Course No: S 769

Orange Unified School District

CHEMISTRY HONORS

Year Course

GRADE LEVEL: 10-12

PREREQUISITES: Completion of Biology with a grade of *B* or better. Completion of Algebra I and Geometry with a grade of *B* or better and concurrent enrollment in Honors Algebra II or higher math course; meet criteria for GATE. Recommended reading level at the 10th grade and above.

INTRODUCTION TO THE SUBJECT:
Honors Chemistry is a college preparatory course intended for the high ability, serious science student that meets part of the University of California and CSU laboratory science entrance requirement. Honors Chemistry prepares students for further study in chemistry, which can be accessed through the OUSD Advanced Placement Chemistry course as well as through post-secondary course work. Honors Chemistry is the study of properties that can be used to identify matter, and of techniques to measure those properties. Honors Chemistry stresses the processes of science for obtaining and analyzing information. Laboratory activities and cooperative student activities are designed to give the student first hand experiences to support the theoretical concepts and principles. Measurement is stressed and mathematics is used to process and analyze measurements in order to answer questions about matter. Honors Chemistry extends beyond the regular chemistry curriculum with regard to the amount and level of calculations in each area of chemistry. These calculations support the in-depth treatment each topic receives in laboratory work.

Core topics covered include: atomic and molecular structure, molecular bonds, chemical bonds, conservation of matter and stoichiometry, gasses and their properties, acids and bases, solutions, chemical thermodynamics, reaction rates, chemical equilibrium, organic chemistry and biochemistry, nuclear processes, and investigation and experimentation.

STUDENT OUTCOMES:
Scientific progress is made by asking meaningful questions, problem solving, and conducting careful investigations. As a basis for understanding these concepts, and to address the content standards, students will:

Demonstrate a proficient understanding of the core topics listed above.

Select and use appropriate tools and technology, to perform tests, collect data, analyze relationships, and display data to generate a detailed, in-depth analysis of the information through laboratory reports and/or papers.

When empirical data does not agree with an accepted scientific value, students will recognize the difference and account for the discrepancy.

Correctly construct tables and resulting graphs to organize data and interpret results.

Express his/her analyses and solutions for chemical problems in clear, concise English.

Provide mathematical solutions for chemical problems in an orderly, logical manner.

Demonstrate a proficiency in basic laboratory skills and techniques.

Recognize how knowledge obtained in the study of chemistry can be applied in your daily life including its relationship to other scientific disciplines and career areas.

COURSE OBJECTIVES:

BY THE END OF THE COURSE THE STUDENT WILL BE ABLE TO:

California Chemistry Content Standards

Standards without asterisks represent those that all students are expected to achieve in the course of their studies.
Standards with asterisks represent those that all students should have the opportunity to learn.

Atomic and Molecular Structure

1. The Periodic Table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept, students know:

   a. How to relate the position of an element in the Periodic Table to its atomic number and atomic mass.
   b. How to use the Periodic Table to identify metals, semimetals, nonmetals, and halogens.
   c. How to use the Periodic Table to identify alkali metals, alkaline earth metals and transition metals, and trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.
   d. How to use the Periodic Table to determine the number of electrons available for bonding.
   e. The nucleus is much smaller in size than the atom yet contains most of its mass.
   f.* How to use the Periodic Table to identify the lanthanides and actinides, and transactinide elements, and know that the transuranium elements were man made.
   g.* How to relate the position of an element in the Periodic Table to its quantum electron configuration and reactivity with other elements in the table.

h.* The experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment, and Einstein's explanation of the photoelectric effect.

i.* The experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.

j.* Spectral lines are a result of transitions of electrons between energy levels. Their frequency is related to the energy spacing between levels using Planck's relationship (E=hv).

