

**College Preparatory Chemistry**  
**2005**

**COURSE DESCRIPTION:** (The course description sets the parameters, scope and sequence for the course:

**I. SAFETY**

A. Laboratory Safety

1. Predict what could occur in various laboratory situations.
2. Apply laboratory safety rules to laboratory situations throughout the year.

B. Laboratory Precautions

1. Plan a course of action for an emergency in the laboratory.
2. Demonstrate consistently the safe use of laboratory equipment.

**II. SCIENTIFIC METHOD**

A. Scientific Method

1. Identify the steps in the Scientific Method.
2. Utilize the scientific method in laboratory experiments

**III. MEASUREMENT AND UNCERTAINTY IN MEASUREMENTS**

A. Metric Units

1. Identify the SI units of measurement.
2. Recognize the need for a unified system of measurement.

B. Significant Figures

1. Identify if a number is significant or non-significant according to the rules.
2. Apply the rules of significant digits to problem solving.

C. Scientific Notation

1. Convert numbers between scientific notation and standard form.
2. Demonstrate the ability to use a calculator to perform scientific notation operations.

D. Dimensional Analysis

1. Explain how dimensional analysis and conversion factors are used to solve problems.
2. Demonstrate the ability to complete lengthy conversions.

**IV. MATTER**

A. Measuring Matter

1. Demonstrate the proper use of scientific equipment.

2. Exhibit the ability to read the correct number of significant figures on a piece of scientific equipment.
- B. Physical and Chemical Properties
  1. Distinguish between physical and chemical properties.
  2. Recognize and describe the various phases of matter.
- C. Physical and Chemical Changes
  1. Describe the difference between a physical and chemical change.
  2. Recognize physical and chemical changes.
- D. Classifying Matter
  1. Define element, compound, solution, and mixture.
  2. Compare and contrast different forms of matter.
- E. Determine Density
  1. Determine density using measured means.
  2. Determine density using water displacement.
  3. Determine density using geometric formulas.

## V. ENERGY

- A. Energy
  1. Define energy
  2. Identify and distinguish among different forms of energy.
  3. Define Law of Conservation of Energy
- B. Temperature
  1. Demonstrate the ability to properly use and read a thermometer.
  2. Exhibit an ability to convert between the temperature scales.
- C. Heat in Chemical Reactions
  1. Define exothermic reaction, endothermic reaction, enthalpy, heat capacity and calorimetry.
  2. Describe enthalpy change.
  3. Calculate enthalpy changes using Hess's Law.
  4. Determine heat loss and gain using calorimetry.

## VI. ATOMIC THEORY

- A. Early Models of the Atom
  1. Discuss the various scientists and their contributions to modern atomic theory.
  2. Discuss and describe the experiments which contributed to the modern atomic theory.
- B. Modern Atomic Theory
  1. Describe the subatomic particles and their functions in an atom.
  2. Determine the number of subatomic particles in an atom or ion.
  3. Identify isotopes, and describe their uniqueness and uses.
  4. Calculate atomic mass.

5. Compare stability and changes in an atom's nucleus.

## VII. ELECTRON ARRANGEMENT

### A. Electromagnetic Radiation

1. Describe the parts of a wave.
2. Solve problems using frequency, wavelength, and the speed of light.
3. Discuss the electromagnetic spectrum, relating energy to frequency.
4. Identify elements using bright line spectra.
3. Classify the probability of the location of an electron based upon the four quantum numbers.

### B. Quantum Theory

1. Discuss Planck's experiment.
2. Solve problems using energy, Planck's Constant and frequency.

### C. Electron Configurations

1. Define the Aufbau Principle, the Pauli Exclusion Principle and Hund's Rule.
2. Apply the Aufbau Principle, the Pauli Exclusion Principle and Hund's Rule to writing electron configurations and orbital notations.

## VIII. THE PERIODIC TABLE

### A. Development of the Periodic Table

1. Discuss the contributions of major scientists involved in creating the Modern Periodic Table.

2. State the Periodic Law.

### B. The Periodic Table as a Tool

1. Define and compare several periodic properties.
2. Identify the four main blocks of the Periodic Table.

### C. Periodic Trends

1. Identify four important periodic trends.
2. Explain how each trend reflects the electron configuration of the elements.

