Carlsbad Unified School District
6225 El Camino Real • Carlsbad, CA 92009
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Course Description Outline

Date of Submission/Revision (include month and year): April 2009

Course Title and Course Code Number: Chemistry AP Course Code # 1435	**School(s):** Carlsbad High School
CBEDS #: 2671	
Department: Science	**Grade Level(s) for which this course is offered:** □ 6th □ 7th □ 8th □ 9th □ 10th x 11th x 12th
Length of Course/Credits: ☐ One semester/five credits x One year/ten credits	**Course Completion Satisfies:** *(for high school only)* x Graduation requirement for_science___ (content area) □ Graduation requirement for electives □ University requirement for UC Designate which a-g requirement: _____ □ University requirement CSU Designate which a-g requirement: _____
Sequence Data – Prerequisite(s) Required: Prerequisite: "B" or better in Chemistry 1-H "B" or better in Algebra 1, Geometry and Algebra 2, or teacher recommendation .	**Sequence Data: - Co-Requisites Required:**
Textbook(s): Chemistry, 7th Edition Zumdahl, Steven and Zumdahl, Susan McDougal Littell	**Supplemental Instructional Materials:** Four sources are used for laboratories: 1. Vonderbrink, Sally Ann. Laboratory Experiments for Advanced Placement Chemistry 2. Holmquiest, Dan D. and Volz, Don. Chemistry with Computers 3. Hall, James F. Experimental Chemistry 4. Metcalfe, H.Clarak, Laboratory Experiments in Modern Chemsitry**.**

Brief Course Description (i.e. description that could be used in a Course Description Booklet):
A first year college course that will expand upon and extend concepts and principles learned in Chemistry 1 and Chemistry 1-Honors. The course is designed to prepare students for the Advanced Placement exam for college credit. The course includes the study of stoichiometry, reactions, and interactions, phase changes, states of matter, equilibrium, kinetics, thermodynamics, electrochemistry.

Course Goals and/or Major Student Outcomes:

- To encourage thought.
- To increase students' knowledge of Chemistry for personal and societal application.
- To encourage all students to take and pass the AP Chemistry exam administered in May.
- To acquire hands-on laboratory skills, both observational and technical by generating reproducible data for analysis and calculation and to formally present experimental results in a written laboratory report.
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Content Standards Addressed:

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:
    a. Students know how to relate the position of an element in the periodic table to its atomic number and atomic mass.
    b. Students know how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.
    c. Students know how to use the periodic table to identify alkali metals, alkaline earth metals and transition metals, trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.
    d. Students know how to use the periodic table to determine the number of electrons available for bonding.
    e. Students know the nucleus of the atom is much smaller than the atom yet contains most of its mass.
    f. * Students know how to use the periodic table to identify the lanthanide, actinide, and transactinide elements and know that the transuranium elements were synthesized and identified in laboratory experiments through the use of nuclear accelerators.
    g. * Students know how to relate the position of an element in the periodic table to its quantum electron configuration and to its reactivity with other elements in the table.
    h. * Students know 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. * Students know 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. * Students know that spectral lines are the result of transitions of electrons between energy levels and that these lines correspond to photons with a frequency related to the energy spacing between levels by 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 from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:
    a. Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.
    b. Students know chemical bonds between atoms in molecules such as H_2 , CH_4 , NH_3 , H_2CCH_2 , N_2 , Cl_2 , and many large biological molecules are covalent.
    c. Students know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.
    d. Students know the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.
    e. Students know how to draw Lewis dot structures.
    f. * Students know how to predict the shape of simple molecules and their polarity from Lewis dot structures.
    g. * Students kno*w* how electronegativity and ionization energy relate to bond formation.
    h. * Students *know* 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:

a. Students know how to describe chemical reactions by writing balanced equations.

b. Students know the quantity one mole is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.

c. Students know one mole equals 6.02×10^{23} particles (atoms or molecules).

d. Students know how to determine the 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. Students know 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. * Students know how to calculate percent yield in a chemical reaction.

g. * Students know 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:

a. Students know the random motion of molecules and their collisions with a surface create the observable pressure on that surface.

b. Students know the random motion of molecules explains the diffusion of gases.

c. Students know 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. Students know the values and meanings of standard temperature and pressure (STP).

e. Students know how to convert between the Celsius and Kelvin temperature scales.

f. Students know there is no temperature lower than 0 Kelvin.

g. * Students know the kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.

