

Chemistry Honors

Brief Course Description

The Chemistry Advanced class is a junior-level, honors course developed to challenge the top math and science students at our school. The course is designed to cover the concepts of a general chemistry course usually taken during the first college year. The course is highly quantitative with an emphasis on chemical calculations and the mathematical formulation of principle and is focused around a substantial project-based laboratory component. Laboratory work will allow the students to apply formulas, analyze data and express their results in both written lab reports and formal technical presentations. Laboratory investigations incorporate the use of computers in gathering and analyzing data. Proper laboratory techniques will be stressed.

Pre-Requisites

B+ or better in Biology Honors
B+ or better in Algebra Honors
B+ or better in Geometry Honors

Co-Requisites

Concurrent enrollment in an honors math course (Algebra 2 Trigonometry Honors, Trigonometry/Pre-calculus or Calculus)

Textbook

Title: Foundations of College Chemistry
Edition: Twelfth Edition
Publication Date: 2007
Publisher: John Wiley & Sons
Author(s): Morris Hein and Susan Arena
URL Resource: www.wiley.com/college/hein
Usage:
 Primary Text
 Read in entirety or near entirety

Supplemental Instructional Materials

Chemistry, by Steven Zumdahl and Susan Zumdahl, Seventh Edition, Houghton Mifflin Company, 2001. ISBN 0-618-71370-0

Study Guide for Hein and Arena's Foundations of College Chemistry, by Peter Scott and Rachael Henriquez Porter, Twelfth Edition, John Wiley & Sons, 2007. ISBN 0-470-06716-0

Lab Manuals:

Foundations of Chemistry in the Laboratory, By Morris Hein, Judith N. Peisen, Leo R. Best and Robert L. Miner, Twelfth Edition, John Wiley and Sons, Inc. 2007. ISBN 0-470-04385-7

Guided Inquiry Experiments for General Chemistry: Practical Problems and Applications, by Nancy Konigsberg Kerner and Ram Lamba, First Edition, John Wiley and Sons, 2008. ISBN 978-0-471-69842-5

Chemistry with Computers, Chemistry Experiments Using Vernier Sensors, by Dan Holmquist and Donald Volz, Third Edition, Vernier Software and Technology, 2003. ISBN 1-929075-27-8

Additional Resources:

Experiments from the California Institute of Technology Center for Chemical Innovation Teacher workshop, held at Cal Tech on May 2011, and founded by the National Science Foundation, Cal Tech Solar Army, www.ccsolar.caltech.edu

Also websites, online animations and publications that further enhance student learning.

Course Purpose

The course will present chemistry as a highly organized body of knowledge held together by unifying principles that clarify the world around them. The course will provide maximum opportunity for students to learn through demonstrations and laboratory experiences, enabling students to make observations, analyze data and facts and form logical conclusions. Students should leave the course having an understanding and appreciation of how chemistry affects their daily lives. Students in chemistry honors will be expected to advance beyond the basic delineation of principles to examine concepts and applications of greater depth and complexity.

Chemistry honors will contribute to the development of the students' abilities to solve problems, work effectively in both independent and cooperative settings, think clearly,

and to express their ideas orally and in writing, with clarity and logic. Students enrolled in chemistry honors are required to write formal lab reports, complete a science fair project and participate in the Ventura County Science Fair. Although the concepts and labs that form the foundation of this course are included in the College Board's AP Chemistry curriculum, the goal of this class is not to prepare students to take the AP chemistry exam, but to give the students the opportunity to do advanced work in chemistry. The problem solving strategies obtained in this course will prepare college bound students majoring in the sciences, engineering, medicine and other technical areas.

Course Outline

Saint Bonaventure has a modified block schedule with classes meeting three times a week for fifty minutes and once a week for ninety-five minutes. Students will be participating in hands-on lab experiences once a week during the ninety-five minute schedule.

Students enrolled in chemistry advanced will be required to complete summer assignments. Summer work, primarily a review of certain topics covered in junior high physical science, must be completed by each student and will be collected the first day of school. The summer work is the study guide for chapters one and three. Students will be tested on chapters one and three on the first day of school.