Chemical Bonds

2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds based on electrostatic forces between electrons and protons, and between atoms and molecules. As a basis for understanding this concept, students know:

a. Atoms combine to form molecules by sharing electrons to form covalent or metallic bonds, or by exchanging electrons to form ionic bonds.

b. Chemical bonds between atoms in molecules such as H_2, CH_4, NH_3, H_2CCH_2, N_2, $C1_2$, and many large biological molecules are covalent.

c. Salt crystals such as NaC1 are repeating patterns of positive and negative ions held together by electrostatic attraction.

d. In a liquid, the inter-molecular forces are weaker than in a solid so that the molecules can move in a random pattern relative to one-another.

e. How to draw Lewis dot structures.

f.* How to predict the shape of simple molecules and their polarity from Lewis dot structures.

g.* How electronegativity and ionization energy relate to bond formation.

h.* How to identify solids and liquids held together by Van der Waals forces or hydrogen bonding, and relate these forces to volatility and boiling/melting point temperatures.

Conservation of Matter and Stoichiometry

3. The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. As a basis for understanding this concept, students know:

a. How to describe chemical reactions by writing balanced equations.

b. The quantity one mole is defined so that one mole of carbon 12 atoms has a mass of exactly 12 grams.

c. One mole equals $6.02x10^{23}$ particles (atoms or molecules).

d. How to determine molar mass of a molecule from its chemical formula and a table of atomic masses, and how to convert the mass of a molecular substance to moles, number of particles or volume of gas at standard temperature and pressure.

e. How to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products, and the relevant atomic masses.

f.* How to calculate percent yield in a chemical reaction.
g.* How to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.

Gases and Their Properties

4. The Kinetic Molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept, students know:

a. The random motion of molecules and their collisions with a surface create the observable pressure on that surface.
b. The random motion of molecules explains the diffusion of gases.
c. How to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.
d. The values and meanings of standard temperature and pressure (STP).
e. How to convert between Celsius and Kelvin temperature scales.
f. There is no temperature lower than 0 Kelvin.
g.* The kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules and atoms.
h.* How to solve problems using the ideal gas law in the form PV = nRT.
i.* How to apply Dalton's Law of Partial Pressures to describe the composition gases, and Graham's Law to describe diffusion of gases.

Acids and Bases

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept, students know:

a. The observable properties of acids, bases and salt solutions.
b. Acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.
c. Strong acids and bases fully dissociate and weak acids and bases partially dissociate.
d. How to use pH scale to characterize acid and base solutions.
e.* The Arrhenius, Bronsted-Lowry, and Lewis acid-base definitions.
f.* How to calculate pH from the hydrogen ion concentration.
g.* Buffers stabilize pH in acid-base reactions.

Solutions

6. Solutions are homogenous mixtures of two or more substances. As a basis for understanding this concept, students know:

a. Definitions of solute and solvent.
b. How to describe the dissolving process as a result of random molecular motion.
c. Temperature, pressure, and surface area affect the dissolving process.
d. How to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million and percent composition.
e.* The relationship between the molality of solute in a solution, and the solution's

depressed freezing point or elevated boiling point.

f.* How molecules in solution are separated or purified by the methods of chromatography and distillation.

Chemical Thermodynamics

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept, students know:

a. How to describe temperature and heat flow in terms of the motion of molecules (or atoms)
b. Chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
c. Energy is released when a material condenses or freezes and absorbed when a material evaporates or melts.
d. How to solve problems involving heat flow and temperature changes, using known values of specific heat, and latent heat of phase change.
e.* How to apply Hess's Law to calculate enthalpy change in a reaction.
f.* How to use the Gibbs free energy equation to determine whether a reaction would be spontaneous.

Reaction Rates

8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept, students know:

a. The rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
b. How reaction rates depend on such factors as concentration, temperature, and pressure.
c. The role a catalyst plays in increasing the reaction rate.
d.* The definition and role of activation energy in a chemical reaction.

Chemical Equilibrium

9. Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept, students know:

a. How to use LeChatelier's Principle to predict the effect of changes in concentration, temperature and pressure.
b. Equilibrium is established when forward and reverse reaction rates are equal.
c.* How to write and calculate an equilibrium constant expression for a reaction.

Organic and Biochemistry

Define a hydrocarbon and identify homologas series of alkanes, alkenes, and alkynes carbohydrates.

