#444 HONORS CHEMISTRY

GRADE: 11 & 12

LEVEL: 1

CREDITS: 5

PREREQUISITE: 441 (C or better; or teacher recommendation); 352 (B- or better; or department head recommendation)

BASIC TEXT: Chemistry, Connections to Our Changing World,
PRENTICE HALL, 1996

REQUIRED MATERIALS: lecture, notebook, pen/pencils, scientific calculator, and laboratory notebook

COURSE DESCRIPTION:
A continuation of College Chemistry/Lab (441), this course will include chemistry topics such as acids and bases, oxidation-reduction, electrochemistry, kinetics and thermodynamics, applications of nuclear chemistry, classes of organic compounds, polymers, and the chemistry of life. Laboratory investigation is an integral part of this course.

MISSION RELATED GOALS:
Foster communication
Foster problem solving
Academic excellence
Intellectual curiosity
Respect rights of others
Self-confidence

STUDENT EXPECTATIONS ADDRESSED:
Students will communicate effectively and work towards a common goal while developing appropriate problem solving skills. The student will focus on in class discussions and listen to each other's questions. Students must respect different observations, points of view, different conclusions, and work constructively and cooperatively on in-class activities. It is important that students respect themselves, respect their peers, and respect the class. Students must be punctual to class.

GENERAL PERFORMANCE OBJECTIVES:

Unit 1: Introduction to Matter and Measurement

- Describe what chemistry is and why it is useful.
- Classify materials according to its physical state and its composition.

- Distinguish between pure substances and mixtures. Categorize these into descriptive terms: elements, compounds, heterogeneous, and homogenous.
- Identify the characteristics or properties that are used to characterize, identify, and separate substances.
- Differentiate between qualitative and qualitative observations.
- Identify the metric units of measurement used in chemistry.
- Use the metric system for problem solving.
- Solve density problems.
- Explain what causes uncertainty in measurements.
- Express quantities in significant figures
- Compare accuracy and precision.
- Explain how dimensional analysis and conversion factors are used to solve problems in chemistry.
- Practice laboratory safety rules.
- Students will be proficient in general laboratory skills, and will identity and utilize laboratory equipment.

Unit 2: Atoms, Molecules, and Ions

- Define the term atom.
- Name and describe three subatomic particles in an atom.
- Determine the number of protons, neutrons, and electrons in an atom or ion.
- Discuss the modern theory of atomic structure.
- Define atomic number, isotope, and atomic mass.
- Calculate the average atomic mass (atomic weight) for a given element.
- Describe how the elements are arranged on the periodic table in order of increasing atomic number and grouped by chemical similarity.
- Define molecule, molecular formula, empirical formulas, structural formula, and diatomic molecules.
- Define ion, and use the periodic table to predict the charges on ions and the empirical formula of ionic compounds.
- Name and write the formula for inorganic compounds (acids and molecular compounds).
- Introduce basic ideas of organic chemistry. Name and write the formulas for basic alkanes.

Unit 3: Stoichiometry: Calculations with Chemical Formulas and Equations

- Use chemical formulas to write equations that represent chemical reactions.
- Classify the reactions: synthesis, decomposition, combustion, single and double replacement.
- Use chemical formulas to relate the masses of substances with the numbers of atoms, molecules, or ions they contain, which leads to understanding the mole.
- Define the mole.

- Apply the mole concept to determine chemical formulas from the masses of each element in a given quantity of a compound. (In other words, quantitatively determine molecular and empirical formulas.
- Quantitatively predict the amounts of substances consumed and/or produced in chemical reactions.
- Calculate the limiting and excess reactant.

Unit 4: Solutions - CH 15

- Describe the properties of solutions.
- Identify the different types of solutions.
- Measure the concentration of solutions in terms of molarity, molality, and mole fraction.
- Differentiate among saturated, unsaturated, and supersaturated solutions.
- Explain how a solution forms.
- Define solubility and describe the factors that affect solubility.
- Describe the factors that affect the rate at which a solute dissolves in a solvent.
- Define colligative property of a solution.
- Describe four colligative properties of solutions.