h. * Students know how to solve problems by using the ideal gas law in the form $PV = nRT$.

i. * Students know how to apply Dalton's law of partial pressures to describe the composition of gases and Graham's law to predict 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:

a. Students know the observable properties of acids, bases, and salt solutions.

b. Students know acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.

c. Students know strong acids and bases fully dissociate and weak acids and bases partially dissociate.

d. Students know how to use the pH scale to characterize acid and base solutions.

e. * Students know the Arrhenius, Brønsted-Lowry, and Lewis acid-base definitions.

f. * Students know how to calculate pH from the hydrogen-ion concentration.

g. * Students know buffers stabilize pH in acid-base reactions.

Solutions

6. Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:

a. Students know the definitions of solute and solvent.

b. Students know how to describe the dissolving process at the molecular level by using the concept of random molecular motion.

c. Students know temperature, pressure, and surface area affect the dissolving process.

d. Students know how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.

e. * Students know the relationship between the molality of a solute in a solution and the solution's depressed freezing point or elevated boiling point.

f. * Students know how molecules in a 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:

   a. Students know how to describe temperature and heat flow in terms of the motion of molecules (or atoms).

   b. Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.

   c. Students know energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.

   d. Students know how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.

   e. * Students know how to apply Hess's law to calculate enthalpy change in a reaction.

   f. * Students know 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:

   a. Students know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

   b. Students know how reaction rates depend on such factors as concentration, temperature, and pressure.

   c. Students know the role a catalyst plays in increasing the reaction rate.

   d. * Students know 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:

   a. Students know how to use Le Chatelier's principle to predict the effect of changes in concentration, temperature, and pressure.

   b. Students know equilibrium is established when forward and reverse reaction rates are equal.

   c. * Students know how to write and calculate an equilibrium constant expression for a reaction.

Organic Chemistry and Biochemistry

10. The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. As a basis for understanding this concept:

    a. Students know large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.

    b. Students know the bonding characteristics of carbon that result in the formation of a

large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.

c. Students know amino acids are the building blocks of proteins.

d. * Students know the system for naming the ten simplest linear hydrocarbons and isomers that contain single bonds, simple hydrocarbons with double and triple bonds, and simple molecules that contain a benzene ring.

e. * Students know how to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.

f. * Students know the R-group structure of amino acids and know 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 human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:

    a. Students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.

    b. Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc^2$) is small but significant in nuclear reactions.

    c. Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.

    d. Students know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.

    e. Students know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

    f. * Students know how to calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed.

    g. * Students know protons and neutrons have substructures and consist of particles called quarks.

Course Outline of Units of Study:

Ch 1 and 2: Calculation and Uncertainty and Atoms, Molecules, and Ions

Timeframe: summer assignment and 2 blocks

Content and/or Skills Taught:

Review of uncertainty in measurement, significant figures, dimensional analysis, temperature scales and density, formula writing, naming binary compounds.

Major Assignments and/or Assessments:

Completion of study guide (summer assignment).Discussion on key points of Chapters 1 and 2, quiz on polyatomic ions, pre lab assignment, Lab safety review, inventory of lab equipment, scale use. Unit exam.
Lab: Measurement of Temperature (Hall), includes thermometer calibration, boiling point and melting point determination.
Lab: Accuracy and Precision in Measurements (Metcalfe)

Ch 3 and 4: Stoichiometry, Types of Chemical Reactions and Solution Stoichiometry. Timeframe: 5-6 blocks

Content and/or Skills Taught:

Atomic mass, mole, molar mass,percent composition, empirical formulas, balancing chemical equations, stoichiometry calculations, limiting reactant calculations, solution vocabulary, molarity calculations, molality, dilution calculations, types of chemical reactions, molecula calculations, complete ionic and net ionic equations, titration calculations, oxidation states, balancing redox reactions in

both acidicand basic solutions.
Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completions of assigned text problems, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Mass and Mole Relationships (Metcalfe)
Lab: Water of Crystallization and empirical formula of a Hydrate (Metcalfe)
Lab: Stoichiometric determination of formula: magnesium oxide (Hall)