10. The bonding characteristics of carbon lead to many different molecules with varied sizes, shapes, and chemical properties, providing the biochemical basis of life. As a basis of understanding this concept, students know:

a. Large molecules (polymers) such as lipids and proteins, nucleic acids, and starch are formed by repetitive combinations of simple sub-units.
b. The bonding characteristics of carbon lead to a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
c. Amino acids are the building blocks of proteins.
d.* The system for naming the ten simplest linear hydrocarbons and isomers containing single bonds, simple hydrocarbons with double and triple bonds, and simple molecules containing a benzene ring.
e.* How to identify the functional groups which form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.
f.* The R-group structure of amino acids and how they combine to form the polypeptide backbone structure of proteins.

Nuclear Processes

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and man-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept, students know:

a. Protons and neutrons in the nucleus are held together by strong nuclear forces which are stronger than the electromagnetic repulsion between the protons.
b. The energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions: change in mass (calculated by $E = mc^2$) is small but significant in nuclear reactions.
c. Many naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
d. The three most common forms of radioactive decay (alpha, beta, gamma) and how the nucleus changes in each type of decay.
e. Alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.
f.* How to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.
g.* Protons and neutrons have substructure and consist of particles called quarks.

Investigation and Experimentation in Honors Chemistry

12. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
b. Identify and communicate sources of unavoidable experimental error.
c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
d. Formulate explanations by using logic and evidence.
e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
f. Distinguish between hypothesis and theory as scientific terms.
g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
h. Recognize the issues of statistical variability and the need for controlled tests.
i. Recognize the cumulative nature of scientific evidence.
j. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
k. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
l. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e. g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

COURSE OVERVIEW AND APPROXIMATE UNIT TIME ALLOTMENTS:
(California Content Standards are denoted in **bold**)

FIRST SEMESTER	**WEEKS**
I. Introduction	
A. Class standards	1
B. Lab write-up format	
C. Chemistry laboratory materials and equipment (**12a, b, c, d, f, j, n**)	
D. Safety in the chemistry laboratory	
II. Measurement and Problem Solving	1
A. Scientific method (**12f, j, k**)	
B. SI units and prefixes	
C. Percent error (**12c**)	
D. Accuracy, precision, and significant figures (**12b, c**)	
E. Scientific notation (**12a**)	
F. Dimensional analysis (**12d**)	

		WEEKS
III.	Matter and Energy (**7a**)	1
	A. Energy	
	B. Temperature - Fahrenheit, Celsius, Kelvin (**4e, 1f**)	
	C. Matter	
	D. Elements and compounds (**1a, b, c, d**)	
	E. Mixtures	
IV.	Atomic Structure/Modern Atomic Theory/Periodicity (**1e**)	3
	A. Progression of models of atoms (**1i**)	
	B. Discovery of atomic structure (**1h, i**)	
	C. Subatomic Particles (**1e**)	
	D. Atomic numbers, Atomic mass, Isotopes, and ions (**1a**)	
	E. Electromagnetic waves and Quantum theory (**1g, j**)	
	F. Electron configurations and periodicity (**1f**)	
V.	Radioactivity and Nuclear Reactions	1
	A. Fission versus fusion (**11b, 1f**)	
	B. Radioactive decay and half life (**11d, e, f**)	
	C. Practical applications of radioactivity (**12m**)	
	1. Medicinal	
	2. Dating	
	3. Nuclear energy (**11b**)	
VI.	Nomenclature	2
	A. Polyatomic ions	
	B. Naming ionic compounds	
	C. Naming molecular compounds	
	D. Naming acids and bases	
	E. Naming organic and biochemical compounds (**10d**)	
VII.	Chemical Bonding (**2a-h**)	2
	A. Electronegativity (**2g**)	
	B. Ionic vs. covalent bonding (**2a, b**)	
	C. Bond polarity (**2b**)	
	D. Valence Shell Electron Pair Repulsion Theory (**2f**)	
	E. Lewis structures (**2e, f**)	
	F. Intermolecular forces (**2d**)	
VIII.	Chemical Reactions	2
	A. Balancing equations (**2a, 3a**)	
	B. Reaction types (**2a, b, 3a**)	
	C. Predicting products (**1e, g)**	

