

APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Chemistry II Course Number: 44112

Department: Science ADS Number: 17234944

Prerequisites: Successful completion of Chemistry I and Algebra I

Length of Course: One Year Credit/PRI Area: .50 per Sem/Elective Grade Level(s): 11-12

Important Notes: It is strongly recommended that the student has successfully completed or is concurrently enrolled in Algebra II.

COURSE DESCRIPTION:

This laboratory course* is designed to provide an in-depth investigation of more specialized areas of chemistry and laboratory techniques including, but not limited to, acid-base theory, oxidation-reduction, chemical equilibrium, kinetics, ionic equilibrium, solubility products, electrochemistry, thermodynamics, and nuclear chemistry. Topics (e.g., stoichiometry, chemical equations, atomic structure, molecular bonding and geometry, periodic relationships, gases, liquids, solids, and solutions) studied in Chemistry I are further developed. Chemical analysis, physical and mathematical models of matter and its interaction, organic biochemistry, and principles of technology are also studied. Literacy strategies are integrated throughout the curriculum.

* Lab Courses: A minimum of 250 minutes per week of directed class activity for 36 weeks, 40% of which must be lab oriented, for a total of 150 clock hours (90 hours of class plus 60 hours of lab) shall be required for one (1) unit of credit, excluding passing period. [APS Procedural Directives, Section I – Instruction, Basis for offering credit].

References in parentheses following a performance standard refers to and is aligned with the New Mexico Science Standards (NM) and APS Language Arts Standards (APS-LA).

STRATEGIES:

The “Illustrations” column provides exemplars of the performance standards, strategies, and the best practices suggested by the high school science teachers in the Albuquerque Public Schools. Some illustrations are introductory and others are culminating activities for concepts. Illustrations may be modified for individualized instruction, accessibility of equipment and materials, etc.

ASSESSMENTS:

Assessments include authentic and performance-based assessment, cooperative learning, teacher observations, role playing, checklists, rubrics, tests and exams, formal and informal writing, oral presentations, group discussions, multimedia presentations, projects and demonstrations. The “Illustrations” column also incorporates a variety of assessments

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:

- State adopted textbooks and ancillary materials
- Supplementary materials
- Films/videos
- Internet

SUGGESTED TITLES/AUTHORS WEB SITES:

- Chemistry lesson plans http://www.chemistrycoach.com/links_to_chemistry_lesson_plans.html
- Chemistry experiments http://www.chemistrycoach.com/Links%20to%20chemistry_experiments.html
- What’s Happening in Chemistry http://www.chemistrycoach.com/hs_chemistry_sites.html
- Tutorials on specific topics <http://www.chemistrycoach.com/high2.html>
- Library search <http://www.library.thinkquest.org/10429>
- *Chemistry with Calculators* Vernier
- *Chemistry – 5th Edition* Zumdahl, Steven
- *Chemistry Plus Student CD and Technology Guide* Zumdahl, Steven
- Cliff’s Chemistry software

Approved by HSCA: 12/04

STRAND I: SCIENTIFIC THINKING AND PRACTICE

CONTENT STANDARD: The student understands the processes of scientific investigations and uses inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

- BENCHMARKS:**
- A. The student uses accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
 - B. The student understands that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.
 - C. The student uses mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ul style="list-style-type: none">1. Describes the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions (NM-I.I.I.1).2. Designs and conducts scientific investigations that include the following:<ul style="list-style-type: none">• testable hypotheses,• controls and variables,• methods to collect, analyze, and interpret data,• results that address hypotheses being investigated,• predictions based on results,• re-evaluation of hypotheses and additional experimentation as necessary, and• error analysis (NM-I.I.I.2).3. Uses appropriate technologies (e.g., computers, calculators, balances, microscopes) to collect, analyze, and communicate scientific data (NM-I.I.I.3).	<p>NOTE: Illustrations include suggested activities for attaining each performance standard. A check (√) refers to a key feature to look for while assessing student performance.</p> <p>1 – 16. The student properly designs and performs a controlled experiment using scientific methods, gathers and analyzes data, and reports results in both an oral and written format.</p> <ul style="list-style-type: none">√ proper safety technique√ correct use of appropriate equipment√ evidence of current scientific knowledge√ organization of data√ appropriate analysis of data√ reasonable and testable problem√ defensible conclusion based on data√ quantitative/qualitative data√ trials to verify data√ theory supported by data√ critical thinking and insights√ use of technology√ effective communication skills√ writing conventions

