Norton City Schools Standards-Based Science Course of Study 2003

HIGH SCHOOL ELECTIVE
ADVANCED PLACEMENT CHEMISTRY (USED AS A YEAR-LONG OR BLOCK-SCHEDULED COURSE)
Physical Sciences Standard (PS)

11-12 Benchmarks	Grade Level Indicators and Sub-Objectives	Teaching Strategies/Resources
By the end of the 11-12 program, the student will, **<u>Physical Sciences</u>** **✶ Explain how variations in the arrangement and motion of atoms and molecules form the basis of a variety of biological, chemical and physical phenomena. (PS-A)** **✶ Recognize that some atomic nuclei are unstable and will spontaneously break down. (PS-B)** **✶ Describe how atoms and molecules can gain or lose energy only in discrete amounts. (PS-C)** **✶ Summarize the historical development of scientific theories and ideas within the study of physical sciences. (PS-E)**	**By the end of Eleventh/Twelfth Grades, the student will:** **<u>Nature of Matter</u>** **✶ Explain that elements with the same number of protons may or may not have the same mass and those with different masses (different numbers of neutrons) are called isotopes. Some of these are radioactive. (PS-11-1)** **✶ Explain that humans have used unique bonding of carbon atoms to make a variety of molecules (e.g., plastics). (PS-11-2)** **✶ Explain how atoms join with one another in various combinations in distinct molecules or in repeating crystal patterns. (PS-12-1)** **✶ Describe how a physical, chemical or ecological system in equilibrium may return to the same state of equilibrium if the disturbances it experiences are small. Large disturbances may cause it to escape that equilibrium and eventually settle into some other state of equilibrium. (PS-12-2)** **✶ Explain how all matter tends toward more disorganized states and describe real world examples (e.g., erosion of rocks and expansion of the universe). (PS-12-3)** **✶ Recognize that at low temperatures some materials become superconducting and offer little or no resistance to the flow of electrons. (PS-12-4)** **<u>Forces and Motion</u>** **✶ Describe real world examples showing that all energy transformations tend toward disorganized states (e.g., fossil fuel combustion, food pyramids and electrical use). (PS-11-3)**	

	✶ Recognize that the nuclear forces that hold the nucleus of an atom together, at nuclear distances, are stronger than the electric forces that would make it fly apart. (PS-12-6) **✶ Recognize that nuclear forces are much stronger than electromagnetic forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the sun and other stars). (PS-12-7)** **Nature of Energy** **✶ Explain the characteristics of isotopes. The nucleus of radioactive isotopes is unstable and spontaneously decays emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate. (PS-12-10)** **✶ Use the predictability of decay rates and the concept of half-life to explain how radioactive substances can be used in estimating the age of materials. (PS-12-11)** **✶ Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules. (PS-12-12)** **✶ Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-12-13)** **Historical Perspectives and Scientific Revolutions** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-12-14)** **✶ Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-12-15)**	

	Sub-Objectives to Meet Indicators: • Define the hierarchy of matter and its components and classify various examples through: ◦ constructing a flowchart of the hierarchy ◦ categorizing forms of matter ◦ listing critical criteria of each category • Define and identify various physical and chemical changes by: ◦ listing critical criteria of each type of change ◦ describing the practical uses of various separations ◦ classifying a change based on observation • Make, define and interpret various forms of measurements using the metric system, significant digits, and scientific notation, including: ◦ examining various ways to determine volume ◦ employing dimensional analysis to make conversions ◦ using correctly a balance, pipette, graduated cylinder, burette, thermometer, and ruler ◦ Name compounds, write their formulas, and distinguish the basic differences between metals and nonmetals in terms of molecular state by: ◦ employing Latin nomenclature for nonmetal binary compounds ◦ employing SI nomenclature rules for inorganic compounds ◦ listing diatomic and catenated forms of elements ◦ employing SI nomenclature for basic alkanes and alcohols • Predict the result of various reactions and write complete, balanced equations to represent the reactions including: ◦ listing the critical criteria of each type of reaction ◦ utilizing solubility rules in metathesis reactions ◦ predicting reaction outcomes ◦ correctly representing products involved in secondary equilibrium reactions ◦ balancing equations in accord with the Law of Conversion of Mass/Energy ◦ classifying the materials in terms of physical state ◦ explaining effects of chemical reactions on the environment • Utilize stoichiometrical principles in solving and predicting outcomes in various chemical reactions by: ◦ employing dimensional analysis	