		WEEKS
IX.	Chemical Composition	2
	A. Mole (**3b, c**)	
	B. Atomic mass (**1a**)	
	C. Molar mass (**3b, d**)	
	D. Percent composition	
	E. Empirical formulas (**3d**)	
	F. Molecular formulas (**2b**)	
X.	Chemical Quantities/Stoichiometry	2
	A. Mole/mole relationships (**3d**)	
	D. Mass calculations (**3e, f**)	
	E. Limiting reagent (**3e, f**)	
	F. Percent yield (**3e**)	
	1st Semester Review & Final Exam	1
	Total:	18

SECOND SEMESTER

I.	Thermochemistry	3
	A. Enthalpy and entropy (**7a**)	
	B. Thermochemical equations (**7d**)	
	C. Hess's Law (**7e**)	
	D. Potential energy diagrams (**7b, c**)	
	E. Specific heat capacity (**7d**)	
	F. Calorimetry (**7d**)	
	G. Gibb's Equation (**7f**)	
II.	Gases	2
	A. Gas behavior (**4a, b, c**)	
	B. Avogadro's Law (**4h**)	
	C. Gas laws	
	1. Boyle's (**4d**)	
	2. Charles' (**4d**)	
	3. Combined Gas Law (**4d**)	
	4. Dalton's Law of Partial Pressures (**4h**)	
	5. Ideal Gas Law (**4c, h**)	
	6. Graham's Law (**4i**)	
	D. Kinetic Molecular Theory (**4a, g**)	
	E. STP and absolute zero (**4g**)	
	F. Gas stoichiometry (**4h**)	

WEEKS

III. Liquids and Solids — 2
- A. Changes of state (**7c**)
- B. Phase diagrams (**7b**)
- C. Kinetic Molecular Theory (**4a**)
- D. Vapor pressure (**6c**)
- E. Intermolecular forces (**2d, h**)

IV. Solutions — 2
- A. Concentration
  1. Molarity (**6d**)
  2. Molality (**6d**)
  3. Mole fraction (**6d**)
- B. Dilutions
- C. Colligative properties
  1. Boiling point elevation (**6e**)
  2. Freezing point depression (**6e**)
- D. Solubility (**6a, b, c**)
- E. Volume/volume and mass/volume solutions (**6a, d**)

V. Chemical Equilibrium — 2
- A. Reversible reactions (**9b**)
- B. Le Chatelier's Principle (**9a**)
- C. Equilibrium Constant Expression (**9c**)
- D. Solubility Product Expression (**9c**)
- E. Reaction rates
  1. Concentration (**8a**)
  2. Heat (**8b**)
  3. Catalyst (**8c**)
  3. Nature of reactants
- F. Activation energy (**8d**)

VI. Acids and Bases — 3.5
- A. Properties of acids and bases (**5a, b**)
- B. Defining acids and bases (**5e**)
  1. Arrhenius (**5e**)
  2. Bronsted-Lowry (**5e**)
  3. Lewis (**5e**)
- C. Strength of acids and bases (**5c**)
  1. Calculating pH and pOH (**5f, d**)
  2. Strong acids and bases (**5c, d**)
  3. Acid dissociation constants (**5c**)
- D. Buffered solutions (**5g**)
- E. Normality (**6d**)

WEEKS

F. Titration (**5g**)

VII. Organic Chemistry — 1.5

A. Hydrocarbons/bonding characteristics of carbon (**10b**)
B. Polymers (**10a**)
C. Six functional groups and organic acids (**10e**)
D. Carbohydrates, lipids, proteins, and nucleic acids, amino acids and polypeptides (**10d, f**)

Standardized Testing and 2nd Semester Review & Final Exam — 2

Total: 18

DATE OF LAST CONTENT REVISION: April 2003

DATE OF CURRENT CONTENT REVISION: May 2006

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