Unit 5: Chemical Equilibrium- CH 16

- Describe a reversible reaction.
- Define chemical equilibrium and explain how it is achieved.
- Determine the equilibrium constant for a given reaction.
- Analyze the extent of a reaction from its equilibrium constant.
- Use the reaction quotient of a reaction from its equilibrium constant.
- Explain Le Chatelier's principle.
- Describe how changes in concentration, pressure, and temperature affect a reaction at equilibrium.
- Relate the Haber process to Le Chatelier's principle.

Unit 6: Solubility and Precipitation- CH 17

- Compare dissolution and precipitation.
- Describe equilbria for aqueous solutions of ionic solids.
- Predict whether or not a precipitate will form using the solubility product.
- Describe a precipitation reaction and relate it to solubility.
- Write net ionic equations to describe the formation of an aqueous solution.
- Describe a common ion and explain how the common-ion effect shifts solubility equilbria.

Unit 7: Acids and Bases and Reactions of Acids and Bases- CH 18 and 19

- State the Bronsted-Lowry definition of acids and bases.
- Identify the common physical and chemical properties of acids and bases.

- Explain what dissociation constants indicate about an acid or base.
- Use experimental data to calculate the dissociation constant.
- Explain what most acidic hydrogen atoms have in common.
- Explain what most bases have in common.
- Describe how acids are named.
- Identify the ion concentration in pure water.
- Describe the pH scale.
- Identify a buffer, and explain how they work.
- Describe an acid-base titration.
- Explain how indicators are used in titrations and how they are chosen.

Unit 8: Oxidation and Reduction and Electrochemistry – CH 20 and 21

- Define oxidation and reduction.
- Explain what oxidation numbers are and how they are assigned.
- Explain what is meant by the activity series of metals.
- Describe some applications of redox reactions.
- List the steps in balancing a redox equation.
- Describe electrochemical cells.
- Explain the operation of a voltic cell.
- Relate standard electrode potentials to standard cell potentials.
- Describe the operation and rechargeable and nonreachargeable batteries.
- Describe some applications of electrolytic cells.

Unit 9: Rates of Reaction and Thermodynamics – CH 12, 22, and 23

- Define the rate of chemical reaction.
- Identify the intermediate products of a reaction mechanism.
- Describe a rate law for a chemical reaction.
- Understand chemical reactions in terms of collision theory
- Explain how energy is involved in chemical reactions.
- Define activation energy and describe an activated complex.
- List the factors that affect reaction rates and explain them according to collision theory.
- Explain what is meant by a spontaneous process.
- Relate enthalpy changes to spontaneity.
- Define entropy criterion for a spontaneous process.
- State the criterion for reaction spontaneity tin terms of is free energy change.

Unit 10: Applications of Nuclear Chemistry – CH 24

- Explain what is meant by the half-life of a radioactive element.
- Describe what happens in a nuclear bombardment reaction
- Describe how radiation affects living things.
- Discuss several beneficial applications of radioisotopes.
- Compare nuclear fission and nuclear fusion.
- Explain how nuclear reactors are used to produce energy.

Unit 11: Chemistry of Life.

- Explain why the sun is the ultimate source of energy for life on Earth
- Explain how energy is stored and used in biochemical reactions.
- Describe the chemical composition and functions of carbohydrates.
- Describe the chemical composition and functions of lipids, proteins, and nucleic acids.
- Identify different types of vitamins and their metabolic functions.

Massachusetts Science Curriculum Framework Learning Standard Strands

1.1 Identify and explain some of the physical properties that are used to classify matter, e.g., density, melting point.
1.2 Explain the difference between mixtures and pure substance.
1.3 Describe the four states of matter (solid, liquid, gas, plasma) in terms of energy, particle motion, and phase transitions.
1.4 Distinguish between chemical and physical changes.

2.3 Identify the major components of the nuclear atom (protons, neutrons, and electrons) and explain how they interact.
2.8.1 Describe alpha, beta, and gamma particles; discuss the properties of alpha, beta, and gamma radiation; and write balanced nuclear reactions.
2.9 Compare nuclear fission and nuclear fusion and mass defect.
2.10 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.
2.11 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.

4.7 Name and write formulas for simple ionic and molecular compounds, including those that contain common polyatomic ions.

