ identify the charges of monatomic ions by using the periodic table and name the ions.
- ☑ define a polyatomic ion and write the names and formulas of the most common polyatomic ions.
- ☑ identify the two common endings for the names of most polyatomic ions.
- ☑ apply the rules for naming and writing formulas for binary ionic compounds.
- ☑ apply the rules for naming and writing formulas for compounds with polyatomic ions.
- ☑ interpret the prefixes in the names of molecular compounds in terms of their chemical formulas.
- ☑ apply the rules for naming and writing formulas for binary molecular compounds.
- ☑ apply the rules in reverse to write formulas for acids.
- ☑ apply the rules for naming bases.

CHEMICAL QUANTITIES

The learner will

- ☑ describe methods of measuring the amount of something.
- ☑ define Avogadro's number and it relates to molar mass.
- ☑ describe how the mass of a mole of a compound is calculated.
- ☑ describe how to convert the mass of a substance to the number of moles of a substance and moles to mass.
- ☑ identify the volume of a quantity of gas at STP
- ☑ describe how to calculate the percent by mass of an element in a compound.
- ☑ interpret an empirical formula.
- ☑ distinguish between empirical and molecular formulas.

CHEMICAL REACTIONS

The learner will

- ☑ describe how to write a word equation.
- ☑ describe how to write a skeleton equation.
- ☑ describe the steps for writing a balanced chemical equation.
- ☑ describe the five general types of reactions.
- ☑ predict the products of the five general types of reactions.
- ☑ describe the information found in a net ionic equation.
- ☑ predict the formation of a precipitate in a double-replacement reaction.

STOICHIOMETRY

The learner will

- ☑ explain how balanced equations apply to both chemistry and everyday life.
- ☑ interpret balanced chemical equations in terms of moles, representative particles, mass and gas volume at STP.
- ☑ identify the quantities that are always conserved in chemical reactions.
- ☑ construct mole ratios from balanced chemical equations and apply these ratios in stoichiometric calculations.
- ☑ calculate stoichiometric quantities from balanced chemical equations using units of moles, mass, representative particles and volumes of gases at STP.
- ☑ identify and use the limiting reagent in a reaction to calculate the maximum amount of products produced and the amount of excess reagent that remains unreacted.
- ☑ calculate theoretical yield, actual yield or percent yield given appropriate information.

STATES OF MATTER

The learner will

- ☑ describe the assumptions of the kinetic theory as it applies to gases.
- ☑ interpret gas pressure in terms of kinetic theory.
- ☑ define the relationship between Kelvin temperature and average kinetic energy.
- ☑ identify factors that determine physical properties of a liquid.
- ☑ define evaporation in terms of kinetic theory.
- ☑ describe the equilibrium between a liquid and its vapor.
- ☑ identify the conditions at which boiling occurs.
- ☑ evaluate how the way particles are organized explains the properties of solids.
- ☑ identify the factors that determine the shape of a crystal.
- ☑ explain how allotropes of an element are different.
- ☑ identify the conditions necessary for sublimation.
- ☑ describe how equilibrium conditions are represented in a phase diagram.

THE BEHAVIOR OF GASES

The learner will

- ☑ explain why gases are easier to compress than solids or liquids are.
- ☑ describe three factors that affect gas pressure.
- ☑ describe the relationships among the temperature, pressure and volume of a gas.
- ☑ use the combined gas law to solve problems.
- ☑ compute the value of an unknown using the ideal gas law.
- ☑ compare and contrast real and ideal gases.
- ☑ relate the total pressure of a mixture of gases to the partial pressures of the component gases.
- ☑ explain the high surface tension and low vapor pressure of water in terms of the structure of the water molecule and hydrogen bonding.

WATER AND AQUEOUS SYSTEMS

The learner will

- ☑ explain the high surface tension and low vapor pressure of water in terms of the structure of the water molecule and hydrogen bonding.
- ☑ describe the structure of ice.
- ☑ distinguish between a solvent and a solute.
- ☑ describe what happens in the solution process.
- ☑ explain why all ionic compounds are electrolytes.
- ☑ demonstrate how the formula for a hydrate is written.
- ☑ distinguish between a suspension and a solution.
- ☑ identify the distinguishing characteristics of a colloid.

SOLUTIONS

The learner will

- ☑ identify the factors that determine the rate at which a solute dissolves.
- ☑ identify the units used to express the solubility of a solute.
- ☑ identify the factors that determine the mass of solute that will dissolve in a given mass of solvent.
- ☑ solve problems involving the molarity of a solution.
- ☑ describe the effect of dilution on the total moles of solute in solution.
- ☑ define percent by volume and percent by mass solutions.
- ☑ identify three colligative properties of solutions.
- ☑ explain why vapor pressure, freezing point and boiling point of a solution differ from those properties of the pure solvent.
- ☑ solve problems related to the molality and mole fraction of a solution.
- ☑ describe how freezing-point depression and boiling-point elevation are related to molality.

THERMOCHEMISTRY

The learner will

- ☑ explain how energy heat and work are related.
- ☑ classify processes as either exothermic or endothermic.
- ☑ identify the units used to measure heat transfer.
- ☑ distinguish between heat capacity and specific heat.
- ☑ describe how calorimeters are used to measure heat flow.
- ☑ construct thermochemical equations.
- ☑ solve for enthalpy changes in chemical reactions by using heats of reaction.
- ☑ classify the enthalpy change that occurs when a substance melts, freezes, boils, condenses or dissolves.
- ☑ solve for the enthalpy change that occurs when a substance melts freezes, boils, condenses or dissolves.
- ☑ state Hess' Law of Heat summation and describe how it is used in chemistry.
- ☑ solve for enthalpy changes by using Hess' law or standard heats of formation.

REACTION RATES AND EQUILIBRIUM

The learner will

- ☑ describe how to express the rate of a chemical reaction.
- ☑ identify four factors that influence the rate of a chemical reaction.
- ☑ describe how the amounts of reactants and products change in a chemical system at equilibrium.
- ☑ identify three stresses that can change the equilibrium position of a chemical system.
- ☑ explain what the value of Keq indicates about the position of equilibrium.
- ☑ describe the relationship between the solubility product constant and the solubility of a compound.
- ☑ predict whether precipitation will occur when two salt solutions are mixed.
- ☑ identify two characteristics of spontaneous reactions.
- ☑ describe the role of entropy in chemical reactions.
- ☑ identify two factors that determine the spontaneity of a reaction.
- ☑ define Gibbs free-energy change.
- ☑ describe the general relationship between the value of the specific rate constant, K and the speed of a chemical reaction.
- ☑ interpret the hills and valleys in a reaction progress curve.

RESOURCES

Prentice-Hall Chemistry (2005 Ed.)

Internet research, applications and supplementary materials.