### D. Groups of the Periodic Table

1. Compare and contrast characteristics of the major groups.
2. Identify examples in each major group.

### E. Periods of the Periodic Table

1. Recognize that the period in which an element resides is equal to the Principle Quantum Number of the outer shell electrons.

2. Relate each period to the number of sublevels present per energy level.

## IX. CHEMICAL BONDING

### A. Ionic Bonding

1. Describe the characteristics of an ionic bond.
2. State and apply the octet rule.
3. Describe the types of ions and how they bond.
4. Formulate Lewis Dot structures.

### B. Covalent Bonding

1. Describe the characteristics of a covalent bond.
2. Discuss multiple bonds.
3. Discuss properties of covalent bonds.

### C. Molecular Shapes

1. Identify the most common shapes of molecules.
2. Compare the shapes of linear and angular molecules to the properties exhibited by each shape.

## X. CHEMICAL NOMENCLATURE

### A. Formula Writing

1. Apply oxidation numbers to elements.
2. Determine molecular and ionic formulas.

### B. Nomenclature

1. Write names for ionic compounds, molecular compounds and acids.
2. Utilize compound names to determine proper formulas of compounds.

## XI. CHEMICAL REACTIONS

### A. Chemical Reactions

1. Describe what occurs in each type of chemical reaction.
2. Classify chemical reactions into four main types.

### B. Chemical Equations

1. Write proper chemical equations.
2. Balance chemical equations by inserting proper coefficients.

## XII. STOICHIOMETRY

### A. The Mole

1. Define the mole.
2. Apply Avogadro's Principle.
3. Calculate molar mass.

### B. Mole Problems

1. Define percent composition, empirical formula, and molecular

- formula.
  - 2. Calculate the percent composition of a certain formula.
  - 3. Determine empirical formulas based upon percent composition.
  - 4. Calculate molecular formulas.
  - 5. Convert among the numbers of particles, moles and mass of substances.
- C. Stoichiometry
- 1. Define stoichiometry and describe its importance.
  - 2. Relate stoichiometry to balanced chemical equations.
  - 3. Solve several different types of stoichiometry problems.
- D. Limiting Reactants
- 1. Determine the limiting reactant of a chemical reaction.
  - 2. Calculate the amount of products formed in a chemical reaction when reactants are present in excess.

### **XIII. THE GAS LAWS**

- A. Gas Behavior
- 1. Describe the kinetic-molecular theory.
  - 2. Explain how the kinetic molecular theory accounts for gas behavior.
- B. Measuring Gases
- 1. Explain what gas pressure means and describe how it is measured.
  - 2. Relate pressure to kinetic molecular theory.
- C. Gas Law Problems
- 1. State Boyle's Law, Charles' Law, the Combined Gas Law, and the Ideal Gas Law.
  - 2. Apply the Gas Laws to problems.
  - 3. Discuss the significance of the Ideal Gas Equation.
  - 4. Compare and contrast ideal and real gases.
  - 5. Relate gas density to temperature and molar mass.

### **XIV. SOLUTIONS**

- A. Solutions
- 1. Distinguish between solutes and solvents.
  - 2. Describe the properties of solutions.
  - 3. Identify different types of solutions and give examples of each.
- B. Concentration
- 1. Measure concentrations of solutions.
  - 2. Calculate concentrations of solutions.
  - 3. Distinguish among percent concentration by mass, percent concentration by volume, and molarity.
- C. Solubility
- 1. Define solubility and describe the factors that affect solubility.

2. Utilize and interpret graphs of solubility curves.

#### CORE CURRICULUM CONTENT STANDARDS:

Standard 5.1 (Scientific Processes) all students will develop problem-solving, decision-making and inquiry skills, reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating results.

Standard 5.2 (Science and Society) all students will develop an understanding of how people of various cultures have contributed to the advancement of science and technology, and how major discoveries and events have advanced science and technology.