Summer Assignment Student Learning Outcomes:

Chapter 1: An Introduction of Chemistry

1. Definition of Chemistry

- Understand the definition and nature of chemistry in explaining the world we live in
- Analyze the relationship between chemistry, biology and physics
- Think like a chemist and use the scientific method in making predictions and testing those predictions

2. States of Matter

- Compare and contrast the states of matter
- Classify matter, pure substances and mixtures, elements and compounds, homogeneous and heterogeneous

Chapter 3: Elements and Compounds

1. Elements

- Understand the history behind the names and symbols of the elements
- Use the periodic table to find information of an element
- Know the characteristics of metals, nonmetals and metalloids

2. Compounds

- Identify the diatomic molecules and interpret chemical formulas

First Semester Syllabus and Student Learning Outcomes

Chapter 2: Standards for Measurement

1. Significant Figures and Precision and Accuracy

- Understand the difference between precision and accuracy of a measurement and use significant figures in mathematical operations

2. SI Prefixes and the Metric System

- Use SI units, conversion factors and dimensional analysis in solving length, mass or volume problems

3. Temperature Conversions

- Compare the three temperature scales Celsius, Kelvin and Fahrenheit and perform temperature conversions using their respective formulas

4. Density

- Use the density formula to analyze the relationship between mass and volume of a substance, graph density and relate to slope of a line

Chapter 4: Properties of Matter and Thermodynamics

1. Characteristics of Substances

- Identify the properties of substances and distinguish between physical property, chemical property and physical change, chemical change

2. Energy

- Understand the relationship between potential and kinetic energy and energy in chemical changes: exothermic and endothermic reactions and conservation of energy

3. Heat: Quantitative Measurement

- Perform calculations involving specific heat of a substance and understand everyday application of the specific heat of metals
- Draw label and perform associated calculations for heating curves

4. Calorimetry

- Discuss how a calorimeter is used and perform related calculations

Chapter 5: Atomic Theory and Structure

1. Early History of Chemistry

- Know the contributions of Empedocles, Democritus and Aristotle

2. Dalton's Atomic Theory

- Evaluate John Dalton's model of the atom in terms of later discoveries including research of Michael Faraday, Svante Arrhenius, Sir William Crooke, J.J. Thompson and James Chadwick

3. Rutherford's Gold Foil Experiment

- Interpret Ernest Rutherford's experiment

4. Conservation of Mass and Laws of Definite and Multiple Proportions

- Define and apply the law of conservation of mass, law of definite proportion and law of multiple proportions

5. Subatomic Parts of the Atom

- Describe the current atomic model, compare the subatomic parts of the atom, explain how ions are formed, and use the periodic table to find atomic number, mass number, protons, neutrons and electron.

Isotopes

- Understand isotopes, isotope notation and determining the average atomic mass of isotopes.

Chapter 6: Nomenclature and Formulas of Inorganic Compounds

1. Naming Compounds

- Compare common and systematic naming system developed by the International Union of Pure and Applied Chemistry (IUPAC)

2. Binary Compounds

- Name and write formulas of binary compounds, binary ionic compounds containing a metal forming only one type of cation, binary ionic compounds containing a metal that can form two or more types of ions (understanding of stock and classical naming) and binary compounds containing two nonmetals.

3. Compounds Containing Polyatomic Ions

- Name and write formulas of compounds containing polyatomic ions and hydrates

4. Acids

- Name and write formulas of acids derived from binary compounds and polyatomic ions

Chapter 8: Chemical Equations

1. Writing and Balancing Chemical Equations

- Analyze the connection between the Law of Conservation of Mass and the purpose of balancing equations
- Apply the appropriate symbols when writing and balancing chemical equations and interpret the information in a chemical equation

2. Types of Chemical Reactions

- Complete and balance equations involving the four basic types of reactions; combination, decomposition, single displacement and double displacement and predict if a precipitate will occur
- Use the activity series of metals and a solubility table to determine if a reaction will occur

3. Heat in Chemical Reactions

- Determine if a reaction is exothermic and endothermic; understand activation energy and the effect of a catalyst, interpret potential energy diagrams for endothermic and exothermic reactions

Chapter 7: Quantitative Composition of Compounds

1. Molar Mass

- Use the periodic table to determine the molar mass of a compound

2. Avogadro's Number and the Mole

- Use dimensional analysis, Avogadro's number and molar mass to find the number of moles, mass and amount of atoms or molecules

3. Percent Composition of Compounds

- Determine the percent composition of a compound and the empirical or molecular formula of a compound

4. Empirical and Molecular Formula

- Calculate the empirical and molecular formula of a compound

Chapter 9: Calculations from Chemical Equations

1. Stoichiometry

- Write and balance chemical equations and use the coefficients to write mole ratios
- Evaluate the quantitative relationship between reactants and products by performing stoichiometry calculations