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including</p> <ul style="list-style-type: none"> • scientific language and symbols, • diagrams, charts, and other data displays, • mathematical expressions and processes (e.g., mean, median, slope, proportionality), • clear, logical, and concise communication, and • reasoned arguments (NM-I.I.I.4). <p>5. Understands how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom) (NM-I.I.I.5).</p> <p>6. Understands how scientific processes produce valid, reliable results, including</p> <ul style="list-style-type: none"> • consistency of explanations with data and observations, • openness to peer review, • full disclosure and examination of assumptions, • testability of hypotheses, and • repeatability of experiments and reproducibility of results (NM-I.I.II.1). <p>7. Uses scientific reasoning and valid logic to recognize the following:</p> <ul style="list-style-type: none"> • faulty logic, • cause and effect, • the difference between observation and unsubstantiated inferences and conclusions, and • potential bias (NM-I.I.II.2). <p>8. Understands how new data and observations can result in new scientific knowledge (NM-I.I.II.3).</p> <p>9. Critically analyzes an accepted explanation by reviewing current scientific knowledge (NM-I.I.II.4).</p>	<p style="text-align: center;">-FOR EXAMPLE-</p> <p>The student uses a copper wire and through a series of reactions dissolves the wire, produces several intermediate products, recovers the metallic copper from the solution, and calculates the percentage of metallic copper recovered. As the student performs the reactions, he/she keeps a data table, writing the equation and classifying the types of reactions that occur in each step. At the end of the process, the student completes a self-evaluation describing how to improve the percentage of metallic copper recovery.</p> <ul style="list-style-type: none"> √ accurate measurements √ safety procedures in place and being practiced √ pH controlled and tested √ heating and cooling techniques in place √ vacuum filtration √ solutions and precipitates transferred completely <p>6 – 16. See Strand I (Scientific Thinking and Practice) example for Illustration #1 – 16.</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> <li data-bbox="275 191 1035 280">10. Examines investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe) (NM-I.I.II.5). <li data-bbox="275 313 1125 467">11. Examines the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently (NM-I.I.II.6). <li data-bbox="275 500 1131 557">12. Creates multiple displays of data to analyze and explain the relationships in scientific investigations (NM-I.I.III.1). <li data-bbox="275 589 1047 646">13. Uses mathematical models to describe, explain, and predict natural phenomena (NM-I.I.III.2). <li data-bbox="275 678 1119 768">14. Uses technologies (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling) to quantify relationships in scientific hypotheses (NM-I.I.III.3). <li data-bbox="275 800 1073 857">15. Identifies and applies measurement techniques and considers possible effects of measurement errors (NM-I.I.III.4). <li data-bbox="275 889 1073 946">16. Uses mathematics to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis) (NM-I.I.III.5). 	

STRAND II: THE CONTENT OF PHYSICAL SCIENCE**CONTENT STANDARD:** The student understands the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

