The Department's Educational Philosophy

We believe that students should be exposed to the process of scientific inquiry so they can acquire and interpret scientific knowledge, and begin to realize the wider applicability of scientific problem-solving methods. By making the laboratory the focal point of learning, we seek to foster students' appreciation for the experience of doing science.

Guiding Principles

- Students must be able to collect and analyze data and formulate hypotheses.
- Inductive and deductive problem-solving skills are central to science education.
- An effective program in science addresses the limitations of data and conclusions.
- Students should be able to use or design a strategy for testing scientific concepts.
- A comprehensive science program will emphasize the delicate checks and balances in man's abiotic and biotic environments and the stresses upon these ecosystems, which could affect the destiny of the world.
- Science is integrally related to mathematics.
- An effective science program builds students' ability to communicate accurately and precisely.
- An effective science program stresses both cooperative and independent learning.

CHEMISTRY (AE): COURSE #432

Course Frequency: Full-year course, eight times per six-day cycle
Credits Offered: Six
Prerequisites: Algebra I; AE Algebra II or AE Geometry (concurrently)

Background to the Curriculum

Over the years, the chemistry offerings have included individualized instruction along with more traditional courses. Honors, Accelerated/Enriched and College Preparatory Chemistry are the three levels of introductory chemistry currently offered. They are designed to meet the needs of the diversity of students as they attack the major theoretical concepts and ideas of chemistry through laboratory work, problem solving and classroom dialogue. All courses have a strong emphasis on the experimental foundations of chemistry. In addition, there has been a progression toward maximizing the use of technology along with a reduction in chemical waste through the use of microscale procedures.

Core Topics/Questions/Concepts/Skills

- Properties of Matter – Physical and chemical properties can be used to classify and describe matter.
- Atomic Structure – An atom is a discrete unit. The atomic model can help us to understand the interaction of elements and compounds observed on a macroscopic scale.
- Periodicity – Periodicity of physical and chemical properties relates to atomic structure and led to the development of the periodic table. The periodic table displays the elements in order of increasing atomic number.
- Chemical Bonding – Atoms form bonds by the interactions of their valence electrons.
- Chemical Reactions and Stoichiometry – The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants.
- Gases and Kinetic Molecular Theory – The behavior of gases can be explained by the Kinetic Molecular Theory.
- Solutions – Solids, liquids, and gases dissolve to form solutions.
- Acids and Bases – Acids and bases are important in numerous chemical processes that occur around us, from industrial processes to biological ones, from the laboratory to the environment.
- Equilibrium and Kinetics – Chemical equilibrium is a dynamic process that is significant in many systems (biological, ecological and geological). Chemical reactions occur at different rates.
- Thermochemistry (Enthalpy) – The driving forces of chemical reactions are energy and entropy. This has important implications for many applications (synthesis of new compounds, meteorology, and industrial engineering).
- Oxidation-Reduction and Electrochemistry – Oxidation-reduction reactions occur by electron transfer and constitute a major class of chemical reactions. Examples of redox reactions occur everywhere; their consequences are experienced daily.

Course-End Learning Objectives

Learning Objectives	**Corresponding state standards, *where applicable*** ***Chemistry, Grades 10 or 11, pages 63-67, May 2001.***
Properties of Matter	
1] Identify and explain some of the physical properties that are used to classify matter; e.g., density, melting point, and boiling point**.**	1.1
2] Explain the difference between mixtures and pure substances.	1.2
3] Describe the three states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions.	1.3
4] Distinguish between chemical and physical changes.	1.4
Atomic Structure	
1] Trace the development of atomic theory and the structure of the atom from the ancient Greeks to the present (Dalton, Thomson, Rutherford, Bohr, and modern theory).	2.1
2] Interpret Dalton's atomic theory in terms of the Laws of Conservation of Mass, Constant Composition, and Multiple Proportions.	2.2
3] Identify the major components of the nuclear atom (protons, neutrons, and electrons) and explain how they interact.	2.3
4] Using Bohr's model of the atom, interpret changes (emission/absorption) in electron energies in the hydrogen atom corresponding to emission transitions between quantum levels.	2.5
5] Write electron configurations for elements in the first three rows of the periodic table.	2.7
6] Describe alpha, beta and gamma particles; discuss the properties of alpha, beta and gamma radiation; and write balanced nuclear reactions.	2.8
7] Compare nuclear fission and nuclear fusion and mass defect.	2.9
8] Describe the process of radioactive decay as the spontaneous breakdown of certain unstable elements (radioactive) into new elements (radioactive or not) through the spontaneous emission by the nucleus of alpha or beta particles. Explain the difference between stable and unstable isotopes.	2.10
9] Explain the concept of half-life of a radioactive element; e.g., explain why the half-life of C14 has made carbon dating a powerful tool in determining the age of very old objects.	2.11