Ch 5: Gases.
Timeframe:5 blocks
Content and/or Skills Taught:
Units of pressure, Boyle's Law, Charles'Law, Avogadro's Law, Ideal Gas Law, Gas Stoichiometry,molar mass of a gas, Dalton's Law of Partial Pressure, Kinetic Molecular Theory, effusion and diffusion, Graham's Law.
Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completions of assigned text problems, quizzes, pre-lab assignments, self-test assignment, unit exam.
Lab: Molecular Weight of a Volatile Liquid (Hall)
Lab: Molar Volume of a Gas (Metcalfe)
Lab: Pressure-Volume Relationship in Gases and Pressure-Temperature Relationship in Gases (Holmquist)

Ch 6: Thermochemistry and Ch 16: Spontaneity, Entropy, and Free Energy.
Timeframe: 8 blocks
Content and/or Skills Taught:
Enthalpy, calorimetry, heat capacity, specific heat capacity,exothermic and endothermic reactions,Hess's Law, enthalpy of formation, spontaneity, entropy, positional probability, free energy.
Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completions of assigned text problems, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Heat of Reaction and Hess's Law (Flinn)
Lab: Heat of Combustion (Metcalfe)

Ch 13 Chemical Equilibrium
Timefame: 4 blocks

Content and/or Skills Taught:
Law of mass action, equilibrium constant, equilibrium expression, equilibrium positions, Le Chatelier's principle, homogeneous and hetergeneous equilibria, reaction quotient, effect of changes in temperature, pressure and/or concentration on equilibrium
Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completion of assigned text problems, group calculation session, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Equilibrium with Cobalt Complex Ions (Vonderbrink)
Lab: Equilibrium (Metcalfe)

Ch 14 Acids and Bases
Timeframe: 4-5 blocks
Content and/or Skills Taught:
pH, pH calculations for strong and weak acids and strong and weak bases, conjugate acid-base pairs, percent dissociation calculations, bases,Ka,Kb expressions, Arrhenius, Bronsted-Lowry, Lewis acid-base definitions, polyprotic acid calculations, acid-base properties of salts and calculations of their pH, effect of structure on acid-base properties, acid-base properties of oxides,
Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completion of assigned text problems, group calculation session, quizzes,pre-lab assignment, self-test assignment, unit exam.
Activity: Hydrolysis of Salts (teacher created)
Lab: Determination of the Equivalent Mass and pka of an Unknown Acid (Vonderbrink)
Lab: Determination of a Dissociation Constant of Weak Acid (Vonderbrink)

Ch 15 Applications of Aqueous Equilibria

Timeframe: 6 - 7 blocks

Content and/or Skills Taught:

Common ion effect on equilibirum calculations, buffers, buffering capacity, titrations(weak acid with strong base, weak base with strong acid, strong acid with strong base) and pH curves, Ka calculations, acid-base indicators, solubility equilibria, pH and solubility, relative solubilities.

Major Assignments and/or Assessments:

Lecture with discussion, study guide completion, completion of assigned text problems, group calculation session, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Titration of and (strong)Acid with a (strong)Base (Metcalfe)
Lab: Titration Curves of Strong and Weak Acids and Bases (Holmquist)
Lab: Determination of a Solubility Product of an Ionic Compound (Vonderbrink)

Ch 17: Electrochemistry

Timeframe: 6 blocks

Content and/or Skills Taught:

galvanic cells, cell potential, oxidation and reduction half cells, using standard reduction table,line notation, concentration cells, Nernst equation, calculation of equilibrium constant for redox reactions, electrolysis of water, electrolysis of sodium chloride.

Major Assignments and/or Assessments:

Lecture with discussion, study guide completion, completion of assigned text problems, group calculation session, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Oxidation-Reduction reactions (Metcalfe)
Lab: Electrochemical Cells (Vonderbrink)

Ch 12: Kinetics

Timeframe: 5 blocks

Content and/or Skills Taught:

reaction rates, rate laws, method of initial rates, order or reactions, activation energy, integrated rate laws, half life of first order reactions, reaction mechanisms, catalysts.

Major Assignments and/or Assessments:

Lecture with discussion, study guide completion, completion of assigned text problems, group calculation session, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Rate of a Chemical Reaction (Metcalfe)
Lab: Study of the Kinetics of a Reaction (Vonderbrink)

Ch 7: Atomic Structure and Periodicity, Ch 8: Bonding

Time: 7 blocks

Content and/or Skills Taught:

atomic spectra, bohr model, quantum mechanical model of atom, quantum numbers, atomic orbitals,Pauli exclusion principle, electron configuration, orbital notation, periodic table, periodic trends in atomic properties: ionization energy, electron affinity, atomic radius, types of chemical bonds, electronegativity, bond polarity and dipole moments,Lewis structures, octet rule and exceptions, resonance, VSEPR model, molecular geometry, formal charge, lattice energy, covalent bond energy and chemical reactions.