- BENCHMARKS:**
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- A. The student understands the properties, underlying structure, and reactions of matter.
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- B. The student understands the transformation and transmission of energy and how energy and matter interact.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none">1. Understands and applies the periodic nature of the Table of Elements.2. Identifies, measures, and uses a variety of physical and chemical properties (e.g., electrical conductivity, density, viscosity, chemical reactivity, pH melting point) (NM-II.L.2).3. Applies properties of matter to understand atoms and their subatomic particles.4. Understands the nature of radioactivity:<ul style="list-style-type: none">• subatomic particles and their interactions,• nuclear reactions, stability of atomic nuclei,• transmutation reactions, fission, fusion, and• electromagnetic radiation, Einstein.5. Understands the basic principles of quantum mechanics and uses quantum numbers to describe the probable location of electrons in atoms.<ul style="list-style-type: none">• Pauli Exclusion Principle, Heisenberg Uncertainty Principle,• orbitals, electron configurations,	<ol style="list-style-type: none">1-3. The student uses paper chromatography to separate a variety of cations and dyes. He/She measures the movement of substances on a chromatogram, investigating the effects of solvent change on R_f values. He/she writes up a lab report with the chromatogram attached.<ul style="list-style-type: none">√ separation of components√ R_f value calculation and comparisons√ proper use of equipment√ precision, accuracy, error analysis√ accurate measurements√ movement of substances predicted based on Periodic Table4. Using a Vernier radiation monitor, the student collects data from a radioactive source to demonstrate the behavior of the inverse square relationship for radioactive decay. He/She inputs the data into a graphing calculator to visually display the data gathered. When the graph is complete, the student infers from the results the answer to the following question: How would the graphs of different isotopes with different half-lives compare to this graph? The student compares and contrasts his/her experimental trial with other radioactive decay.<ul style="list-style-type: none">√ graphing data√ graphical analysis on computer√ accurate comparisons√ application of principle to real half life (e.g., carbon dating)√ response to question5, 6, 15, 16. The student performs a flame test, viewing the burning substance through a spectroscope. He/she looks for emission lines to determine the characteristic wavelengths of light that are produced by each substance. Results are recorded in a data table for each substance. When given an unknown mixture, the student uses the data from the

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ul style="list-style-type: none"> • ion electron configurations, and • energy changes. <p>6. Understands how the type and arrangement of electrons in atoms and the bonds between atoms determine the characteristics of a substance:</p> <ul style="list-style-type: none"> • Lewis Dot structures, • orbit theory, • resonance structures, • electronegativity to determine bond type, and • bond order and bond lengths <p>7. Understands and identifies types of chemical reactions, including</p> <ul style="list-style-type: none"> • names of polyatomic ions, given formulas, • names of inorganic compounds, including acids, • formulas of inorganic substances, • synthesis, decomposition, combustion, replacement, redox and Lewis acid-base reactions, neutralization, • prediction of reaction products, • balancing equations, given reactants and products, • differentiation between acids, bases, salts, and • concept of conjugate acids/bases; recognition of amphiprotic species <p>8. Uses balanced chemical reactions as a basis or stoichiometric calculations.</p> <p>9. Solves chemistry problems involving percent yield, limiting reagents, mole concept, molarity, percent composition, empirical/molecular formulas, pH, pOH, Ka, and Kb, Ksp and Keq and applies these concepts in a laboratory setting.</p>	<p>flame test to determine the identity of elements in the mixture. He/She prepares a formal lab report describing the process and the data collected.</p> <ul style="list-style-type: none"> √ proper use and calibration of equipment √ accurate description of known chemical results √ application of knowledge to new situation √ precision, accuracy, and error analysis √ accurate technical paper format √ writing conventions √ clear communication <p>7, 8. The student uses titration techniques and starch as an indicator to quantize the amount of hypochlorite in household bleach. He/She combines the bleach with thiosulfate, recognizing that the end point is reached when the solution turns clear.</p> <ul style="list-style-type: none"> √ proper titration techniques √ precision and accuracy √ replication of results √ data table √ accurate calculation of percentage <p>9. Given a specific quantity of reactants, the student calculates the mole ratio for a chemical reaction. He/She combines $\text{NaHCO}_3(\text{s}) + \text{HCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{CO}_2(\text{g})$ in a container to determine how much CO_2 gas is produced. The student compares the theoretical with the actual results, describing possible reasons for any differences. While testing several quantity combinations of reagents, the student determines substances in excess, limiting reactants, etc. The process includes the following:</p> <ul style="list-style-type: none"> • stoichiometric calculations, measurements of products • determination of mole ratios • comparison of theoretic with actual quantities of products • calculation of percentage of error in the experiment √ thoroughness √ accurate calculations √ description of differences between theoretical and actual results