Periodicity	
1] Explain the relationship of an element's position on the periodic table to its atomic number and mass.	3.1
2] Use the periodic table to identify metals, nonmetals, metalloids, families (groups), periods, valence electrons, and reactivity with other elements in the table.	3.2
3] Relate the position of an element on the periodic table to its electron configuration.	3.3
4] Identify trends on the periodic table (ionization energy, electronegativity, electron affinity, and relative size of atoms and ions).	3.4
Chemical Bonding	
1] Explain how atoms combine to form compounds through both ionic and covalent bonding.	4.1
2] Draw Lewis dot structures for simple molecules.	4.2
3] Relate electronegativity and ionization energy to the type of bonding an element is likely to undergo.	4.3
4] Predict the geometry of simple molecules and their polarity (valence shell electron pair repulsion).	4.4
5] Identify the types of intermolecular forces present based on molecular geometry and polarity.	4.5
6] Predict chemical formulas based on the number of valence electrons.	4.6
7] Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain common polyatomic ions.	4.7
Chemical Reactions and Stoichiometry	
1] Balance chemical equations by applying the law of conservation of mass.	5.1
2] Recognize synthesis, decomposition, single displacement, double displacement and neutralization reactions.	5.2
3] Understand the mole concept in terms of number of particles, mass, and gaseous volume.	5.3
4] Determine molar mass, percent compositions, empirical formulas, and molecular formulas.	5.4
5] Calculate mass-mass, mass-volume, volume-volume, and limiting reactant problems for chemical reactions.	5.5
6] Calculate percent yield in a chemical reaction.	5.6

Gases and Kinetic Molecular Theory	
1] Using the kinetic molecular theory, explain the relationship between pressure and volume (Boyle's law), volume and temperature (Charles' law), and the number of particles in a gas sample (Avagadro's hypothesis).	6.1
2] Explain the relationship between temperature and average kinetic energy.	6.2
3] Use Dalton's Law of Partial Pressures to calculate partial and total pressure.	6.5
4] Use the combined gas law to determine changes in pressure, volume, or temperature.	6.6
Solutions	
1] Describe the process by which solutes dissolve solvents.	7.1
2] Identify and explain the factors that affect the rate of dissolving (i.e., temperature, concentration and mixing).	7.2
3] Calculate the concentration in terms of molarity, molality and percent by mass.	7.4
4] Use a solubility curve to determine saturation values at different temperatures.	7.5
5] Calculate the freezing point depression and boiling point elevation of a solution.	7.6
Acids and Bases	
1] Define Arrhenius' theory of acids and bases in terms of the presence of hydronium and hydroxide ions, and Bronsted's theory of acids and bases in terms of proton donor and acceptor, and relate their concentrations to the pH scale.	8.1
2] Compare and contrast the nature, behavior, concentration and strength of acids and bases. a. Acid-base neutralization b. Degree of dissociation or ionization c. Electrical conductivity	8.2
3] Identify a buffer and explain how it works.	8.3
4] Explain how indicators are used in titrations and how they are selected.	8.4
5] Describe an acid-base titration. Identify when the equivalence point is reached and its significance.	8.5
6] Calculate pH or pOH of aqeuous solutions using the hydronium or hydroxide ion concentration.	8.6

Equilibrium and Kinetics	
1] Write the equilibrium expression and calculate the equilibrium constant for a reaction.	9.1
2] Predict the shift in equilibrium when the system is subject to a stress (LeChatelier's principle).	9.2
3] Identify the factors that affect the rate of a chemical reaction (temperature, concentration) and the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature).	9.3
4] Explain rates of reaction in terms of collision frequency, energy of collisions, and orientation of colliding molecules.	9.4
5] Define the role of activation energy in a chemical reaction.	9.5
Thermochemistry (Enthalpy)	
1] Interpret the law of conservation of energy.	10.1
2] Analyze the energy changes involved in physical and chemical processes using calorimetry.	10.3
3] Apply Hess's Law to determine the heat of reaction.	10.4
Oxidation-Reduction and Electrochemistry	
1] Describe the chemical process as oxidation and reduction.	11.1
2] Assign oxidation numbers.	11.2
3] Identify the components and describe the processes that occur in an electrochemical cell.	11.4
4] Calculate the voltage of a cell given a table of standard reduction potentials.	11.7

Assessment

- Tests: multiple choice and problem solving
- Quizzes: short answer and problem solving
- Formal laboratory reports: Organization, data presentation, error analysis, data analysis are major points of emphasis.
- Informal laboratory reports: Organization and data analysis are major points of emphasis.
- Homework is checked several times per term.

Technology and Health Learning Objectives Addressed in This Course

(This section is for faculty and administrative reference; students and parents may disregard.)

Course activity: skills &/or topics taught	**Standard(s) addressed through this activity**
1] Students use computers for word processing, data organization and data analysis on a consistent basis through the year. **2]** Students also use a variety of probes in the laboratory. We have several computer animations that we use to help students see the chemistry that is involved on a microscopic level.	

Materials and Resources

Student text:

Lemay, Eugene, et al. **Chemistry: Connections to Our Changing World**, 2nd edition (2000), Prentice Hall Publishing.