Curriculum Guide

The following curriculum guide was designed with consideration for the Chemistry High School Standards as presented in the current Massachusetts State Frameworks

Course 531: College Preparatory Chemistry **Level:** Grades 11 & 12

1. Course Structure

This full-year course meets five class periods a week. One period a week is scheduled for laboratory purposes.

2. Intended Audience

College Preparatory Chemistry is an elective course intended for junior/senior students as an introductory course in chemistry. Prerequisites include concurrent enrollment in or completion of CPI or CPII level Algebra II and/or teacher recommendation.

3. Course Goals

Students in this course will develop a solid, introductory foundation in general chemical principles, in laboratory skills, and in the solving of chemical problems. They will strengthen their abilities to think clearly and to express their ideas, orally and in writing, with clarity and logic. In addition, the course is structured around development of specific, content driven study skills and will serve to prepare the students for the more independent nature of study at the college level. This course does not prepare the student to take the SATII in Chemistry.

4. Course Objectives

Content:

I. Properties of Matter
II. Atomic Structure
III. Periodicity
IV. Chemical Bonding
V. Chemical Reactions and Stoichiometry
VI. States of Matter and Kinetic Theory
VII. Solutions
VIII. Thermochemistry
IX. Rates of Reaction and Chemical Equilibrium
X. Acids and Bases
XI. Reduction-Oxidation Reactions
XII. Nuclear Chemistry

Skills:

Scientific Inquiry Skills:

- Follow procedures to replicate experiment.
- Use appropriate tools and techniques to gather, analyze and interpret data
- Distinguish between hypothesis, theory and law as scientific terms
- Pose questions and state hypotheses based on prior scientific observations, experiments and knowledge.
- Design and conduct scientific investigations
- Use and refine scientific models that simulate physical processes or phenomena
- Identify reasons for insconsistent results, such as sources of error or uncontrolled conditions
- Communicate and defend a scientific argument
- Select and use appropriate technology to conduct investigations and communicate about science

Quantitative and Measurement Skills

- Construct and use tables and graphs to interpret data sets
- Use the metric/SI (standard international) system
- Convert within a unit (e.g., centimeters to meters)
- Use common prefixes such as milli-, centi- and kilo-
- Measure with accuracy and precision
- Use scientific notation
- Apply rules of significant figures to lab data and calculations
- Determine percent error or percent yield for lab results with known theoretical values
- Use Celsius, Fahrenheit and Kelvin scales for temperature

5. Content Standards: Broad Concepts

I. Properties of Matter

- Physical and chemical properties reflect the nature of the interactions between molecules or atoms and can be used to classify and describe matter.

II. Atomic Structure

- Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observation macroscopic scale.

III. Periodicity

- Periodic patterns of physical and chemical properties occur among elements that define families with similar properties. The periodic table displays this repeating pattern, which is related to an atom's

outermost electrons.

IV. Chemical Bonding
- Atoms bond with each other by transferring or sharing valence electrons to form compounds.

V. Chemical Reactions and Stoichiometry
- In a chemical reaction, one or more reactants are transformed into one or more new products. Chemical equations represent the reaction and must be balanced. The conservation of atoms in a chemical reaction leads to the ability to calculate the amount of products formed and reactants used.

VI. States of Matter and Kinetic Theory
- Gas particles move independently of each other and are far apart. Their behavior can be modeled by the kinetic theory. In liquids and solids, the particles are close to each other.

VII. Solutions
- Solids, liquids and gases dissolve to form solutions.

VIII. Thermochemistry
- The driving forces of chemical reactions are energy and entropy. The reorganization of atoms in chemical reactions result in the release or absorption of heat energy.

IX. Kinetics and Equilibrium
- Rates of reactions and chemical equilibrium are dynamic processes that are significant in many systems (biological, ecological and geological).

X. Acids and Bases
- Acids and bases are important in numerous chemical processes that occur around us, from industrial processes that occur around us, from industrial procedures to biological ones, from the laboratory to the environment.

XI. Oxidation-Reduction Reactions
- Oxidation-reduction reactions constitute a major class of chemical reactions and occur when one substance transfers electrons to another substance.

XII. Nuclear Chemistry
- Nuclear chemistry deals with radioactivity, nuclear processes and nuclear properties. Nuclear reactions produce tremendous amounts of energy and the formation of the elements.

6. Course Outline/ Curriculum Map

Quarter 1

I. Introductory Topics and Skills
- Matter, Change, and Energy
- Measurement, Significant Figures, and Scientific Notation
- Uncertainty of Measurement, Accuracy and Precision
- Problem Solving and the Factor-Label Method (Dimensional Analysis)
- Symbols of Common Elements

II. Properties of Matter

- Identify and explain physical and chemical properties. Distinguish between physical and chemical changes.
- Explain the difference between pure substances and mixtures.
- Differentiate between heterogeneous and homogeneous mixtures.
- Describe the three normal states of matter in terms of energy, particle motion and phase transition.

III. Atomic Structure
- Recognize discoveries from Dalton, Thomson, Rutherford and Bohr and understand how these discoveries led to the modern theory of the atom.
- Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom and explains how they interact.
- Apply the lase of conservation of mass, constant composition (definite proportions) and multiple proportions.
- Write the electron configuration for the first twenty elements of the periodic table.