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>10. Understands chemical kinetics/reaction mechanisms, including the following:</p> <ul style="list-style-type: none"> • rate laws, order of reactions, • reaction mechanisms, and • activation energy <p>11. Calculates the rate of chemical reactions and determines the effect of changes in various factors (e.g., temperature, concentration, presence of catalysts).</p> <p>11. Understands the basic concepts of thermodynamics, including the following:</p> <ul style="list-style-type: none"> • recognition of state functions, • three laws of thermodynamics, • Hess's Law, and • spontaneity of reactions. <p>13. Understands concepts of thermal energy vs. temperature and the relationship to the phase of matter of a substance (NM-II.I.II.2).</p> <p>14. Understands that energy can change from one form to another (e.g., changes in kinetic vs. potential, kJ to Cal conversions) and that energy is conserved in these changes (NM-II.I.II.3).</p> <p>15. Applies concepts of equilibrium:</p>	<p>10 – 12. Using starch and iodine, the student varies concentrations of the iodine in a test solution, timing the rate of reaction of each solution. He/She determines how the change affects the rate of reaction with the starch. The student uses the same process again, maintaining the concentration of the reactants at the optimum level but changing the temperature of the reactants to determine optimum temperature for the reaction.</p> <ul style="list-style-type: none"> √ data table √ accurate analysis <p>13, 14. The student weighs the mass of food particles (e.g., popcorn, marshmallows, peanuts), and burns the particles under a simple calorimeter made from a soft drink can that contains a known quantity of water. He/She uses a CBL temperature probe programmed to read temperatures every 10 seconds to measure temperature changes. These are used with other data to calculate the number of kilojoules of energy per gram the food contains. Using this information, the student determines converted kJ of energy into calories per gram for the food. He/She then compares the results of his/her own experiment to the actual calorie count listed on the food package. The student then determines the percent of error in his/her findings. Finally, the student designs a test system to lower the percent error.</p> <ul style="list-style-type: none"> √ use of technology √ problem-solving ability √ accuracy, precision √ identification of energy transformation from one source to another √ proper use of thermochemistry techniques (e.g., calorimeter) to collect data √ analysis and interpretation of data to validate/disprove hypothesis generated in pre-lab <p>15. The student uses a soda can, adds a bit of water to the can, puts can</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ul style="list-style-type: none"> • physical vs. chemical equilibrium, • equilibrium constants, • Le Chatelier's Principle, • interpretation of phase diagrams, • boiling point vs. pressure, principles for measuring pressure, and • gas laws (i.e., Charles, Boyles, Gay-Lussac's Law, Avogadro's Law, Dalton's Law, Ideal Gas Law, van de Waal's forces). <p>16. Understands the basic structural groups found in organic chemistry and applies accurate nomenclature.</p>	<p>on a hot plate, and heats until the water boils and fills with vapor. Using beaker tongs, the student picks up the container and quickly holds it in a vertical position in a container (e.g., sink, bucket) of cold water. The student explains what happens to the can and the cause and effect for the outcome.</p> <ul style="list-style-type: none"> √ safe lab procedures √ logical conclusion √ connection of shifts in equilibrium with outcome of experiment √ connection with gas laws, chemical and thermal equilibrium of chemical reactions <p>16. The student prepares an ester by combining salicylic acid with methyl alcohol to produce methylsalicylate (i.e., oil of wintergreen). He/She discusses this process of esterification, a common organic procedure used to produce artificial flavorings and odors in industry.</p> <ul style="list-style-type: none"> √ safety √ calculation of percent yield √ identification of color and odor of product <p>The student researches other esters selected by the teacher and used by industry to simulate flavorings. The student then looks at the general formula for esterification (i.e., acid + alcohol → ester + water) and predicts equations for making those esters. The student then answers the following questions: What happens to the equilibrium if the water is removed? How would the quantity of the ester produced be changed if the water is constantly removed or if the water isn't removed? The student writes a short paper explaining how to apply the information learned about esterification in the flavor industry.</p> <ul style="list-style-type: none"> √ writing conventions √ logical conclusions √ clear communication