5.1 Balance chemical equations by applying the law of conservation of mass.
5.2 Recognize synthesis, decomposition, single displacement, double displacement, and neutralization reactions.
5.3 Understand the mole concept in terms of number of particles, mass, and gaseous volume.
5.4 Determine molar mass, percent composition, empirical formulas, and molecular formulas.
5.5 Calculate mass-mass, mass-volume, volume-volume, and limiting reactant problems for chemical reactions.
5.6 Calculate percent yield in a chemical reaction.

7.1 Describe the process by which solutes dissolve in solvents.
7.2 Identify and explain the factors that affect the rate of dissolving (temperature, concentration, and mixing).
7.3 Describe the dynamic equilibrium that occurs in saturated solutions.
7.4 Calculate the concentration in terms of molarity, molality, and percent by mass.
7.5 Use a solubility curve to determine saturation values at different temperatures.
7.6 Calculate the freezing point depression and boiling point elevation of a solution.
7.7 Write net ionic equations for precipitation reactions in aqueous solutions.

8.1 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.
8.2 Compare and contrast the nature, and behavior, concentration and strength of acids and bases.
8.3 Identify a buffer, and explain how they work.
8.4 Explain how indicators are used in titration and how they are selected.
8.5 Describe and acid-base titration
8.6 Calculate the pH or pOH of aqueous solutions using the hydronium or hydroxide ion.

9.1 Write the equilibrium expression and calculate the equilibrium constant for a reaction.
9.2 Predict the shift in equilibrium expression and calculate the equilibrium constant for a reaction.
9.3 Identify the factors that affect the rate of a chemical reaction and the factors that can cause a shift in equilibrium.
9.4 Explain the rates in terms of collision frequency, energy of collisions, and orientation of colliding molecules.
9.5 Define the role of activation energy in a chemical reaction.

10.1 Interpret the law of conservation of energy.
10.2 Explain the relationship between energy transfer and disorder in the universe.

10.3 Analyze the energy changes involved in physical and chemical processes using calorimetry.
10.4 Apply Hess's law to determine the heat of reaction.

11.1 Describe the chemical processes known as oxidation and reduction.
11.2 Assign oxidation numbers.
11.3 Balance oxidation-reduction equations by using half-reactions.
11.4 Identify the components, and describe the processes that occur in an electrochemical cell.
11.5 Explain how a typical battery works.
11.6 Compare and contrast voltaic and electrolytic cells and their uses.
11.7 Calculate the net voltage of a cell given a table of standard reduction potentials.

UNITS AND THEMES COVERED AND ESTIMATED TIME LINE/COURSE OUTLINE

Unit 1: Introduction to Matter and Measurement: 1 week

Unit 2: Atoms, Molecules, and Ions: 1 week

Unit 3: Stoichiometry: Calculations with Chemical Formulas and Equations: 1 week

Unit 4: Solutions - CH 15: 2 week

Unit 5: Chemical Equilibrium- CH 16: 2week

Unit 6: Solubility and Precipitation- CH 17: 2 week

Unit 7: Acids and Bases and Reactions of Acids and Bases- CH 18 and 19: 2 weeks

Unit 8: Oxidation and Reduction and Electrochemistry – CH 20 and 21: 2 weeks

Unit 9: Rates of Reaction and Thermodynamics – CH 12, 22, and 23: 2 weeks

Unit 10: Applications of Nuclear Chemistry – CH 24: 1 week

Unit 11: Chemistry of Life: 1 week

SUGGESTED INSTRUCTIONAL STRATEGIES

- Inquiry lab investigation
- Role plays
- Cooperative learning
- Creating models

USE OF TECHNOLOGY/TOOLS

1. Uses of classroom computers with Internet access and integrated software packages.
2. Use of computer based simulation labs.
3. Use of scientific calculator.
4. View video selections.
5. Use of laser disc technology.
6. Use an overhead projector with transparencies.
7. A classroom website created by the teacher for students to reference at home for homework listings, student tutorials, and links to other websites that support and reinforce the curriculum.
8. Use of laboratory equipment.

ASSESSSMENT TECHNIQUES

1. Students will take free-response performance tests.
2. Students will participate in classroom discussions and demonstrate problem solving on the chalkboard, overhead projector, and homework/seatwork assignments.
3. Students will work in cooperative situations and report their results both orally and in written form.
4. Students will exercise critical thinking and organizational skills through inquiry and experimentation based laboratory activities.
5. Use of rubrics to assess laboratory investigations.