2. Limiting Reactant and Percent Yield

- Determining the limiting and excess reactant and percent yield

Chapter 10: Quantum Mechanics, Electron Structure and the Periodic Table

1. Quantum Mechanics

- Understand that light is a form of electromagnetic radiation and define wavelength, frequency speed, line spectrum, photons, quanta and the discoveries of Niels Bohr
- Identify characteristics of and perform calculations with frequency and wavelength

2. Energy Levels of Electrons

- Identify the four quantum numbers for an electron in an atom
- Determine the electron configuration, orbital diagram, valence electrons and abbreviation of an element

3. Electron Structure and the Periodic Table

- Use the periodic table to determine the energy level, sublevel, electron configuration, valence electrons and Lewis dot structure of an element

- Use the periodic table to analyze periodic trend in the properties of the elements; atomic radius, ionization energy and electronegativity

4. Periodic Trends in Atomic Properties

- Use the periodic table to analyze patterns in atomic radii, ionization energies and electronegativity

Chapter 11: Chemical Bonding

1. Ionic and Covalent Bonds

- Understand why elements want to form ionic or covalent bonds and compare and contrast the two different types of chemical bonds

2. Lewis Structures of Atoms

- Use Lewis dot structures to indicate how an ionic bond is formed
- Use Lewis structures to represent single, double, triple and coordinate covalent bonds

3. Polar Covalent Bonds

- use the electronegativity table to determine if a bond is nonpolar covalent or polar covalent

4 Molecular Shapes

- Use the valence shell electron pair repulsion (VSEPR) model to determine the molecular geometry and polarity of a covalent compound

First Semester Exam Covering Chapters 1 to 11

Second Semester Syllabus and Student Learning Outcomes

Chapter 12: The Gaseous State of Matter

1. The Kinetic-Molecular Theory

- Understand the properties of gases and the kinetic-molecular theory

2. Measurement of Pressure of Gases

- E. Torricelli's invention of the mercury barometer and use dimensional analysis to convert pressure units

3. The Gas Laws

- Apply Boyle's Law, Charles' Law, Gay-Lussac's Law and combined gas laws in determining an unknown pressure, volume and temperature

4. Dalton's Law of Partial Pressure

- Apply Dalton's Law to determine partial and total pressures and volume of a gas collected over water

5. Stoichiometry Involving Gases

- Solve stoichiometry problems related to gases

6. Ideal Gas Law

- Solve problems using the ideal gas law

7. Density of a gas

- Determine the density of a gas at standard temperature and pressure (STP) and when a gas is not at STP

8. Rates of Effusion

- Perform calculations with rates of effusion to find the molar mass

Chapter 13: Properties of Liquids

1. What is a Liquid?

- Understand the terms evaporation, vapor pressure, surface tension, normal boiling point, melting point

2. Hydrogen Bonding

- Draw representations of hydrogen bonding

3. Changes of State

- Draw and label a heating curve graph
- List the unique properties of water, classify water pollutants and explain water purification processes

4. Reactions Involving Water

- Complete and balance equations for reactions of water and for the formation of water

Chapter 14: Solutions

1. Properties of Solutions and Solubility

- Understand the general properties of solutions and give examples of solutes and solvents and the factors related to solubility, distinguish between soluble, insoluble, miscible and immiscible
- Apply the terms saturated, unsaturated and supersaturated when using a solubility curve
- Discuss the effects of temperature, pressure and structure on solubility

2. Concentration of Solutions

- Solve calculations to find the concentration of a solution using the formulas for; mass percent, volume percent, molarity, molality, the mole fraction and the dilution formula

3. Colligative Properties

- Use the colligative properties of solutions to determine the molar mass, freezing point depression and boiling point elevation

4. Raoulet's Law

- Use the relationship between vapor pressure of the solution and solvent and the mole fraction to solve problems using Raoulet's Law

Chapter 15: Acids, Bases and Salts

1. Acid-Base Theories

- Compare and contrast the definitions of an acid and a base as proposed by Svante Arrhenius, J.N. Bronsted with T.M. Lowry and Gilbert Lewis

2. Conjugate Acid-Base Pair

- Identify conjugate acids and conjugate bases

3. Electrolytes and Nonelectrolytes

- Distinguish between electrolytes and nonelectrolytes and strong and weak electrolytes