Major Assignments and/or Assessments:

Lecture with discussion, study guide completion, completion of assigned text problems, quizzes,pre-lab assignment, self-test assignment, unit exam.
Lab: Flame Test (Metcalfe)
Lab: Relative Solubilities of Group II Metals (Metcalfe)
Lab: Halide Ions (Metcalfe)
Lab: Relative Solubilities of Transition Ions (Metcalfe)
Lab: Construction of VSEPR models, 7 different molecluar geometries using toothpicks and styrofoam balls.

Ch 9: Covalent Bonding 22: Organic Chemistry

Timeframe: 1-2 blocks

Content and/or Skills Taught:

quick overview of organic nomenclature, functional groups, hybridization for the purpose of student enrichment.

Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completion of assigned text problems, quiz, pre-lab assignment, group mini-test as unit assessment.
Lab: Preparation of Esters (Vonderbrink)

Ch 18: Nuclear Chemistry
Timeframe: 1 block
Content and/or Skills Taught:
types of radioactive decay, writing balanced nuclear reations to show types of radioactive decay, half-life, zone of stability, decay series, mass defect
Major Assignments and/or Assessments:
Short lectute, lecture guide completion, completion of assigned text problems, quiz

Ch 10:Liquids and Solids and Ch 11: Solution Composition
TImeframe 6 - 7 blocks
Content and/or Skills Taught:
Intermolecular forces, dipole-dipole forces, London forces, hydrogen bonding, types of solids, metallic bonding, alloys, molecular solids, ionic solids, vapor pressure, changes of state, phase diagrams,solution composition, molarity, molality, mole fractions, solubility, vapor pressure of solutions, nonideal solutions, boiling point elevation and freezing point depression, osmotic pressure, Raoult's law, Henry's law
Major Assignments and/or Assessments:
Lecture with discussion, study guide completion, completion of assigned text problems, quizzes,pre-lab assignment, self-test assignment, unit exam
Lab:Heat of Crystallization (Metcalfe)
Lab:Heat of Fusion of Ice (Metcalfe)
Lab:Solubility and Rate of Solution (Metcalfe)
Lab: Synthesis of Alum (Vonderbrink)
Lab: Identification of Alum (Vonderbrink)
Lab: Molecular Mass by Freezing Point Depression (Vonderbrink)

AP Exam Review
Timeframe: 8-10 blocks
This review includes an overview of major topics (heavy emphasis on Equilibrium calculations) and the use of past exams, both multiple choice and free response questions. Throughout the year we study the general principles of equation writng and "Predicting Reactions" are included on most unit exams.
Content and/or Skills Taught:
Review of all content.
Major Assignments and/or Assessments:
Two full-length practice AP exams, including both multiple choice and free response questions culminate the review.

Instructional Methods and/or Strategies:
See: Course Outline/Units of Study section

Assessment Methods and/or Tools; Grading Practices:
Grading Scale: 87-100% = A 74-86.9% = B 60-73.9% = C 48-59.9% = D

Weighted grading by categories:
Tests and Chapter tests = 50%
Quizzes = 8%
Homework = 15%
Lab reports = 10%
Predicting Reactions = 7%
Final = 10%

Key Assignments:
See: Course Outline/Unit of Study section

Honors Courses: (Indicate how this honors course is different from the standard course.)
A first year college course that will expand upon and extend concepts and principles learned in Chemistry 1

and Chemistry 1-Honors. The course is designed to prepare students for the Advanced Placement exam for college credit

Expected School-wide Learning Results (ESLRs) Addressed (for high school only):

1) Reading, writing and communication skills
   Students demonstrate that they can work effectively and collaboratively with other members of a team or group.
2) Ethical, honest, and healthy behavior
   Students demonstrate that they act honestly, ethically and responsibly toward themselves and others.
   Students demonstrate that they have multi-cultural understanding, and can function effectively in a diverse society.
3) Applied knowledge and reasoning skills
   Students demonstrate the ability to engage in high-level critical thinking and reasoning, to think creatively, make decisions and solve problems.
4) Life-long learners
   Students demonstrate that they possess the essential knowledge and skills of self-management and effective work habits.

Students demonstrate attitudes, skills, and knowledge necessary to successfully transition to their post high school academic and career plans.