STRAND III: SCIENCE AND SOCIETY**CONTENT STANDARD:** The student understands how scientific discoveries, inventions, practices, and knowledge influence and are influenced by individuals and societies.**BENCHMARK:** The student examines and analyzes how scientific discoveries and their applications affect the world and explains how societies influence scientific investigations and applications.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>Science and Technology</p> <ol style="list-style-type: none">1. Knows how science enables technology but also constrains it and recognizes the difference between real technology and science fiction (e.g., rockets vs. antigravity machines, nuclear reactors vs. perpetual-motion machines, medical X-rays vs. Star-Trek tricorders) (NM-III.I.I.1).2. Evaluates the influences of technology on society (e.g., communications, petroleum, transportation, nuclear energy, computers, medicine, genetic engineering) including both desired and undesired effects, and including some historical examples (NM-III.I.I.3).3. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information (NM-III.I.I.6). <p>Science and Society</p> <ol style="list-style-type: none">4. Knows that societal factors (e.g., government funding, laws and regulations about human cloning and genetically modified organisms, gender and ethnic bias, AIDS research, alternative-energy research) can promote or constrain scientific discovery (NM-III.I.I.11).5. Describes how environmental, economic, and political interests impact resource management and use in New Mexico (NM-III.I.I.13). <p>Science and the Individual</p> <ol style="list-style-type: none">6. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM-III.I.I.15).7. Knows that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers) (NM-III.I.I.19).	<ol style="list-style-type: none">1. See Strand II (Content of Physical Science) Illustration #13, 14.2. See Strand II (Content of Physical Science) Illustration #13, 14 and #16.3. See Strand II (Content of Physical Science) Illustration #4 and #5, 6, 15, 16.4. See Strand II (Content of Physical Science) Illustration #7, 8.5. See Strand II (Content of Physical Science) Illustration #5, 6, 15, 16 and #7, 8.6. See Strand II (Content of Physical Science) Illustration #10 – 12 and #13, 14.7. See Strand II (Content of Physical Science) Illustration #5, 6, 15, 16 and #15.

STRAND IV: LITERACY**CONTENT STANDARD:** The student communicates chemical principles through reading, writing, and speaking opportunities.**BENCHMARK:** The student demonstrates proficiency in reading comprehension, specialized vocabulary, and a variety of writing and speaking requirements.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none">1. Develops and demonstrates proficiency with the following strategies to approach reading for information across content areas (APS – LA I.1):<ul style="list-style-type: none">• scans reading selection to determine whether a text contains relevant information,• uses the of the material to make predictions and to validate comprehension of text,• reads and rereads to decode meaning, and• reviews and summarizes essential element headings and subheadings of text for overview.2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APS – LA I.4).3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APS – LA II.2).4. Develops increased competence in using the writing process to create a final product (APS – LA III.1).5. Develops increased competence in using elements of effective writing (APS – LA III.2).6. Responds to a variety of written, electronic, and other media (APS – LA III.7).7. Develops increased competence with speaking and language conventions (APS – LA IV.3).	<ol style="list-style-type: none">1. The student researches and finds a variety of half lives (e.g., skeleton, fossil) of various elements.2. The student relates science vocabulary and nomenclature to Greek and Latin roots (e.g., endo/exo, therm, super/un/saturated).<ul style="list-style-type: none">√ accuracy√ application3. See Strand II (Content of Physical Science) Illustration #5, 6, 15, 16.4. See Strand II (Content of Physical Science) Illustration #16.5. See Strand II (Content of Physical Science) Illustration #5, 6, 15, 16 and #16.6. See Strand II (Content of Physical Science) Illustration #1 – 3.7. See Strand II (Content of Physical Science) Illustration #15 and #16.