4. pH, pOH and the Ionization of Water

- Calculate the pH and pOH of a solution and understand use of indicators
- Understand how a buffer solution works and apply to maintenance of pH in the human body

5. Ionization Constants, K_a and K_w

- Determine the acid ionization constant, K_a and ion product constant K_w for water

6. Reactions of Acids and Bases

- Complete and balance equations for reactions involving acids and bases and determine the resulting pH of the product

7. Net Ionic Equations

- Write total ionic and net ionic equations

8. Titration

- Determine concentration of an acid or base and be familiar with titration curves and identify the end-point

9. Buffer Solutions

- Identify the components of a buffer and perform calculations involving the preparation of a buffer and the addition of strong acid or strong base to a buffer

Chapter 16: Chemical Equilibrium and Thermodynamics

1. Chemical Kinetics

- Describe what is meant by a reaction mechanism, a rate-determining step, an activated complex and activation energy
- Determine the activation energy using Arrhenius equation

2. Le Chatelier's Principle

- Predict the changes of concentration, volume or temperature of a system at equilibrium using Le Chatelier's principle

3. Equilibrium Constants, K_{eq} and K_{sp}

- Write equilibrium constant expressions and solve equations to determine the equilibrium constant (K_{eq}) and the solubility product constant (K_{sp})
- Write balanced equations for the dissociation of a salt

4. Thermodynamics

- Interpret the significance of changes in enthalpy in chemical or physical changes
- Use Hess's law for calculations related to heats of reaction and heats of formation
- Determine the relationship of change in free energy to equilibrium constants and electrode potentials

Chapter 17: Electrochemistry and Oxidation Reduction

1. Oxidation and Reduction

- Assign oxidation numbers, determine the element reduced and oxidized, write balanced half reactions
- Balance oxidation-reduction equations
- Determine the strength of oxidizing agents and reducing agents
- Predict reaction products by using standard reduction potentials and the activity series produced in the single displacement experiment

2. Ionic Redox Equations

- Balance ionic reduction equations

3. Electrochemical Cells

- Describe the operation of a voltaic cell and galvanic cell
- Predict reaction products by using standard reduction potentials and the activity series produced in the single displacement experiment
- Calculate the cell potential for a galvanic and an electrolytic cell
- Use Nernst equation to calculate the cell potential under nonstandard condition

Chapter 18: Nuclear Chemistry

1. Discovery of Radioactivity

- Explain the discover of radioactivity and the contributions of Wilhelm Roentgen, Antoine Becquerel, Marie Curie and Ernest Rutherford

2. Radioactive Decay

- Distinguish between alpha particles, beta particles and gamma rays
- Write nuclear equations for alpha and beta decay
- Determine the amount of a substance remaining after a number of half-lives
- Use a graph to predict the type of decay that will occur

3. Nuclear Power

- Compare three types of particle accelerators
- Distinguish between nuclear fission and nuclear fusion

Chapter 19: Introduction to Organic Chemistry

1. The Carbon atom and Hydrocarbons

- State general properties and describe reactions of organic compounds
- Describe bonding between atoms in the molecules of organic compounds and isomers

2. Nomenclature and structure of Organic Compounds

- Compare the formulas of hydrocarbons and apply the IUPAC naming system
- State the names, structural formulas and uses for member of several types of hydrocarbon derivatives, alkyl group, alcohols, esthers and ketones

Chapter 20: Introduction to Biochemistry

1. Chemistry of Living Organisms

- Give molecular structures and uses of some examples of each of four classes of biochemical compounds
- Describe polymerization
- Describe hydrolysis reactions
- Describe energy changes and the role of enzymes in biochemical reactions

Second Semester Exam Covering Chapters 1-20

Experiments:

Laboratory Techniques and Measurements – Students will learn the laboratory techniques of evaporation and filtration by evaporating a solution of sodium chloride and filtering a solution of lead nitrate and sodium iodide. Students will also practice the techniques for measuring mass, volume and length, apply the rules of significant figures and distinguish between precision and accuracy. Experience will be gained in the techniques of handling laboratory materials and equipment.

Density Determination – Students will learn and practice techniques and calculations for determining volume and density. The identities of an unknown solid and liquid will be determined by calculating their densities.