	∘ defining and applying molarity, Avogadro's number, moles, molecular mass, mol-mol ratios from formulas and equations, and the Ideal Gas Law • Apply the principles of Kinetic Molecular Theory of Gases (KMTG) to real-life situations by utilizing the gas laws, including: ∘ explaining the significance of each aspect and terms associated, such as pressure, to KMTG by illustrating with real-life applications ∘ solving gas law problems ∘ constructing a Maxwell-Boltzman distribution for a sample of varying temperatures and identifying salient features ∘ writing Van der Waal's Equation of State and identifying conditions and reasons behind deviations in ideal gas behavior • Explain how the model of the atom today evolved by citing significant contributions in history and their ramifications through: ∘ participating in small and large group discussions to brainstorm on possible implications to atomic theory when presented historical experiments ∘ constructing representations of the quantum mechanical model of the atom ∘ predicting and explaining the reason behind colors of various materials ∘ comparing and contrasting various models of the atom ∘ delineating the properties of major and minor subatomic particles ∘ listing the forms of electromagnetic radiation and apply wavelength, frequency, photon energy, and amplitude in their discussion • Name and apply trends in the periodic table, while explaining these trends and the properties of elements through: ∘ constructing various representations of electron structure and make predictions of their properties ∘ classifying and differentiating among elements by properties ∘ utilizing Crystal Field Theory to account for discrepancies in oxidation states ∘ explaining the reasons for properties such as stability • Compare, contrast, and make applications among covalent, ionic, and metallic bonding theories by: ∘ constructing models such as Lewis structures, molecular orbital diagrams, Born-Haber cycles, and hybridization energy diagrams	

	° applying bonding theory to explain such things as malleability, boiling point, conductivity, and solubility ° predicting molecular geometry, polarity, and magnetism of simple molecules and stating the ramifications of these predictions ° applying thermodynamic principles to assess the stability of species and the likelihood of possible reactions • Predict and explain the outcome of oxidation-reduction reactions by: ° calculating the oxidation state of elements in various situations ° identifying redox half-reactions, while specifying the oxidizing and reducing agents ° using normality and equivalents to quantitatively assess the outcome of redox reactions ° balancing redox reactions using the ion-electron and oxidation number methods • Explain and apply the concept of thermodynamics to chemical and physical phenomena by: ° determining the change in enthalpy of a reaction given calorimetric data of the heats of formation in the constituent materials ° quantitatively comparing and contrasting among the variables of enthalpy, internal energy, expansion work, heat, temperature, and heat capacity ° applying thermodynamic principles to assess the stability of species and the likelihood of possible reactions ° constructing a protocol for the experimental determination of the heats of combustion ° assessing the impact of entropy, temperature, and enthalpy on the spontaneity of a reaction ° explaining and applying the principles of Gibb's free energy, reversible processes, and energy diagrams • Assess and quantitatively analyze the kinetics of various models to: ° determine the reaction law governing a system, given empirical evidence ° predict the outcome of a chemical reaction and explain it in terms of kinetic theory ° construct graphical models that depict the kinetics of a system ° identify factors which must be taken into account to formulate a reaction mechanism	

	• Explain and predict the outcome of reversible processes through the use of equilibrium principles by: ° writing equilibrium laws governing chemical reactions ° quantitatively calculating and predicting outcomes for applying stress to a system in equilibrium ° relating quantitatively the impact of equilibrium and factors affecting it to Gibb's free energy ° discussing the connection between kinetics and equilibrium ° constructing experimental protocol for determining the equilibrium constant • Accurately predict and explain the outcomes of acid-base reactions through: ° explaining and constructing models accounting for the strength of acids and bases ° predicting and writing the reactions of hydrolysis ° predicting and writing the reactions of neutralizations ° determining the concentration of an unknown through titration ° quantitatively assessing the outcomes of various acid-base reactions ° applying equilibrium principles to acid-base reactions ° examining principles of a buffer system and those of indicators • Apply equilibrium theory to the solubility of insoluble salts and to complex ions, including: ° calculating the solubility product given concentrations of ion species ° determining the molarity of salts given Ksp ° explaining and quantitatively treating solutions containing common ions ° employing nomenclature for complex ions ° depicting and explaining models of ligand coordination reactions • Explain and apply principles of electrochemistry to laboratory and real-life situations by: ° solving for concentrations and cell potentials using the Nernst equation ° discussing voltaic and electrolytic cells in quantitative terms as they apply to practical situations ° discussing related concepts which affect electrochemistry such as oxidation-reduction, equilibrium, kinetics, and thermodynamics ° predicting and explaining the outcomes of cell matches	

	◦ applying the laws of Faraday to the analysis of electrochemical cells • Explain and apply principles of colligative properties to laboratory and real-life situations by: ◦ discussing, applying, and predicting the effects of boiling point elevation and freezing point depression by solutes and the mechanisms involved ◦ calculating the osmotic pressure across a semi-permeable membrane and expounding upon possible practical applications ◦ applying and explaining the uses of Raoult's Law ◦ comparing and contrasting concentration, activity, and the Van Hoff factor • Explain, in general terms, the nature of nuclear reactions and their ramifications upon science and society through: ◦ balancing and predicting outcomes for nuclear reactions ◦ explaining the significance of Einstein's equation to energy production and particle physics research ◦ comparing and contrasting between nuclear fission and fusion and citing recent discoveries ◦ discussing implications of nuclear power to a society ◦ describing the basic forms of radioactivity	