Quarter 2

IV. Periodicity
- Explain the relationship of an element's position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.
- Use the periodic table to identify the three classes of elements: metals, nonmetals and metalloids (semi-metals).
- Relate the position of an element on the periodic table to its electron configuration and compare its reactivity with other elements in the table.
- Identify trends on the periodic table for atomic radius, ionic radius, electronegativity and ionization energy.

V. Chemical Bonding

- Explain how atoms combine to form compounds through both ionic and covalent bonding. Predict chemical formulas based on the number of valence electrons.
- Draw Lewis dot structures for simple molecules.
- Explain the difference between polar and nonpolar covalent bonds.
- Use electronegativity difference and the valence-shell electron-pair repulsion theory (VSEPR) to predict the shape and polarity of simple molecules.
- Name and write the chemical formulas for simple ionic compounds, including those that contain common polyatomic ions.
- Name and write the chemical formulas for simple molecular formulas, including binary and ternary acids.
- Apply the stock system of naming when appropriate.

Quarter 3

VI. Chemical Reactions and Stoichiometry

- Apply the law of conservation of mass and balance chemical equations.
- Classify chemical reactions as synthesis (combination), decomposition, single displacement, double displacement, or combustion.
- Use the mole concept to determine the number of particles and the molar mass of elements and compounds.
- Determine percent compositions, empirical formulas, and molecular formulas.
- Calculate the mass-to-mass stoichiometry for chemical reactions.
- Calculate mixed mole-mass-particle stoichiometry for chemical reactions.
- Calculate the percent yield in a chemical reaction and understand that this is a measure of the efficiency of a reaction undertaken in the laboratory.

VII. States of Matter and Kinetic Theory

- Using the kinetic theory, explain the behavior of gases through the understanding and application of Boyle's law, Charles's Law, Avagadro's hypothesis, and the Combined Gas Law. Use these gas laws to predict changes in pressure, volume and temperature.
- Perform calculations using the Ideal Gas Law. Understand the molar volume at STP (273K and 1 atm).
- Using the kinetic theory, describe and contrast the properties of gases, liquids, and solids. Explain at the molecular level the behavior of matter as it undergoes phase transitions (changes of state).

VIII. Solutions

- Describe the process by which solutes dissolve in solvents ("like dissolves like").
- Calculate concentration in terms of molarity. Use molarity to perform solution dilution and solution stoichiometry.
- Identify and explain the factors that affect the rate of dissolving.
- Compare and contrast the properties of solutions with those of pure solvents (colligative properties).

IX. Thermochemistry

- Describe the law of conservation of energy. Explain the difference between an endothermic and an exothermic process.
- Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy)

Quarter 4

X. Reaction Rates and Equilibrium

- Identify the factors that affect the rate of a chemical reaction.
- Write and understand the meaning of the equilibrium expression for a chemical reaction.
- Predict the shift in equilibrium when the system is subjected to a stress (Le Chatelier's Principle) and the factors that can cause a shift in equilibrium.

XI. Acids and Bases

- Define the Arrhenius theory of acids and bases in terms of the presence of hydronium and hydroxide ions in water. Relate their concentrations to the pH scale.
- Define the Bronsted-Lowry theory of acids and bases in terms of proton donor and acceptor. Compare and contrast the relative strength of common acids and bases.
- Perform titration calculations using experimental data.

XII. Oxidation and Reduction

- Assign oxidation numbers in a chemical reaction.
- Balance simple redox reactions by half reaction.
- Compare and Contrast an electrolytic cell.

XIII. Nuclear Chemistry

- Name the three main types of radioactive decay (alpha, beta and gamma) and explain them in terms of composition, mass, charge and penetrating power.
- Describe the process of radioactive decay by using nuclear equations and explain the concept of half-life for an isotope.
- Compare and contrast nuclear fission and nuclear fusion

- Explain the basic design of a nuclear power plant.
- Consider Nuclear Power Plants both historically and in comparison to other sources of electricity.

7. Course Text and Other Materials

The text for this course is:

- Wilbraham, Staley, Matta and Waterman, ***Chemistry***, Prentice Hall (2005).

Support materials include:

- Wagner, Maxine, ***Chemistry*** *The Study of Matter: Laboratory Manual*, 4th Ed., Prentice Hall Inc. (1992).
- Davis, Raymond E., et al., ***Modern Chemistry*****,** Holt, Rinehart and Winston (2002).
- Zumdahl, Steven S., Zumdahl, Susan L., DeCoste, Donald J., ***World of Chemistry***, Houghton Mifflin Company (2002).

8. Instructional Methods and Course Activities

Content will be conveyed through:

- Class dialogue and discussion
- Laboratory investigations
- Videos and tables
- Topic lectures and demonstrations

9. Learning Strategies

- The primary instructional mode will include class dialogue/discussion and problem solving accompanied by laboratory experiences carefully selected to complement classroom work and to ensure the mastery of essential laboratory skills.
- Students will be encouraged to approach each learning experience with an objective, critical, and analytical attitude.
- Mathematical problem solving will include careful attention to, and processing of, dimensions.

10. Assessment

The assessment of students will occur through:

- Daily evaluation of class preparation and participation
- Laboratory performance including bench work, recording organization, analysis, and reporting of observations and data
- Homework assignments
- Formal testing
- Semester examinations

11. Course Evaluation

The assessment of this course will occur through:

- On-going feedback from current students. graduates and other chemistry teachers.
- A formal student questionnaire at the end of the school year.
- Cooperative re-evaluation at the end of each school year by the chemistry teachers.