Heat of Fusion of Ice – This is the first experiment students will perform using the Vernier computer interface and temperature probe. Students will become familiar with the Vernier program and analyze the graph produced to determine their percent error. Students will explain any sources of error. Students will determine the energy required, in Joules, to melt one gram of ice and determine the molar heat of fusion for ice in kJ/mol

Conservation of Mass – Students will determine experimentally whether mass is conserved during a chemical reaction. The masses of sodium carbonate, calcium chloride and sulfuric acid will be taken before and after mixing. The names and formulas of the reactants and products will be discussed as groundwork for the next topic, nomenclature and writing formulas.

Penny Isotope- Students will mathematically determine the number of pre-1982 and post-1982 pennies in their sealed container and the percent abundance of each "penny isotope" in their sample.

Composition of Hydrates –Students will name and write formulas for hydrates and determine the percentage of water in an unknown hydrate. The data will be used to calculate the formula of the unknown hydrate and the experimental error. Students will explain how their results support the law of definite composition

Preparation and Properties of Oxygen – Students will investigate some of the properties of oxygen. Hydrogen peroxide will be decomposed to generate oxygen. Students will become familiar with the use of a catalyst and the equipment and procedure for collecting a gas by downward displacement of water. Students will learn the difference between a combustible material and oxygen which supports combustion. Students will be able to recognize formulas of oxides

Single Displacement Reactions – Students will perform six single displacement reactions and record the evidence of reaction. Balanced chemical equations will be written for reactions that produced a product. Students will use their observations to produce an activity series and predict when there will be no reaction

Double Displacement Reactions – Students will perform twelve double displacement reactions and record the evidence of reaction. Balanced chemical equations will be written for reactions that produce a product. Students will use a solubility table to predict whether a double displacement reaction will occur

Composition of Potassium Chlorate – Students will decompose potassium chlorate and perform calculations use experimental masses and the molar mass to determine the experimental and theoretical percent composition. Percent error will be calculated and students will explain any sources of error. Students will also do a qualitative examination of their product.

Stoichiometry and Mass-Mass Relationships in Chemical Reactions – Students will compare the theoretical mass of one of the products of a double displacement reaction with the experimentally determined mass of the same product. Students will determine the limiting and excess reactants and the percent yield of both products.

Flame Tests - Students will observe the characteristic colors produced by metallic ions when solutions containing the ion are heated in a flame. Students will identify unknown metallic ions by means of its flame test

Electromagnetic Energy and Spectroscopy – Students will learn to use a spectrophotometer and determine the wavelengths associated with specific spectral lines of nickel (II) nitrate and potassium permanganate. Students will use a computer to graph the transmittance vs. wavelength data

Bonds, Polarity and Solubility – Students will relate solubility of various combinations substances to their shape and molecular polarities

Lewis Structures and Molecular Models - Students will construct three dimensional models of covalent compounds and draw the corresponding Lewis structure. Students will then determine the molecular geometry, bond angles and polarity

Boyle's Law– Students will use the Vernier gas pressure sensor to measure the pressure of an air sample at several different volumes and prove Boyle's Law, $P_1V_1 = P_2V_2$

Charles' Law – Students will heat a set volume of air and using temperature and volume measurements prove Charles' Law, $V_1/T_1 = V_2/T_2$

Surface Tension and Volatility – Students will compare the surface tension, volatility and solubility of polar and non-polar substances and relate their findings to the type of chemical bond in each substance

Solubility of a Salt– Students will dissolve different amounts of potassium chlorate at different temperatures and graph their data to produce a solubility curve for potassium chlorate

Properties of Acids, Bases and Salts – Students will observe and study properties and reactions of acids, bases and salts.

Acid-Base Titration – Students will use the Vernier pH sensor to monitor changes in pH as sodium hydroxide solution is added to a hydrochloric solution. The computer will plot the students' data on a graph which students will interpret to determine the equivalence point of titration and then calculate the concentration of the hydrochloric acid solution

Chemical Equilibrium and Reversible Reactions – Students will perform six reversible reactions, study the equilibrium systems and their responses to stress as described by Le Chatelier's principle

Solubility Product Constant – Students will determine experimentally the solubility product constant for lead (II) nitrate, a slightly soluble salt and graph their data to produce a solubility curve

Both experiments conducted during chapter 17, Electrochemistry and Oxidation-Reduction, are from the California Institute of Technology Center for Chemical Innovation Teacher workshop, held at Cal Tech May 2011

Electrochemistry - Galvanic Cells – Students will build simple galvanic cells and measure cell potential and describe, write, and balance anode and cathode half reactions. Interpret the activity series in terms of elements that are more or less easily oxidized and relate cell potential to the activity series.