Standard 5.3 (Mathematical Applications) all students will integrate mathematics as a tool for problem-solving in science, and as a means of expressing and/or modeling scientific theories.

Standard 5.4 (Nature and Process of Technology) all students will understand the interrelationships between science and technology and develop a conceptual understanding of the nature and process of technology.

Standard 5.6 (Chemistry) all students will gain an understanding of the structure and behavior of matter.

Standard 5.7 (Physics) all students will gain an understanding of natural laws as they apply to motion, forces, and energy transformations.

Standard 5.10 (Environmental Studies) all students will develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena.

#### CUMULATIVE PROGRESS INDICATORS:

##### Standard 5.1

##### A. Habits of Mind

1. When making decisions, evaluate conclusions, weigh evidence, and recognize that arguments may not have equal merit.
2. Assess the risks and benefits associated with alternative solutions.
3. Engage in collaboration, peer review, and accurate reporting of findings.
4. Explore cases that demonstrate the interdisciplinary nature of the scientific enterprise.

## **B. Inquiry and Problem Solving**

1. Select and use appropriate instrumentation to design and conduct investigations.
2. Show that experimental results can lead to new questions and further investigations.

## **C. Safety**

1. Understand, evaluate and practice safe procedures for conducting science investigations.

## **Standard 5.2**

### **A. Cultural Contributions**

1. Recognize the role of the scientific community in responding to changing social and political conditions and how scientific and technological achievement effect historical events.

### **B. Historical Perspectives**

1. Examine the lives and contributions of important scientists who effected major breakthroughs in our understanding of the natural and designed world.
2. Discuss significant technological achievements in which science has played an important part as well as technological advances that have contributed directly to the advancement of scientific knowledge.
3. Describe the historical origin of important scientific developments such as atomic theory, genetics, plate tectonics, etc., showing how scientific theories develop, are tested, and can be replaced or modified in light of new information and improved investigative techniques.

## **Standard 5.3**

### **A. Numerical Operations**

1. Reinforce indicators from previous grade level.

### **B. Geometry and Measurement**

1. When performing mathematical operations with measured quantities, express answers to reflect the degree of precision and accuracy of the input data.

### **C. Patterns and Algebra**

1. Apply mathematical models that describe physical phenomena to predict real world events.

### **D. Data Analysis and Probability**

1. Construct and interpret graphs of data to represent inverse and non-linear relationships, and statistical distributions.

## **Standard 5.4**

### **A. Science and Technology**

1. Know that scientific inquiry is driven by the desire to understand the natural world and seeks to answer questions that may or may not directly influence humans, while technology is driven by the need to meet human needs and solve human problems.

### **B. Nature of Technology**

1. Assess the impacts of introducing a new technology in terms of alternative solutions, costs, tradeoffs, risks, benefits and environmental impact.

## **Standard 5.6**

### **A. Structure and Properties of Matter**

1. Know that atoms are made of a positive nucleus surrounded by negative electrons and that the nucleus, a tiny fraction of the volume of an atom, is composed of protons and neutrons, each almost 2,000 times more massive than an electron.
2. Know that the number of protons in the nucleus defines the element.
3. Know that an atom's electron arrangement, particularly the outermost electrons, determines how the atom can interact with other atoms.
4. Explain that atoms form bonds (ionic and covalent) with other atoms by transferring or sharing electrons.
5. Explain how the Periodic Table of Elements reflects the relationship between the properties of elements and their atomic structure.
6. Know that many biological, chemical and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.
7. Recognize that the properties of matter are related to the structure and arrangement of their molecules and atoms, such as in metallic and nonmetallic crystals and carbon compounds.
8. Know that different levels of energy of an atom are associated with different configurations of its electrons.

### **B. Chemical Reactions**

1. Explain that the rate of reactions among atoms and molecules depends on how often they encounter one another and that the rate is affected by nature of reactants, concentration, pressure, temperature, and the presence of a catalyst.
2. Show that some changes in chemical bonds require a net input or net release of energy.

## **Standard 5.7**

### **A. Motion and Forces**

4. Recognize that electrically charged bodies can attract or repel each other with a force that depends upon the size and nature of the charges and the distance between them and know that electric forces play an important role in explaining the structure and properties of matter.
5. Know that there are strong forces that hold the nucleus of an atom together and that significant amounts of energy can be released in nuclear reactions (fission, fusion, and nuclear decay) when these binding forces are disrupted.

#### **B. Energy Transformations**

1. Explain how the various forms of energy (heat, electricity, sound, light) move through materials and identify the factors that affect that movement.
2. Explain that while energy can be transformed from one form to another, the total energy of a closed system is constant.
3. Recognize that whenever mechanical energy is transformed, some heat is dissipated and is therefore unavailable for use.
4. Explain the nature of electromagnetic radiation and compare the components of the electromagnetic spectrum from radio waves to gamma rays.

#### **Standard 5.10**

##### **B. Human Interactions and Impact**

1. Assess the impact of human activities on the cycling of matter and the flow of energy through ecosystems.
2. Use scientific, economic, and other data to assess environmental risks and benefits associated with societal activity

**SUGGESTED ACTIVITIES THAT ADDRESS THESE STANDARDS MAY INCLUDE BUT ARE NOT LIMITED TO:**

**Standard 5.1**

Cookie Scientific Method Lab  
Ancient Measurement Lab  
Safety Contract

**Standard 5.2**

Police Demonstration of Kevlar  
Lecture Notes on the History of the Atom  
Comparison of Road Salts (Freezing Point Depression)

**Standard 5.3**

Pancake Conversion Lab  
Specific Heat of Sand Laboratory  
Density Lab

**Standard 5.4**

Lecture notes on Gas Laws and Automotive Brakes  
Lecture notes on History of the atom and the atomic bomb  
Video Top Ten Speed Machines of all Time

**Standard 5.6**

Chemical Reaction Packet  
Stoichiometry Unit  
Lab Single and Double Replacements

**Standard 5.7**

Lab on Endothermic and Exothermic Reactions  
Demonstration of Kinetic and Potential Energy  
Lab on Cold Packs

**Standard 5.10**

Decomposition and Synthesis Reaction Packet  
Lecture notes on Solutions discussing nitrates dissolved in Lake Hopatcong

**INSTRUCTIONAL STRATEGIES:**

Direct Instruction  
Cooperative Learning  
Team Learning  
Reciprocal Style Learning

## Constructivist Learning

### **EVALUATION/ASSESSMENT OF STUDENTS:**

Laboratory Reports  
Quizzes  
Homework assignments  
Tests

### **EVALUATION/ASSESSMENT OF CURRICULUM:**

This course of study will be evaluated/assessed by instructional staff during the first year of implementation for the purpose of necessary revision at the end of the first year. In addition, this course of study will be reviewed according to the Five-Year Curriculum Review schedule (see attached).

### **RESOURCES/BIBLIOGRAPHY:**

Course Book:

Chemistry: The Study of Matter 4<sup>th</sup> ed. Henry Dorin, Peter Demmin,  
and Dorothy Gabel, Prentice Hall, 1992, ISBN 0-13-127341-8

Teacher Supplements:

Introductory Chemistry, A Foundation 3<sup>rd</sup> ed. Steven Zumdahl,  
D.C. Heath, 1996, ISBN 0669-39954-X

Chemistry. Antony Wilbraham, Dennis Staley, Edward Waterman,  
and Michael Matta, Prentice Hall, 2005,  
ISBN0-13-115262-9

Chemistry: Visualizing Matter. Salvatore Tocci and Claudia Vieland,  
Holt, Rinehart and Winston, 1996, ISBN 0-03-000193-5

Prentice Hall Chemistry: Laboratory Manual 3<sup>rd</sup> ed. Prentice Hall,  
2004, ISBN 0-13-191363-2

Chemistry: Connections to Our Changing World, Laboratory Manual.  
Prentice Hall, 2000, ISBN 0-13-436222-5