Making a Dye-Sensitized TiO₂ Solar Cell (DSSC) – Students will be able to conduct an experiment that reflects current research that is occurring at Cal Tech and other universities around the world that are part of the Solar Army,
www.ccisolar.caltech.edu

The objectives as stated by the Center for Chemical Innovation:

Students will be able to:

- Learn how a DSSC works
- Understand why high surface area TiO_2 is vital to the successful operation of the DSSC
- Understand why sensitizer molecules are needed for successful operation of the DSSC
- Understand why I^-/I_3^- are needed
- Prepare a DSSC using crushed blackberries to serve as the source of sensitizer molecules

Determining Half-life –Students will simulate nuclear decay to determine half-life of radioactive isotopes

Alcohols, Esters, Aldehydes and Ketones –Students will examine some of the properties and characteristic reactions of four classes of organic compounds

Key Assignments and Writing Projects

In addition to traditional assessments; homework, quizzes, and tests, students will be required to write formal lab reports for all experiments. The typed formal lab report must include a title page, abstract, introduction stating the purpose and theory pertaining to the experiment, materials and methods, experimental procedure, results and calculations, and discussion section. The discussion section must compare expected results with actual results, analyze experimental error, explain how methods could be improved and explain the results in terms of the purpose and course content.

All students in chemistry advanced will participate in the Ventura County science fair. Students must follow the scientific method in developing their project, including a minimum of four typed pages of research related to the topic. The final report, due the first semester, will include a title page and table of contents, research, materials and procedure, results, discussion, conclusions, acknowledgements and a bibliography. Students are required to keep a data notebook while developing and conducting their experiment. The notebook must contain detailed notes and accurate quantitative data with the units and dates of the data.

During the second semester, students will write an abstract of their science fair project in preparation for peer review. The abstracts will be posted on the class blog and each student must read and comment on three of their classmates' abstracts. The students must respond to the posted comments. Students will present their projects orally to the class. In addition to the visual presentation there must be a power point presentation.

Instructional Methods

Instructional methods used comprise:

Lecture using power point and/or smart board
Laboratory experience and demonstrations
Inquiry based activities
Cooperative learning experiences
Discussions and oral presentations

Assessment Methods and/or Tools

Student achievement is assessed formatively by daily homework quizzes, class discussions and observing students' ability to apply concepts learned when solving problems, performing experiments, writing formal lab reports and understanding demonstrations. Summative assessment will include chapter tests, a semester exam in December and a final exam in June. The semester exam will include only the topics learned the first semester and the final exam will assess the student on the content learned during both first and second semester.

Differences in Honors/Non-Honors Courses

In chemistry advanced, presentations and discussions guide most of the class time. It is very rare for students to spend an entire period listening to a lecture about a topic or skills needed. Students are assigned questions and problems several days in advance, and come to class with prepared problems to present. Through this approach, students learn how to organize the vast body of chemical reactions and descriptive chemistry into categories and formats for easy study. Suggestions are made about the best ways to learn various concepts and solve problems with, and sometimes without, calculators. Students are regularly exposed to the types of kinetics and equilibrium problem skills and concepts not included in the non-honors chemistry class. Principles of equilibrium theory as well as calculations required for gaseous and solution equilibria are emphasized. Also, at least once a week, an entire lesson is based on a demonstration performed at the beginning of the class period. During the demonstration, the rest of the class and I probe for a deeper understanding of the chemistry involved.

Student presentations count as homework grades, and a rubric is established and presented to the students early in the school year. Topics strongly emphasized during the presentations are reaction prediction, oxidizing and reducing agents, the behavior of weak and strong acids and bases, and principles of bonding.

The laboratory program consists of inquiry, computer based and college-level labs. Students spend at least one 95-minute block of time per week in the laboratory environment. Much of a qualitative analysis scheme is integrated throughout the year. Students create spreadsheets for each lab assignment, and class data is available for

discussion and statistical treatment. Lab reports are quite sophisticated, with error analysis and improvement suggestions expected in conclusions.

Chemistry advanced covers three additional chapters; nuclear chemistry, biochemistry and organic chemistry and students perform more experiments than the non-honors students. Topics are covered in more depth and there is a heavy focus on calculation-based problem solving and writing chemical equations. Students are required to write formal lab reports and conduct independent research (science fair experiment) which will be presented orally to the class and students must write a properly-annotated research paper. The final exam includes all topic covered for the year compared to the non-honors course exam which test students only on second semester. Students in advanced chemistry are required to do summer assignments.