OFFICE OF CURRICULUM, INSTRUCTION, & PROFESSIONAL DEVELOPMENT

HIGH SCHOOL COURSE OUTLINE

(Revised June 2011)

Department	Science	**Course Title**		Chemistry 1-2		**Course Code**		3831	
Grade Level	10-12	**Short Title**		CHEMISTRY 1-2		**Grad Requirement**			Yes
Course Length	2 semesters	Credits per Semester	5	Approved for Honors	Yes	Required		Elective	X
Prerequisites	Algebra 1-2 or CD with a "C" or better, or science teacher recommendation								
Co-requisites	None								
Articulated with LBCC	No			Articulated with CSULB				No	
Meets UC "a-g" Requirement	Yes (d)			Meets NCAA Requirement				Yes	

COURSE DESCRIPTION:

This course is a standards-based study of fundamental chemical concepts, such as atomic theory and its relation to chemical behavior, chemical bonding, the mole and stoichiometry, molecular kinetics, energy relationships, solution dynamics, acids-bases, equilibrium, organic and biological chemistry, and nuclear interactions. Emphasis is placed on the utilization of mathematical, analytical, data acquisition, and communication skills as well as interdisciplinary approaches to discovery. Concepts and skills are reinforced by a strong emphasis on hands-on laboratory experiences and the integration of other branches of science. Applications to society, individuals, and the utilization of technology are included. Chemistry fulfills both the physical science high school graduation requirement and the UC/CSU "d" laboratory science requirement. A course in the biological sciences is also needed to complete the minimum graduation requirement for high school.

COURSE PURPOSE: GOALS (Student needs the course is intended to meet)

CONTENT
- Students will learn all of the required California State Standards for Chemistry. They will explore the basic building blocks of matter, investigating the quantum structure of atoms, how that structure determines properties and the organization elements on the Periodic Table. They will investigate how atoms interact, bond, and create larger structures with predictable behaviors. Students will investigate basic techniques to quantify various properties and chemical interactions and understand the mathematical means of predicting outcomes of chemical and physical changes. They will also study thermodynamic principles and the mass actions of reaction rates and equilibria that govern chemical processes. Chemistry students also will consider the larger contexts and applications of these concepts, from organic and biochemical to nuclear processes.

SKILLS
- Students will apply measurement, observation, statistical, and technological skills while investigating chemical concepts. Evidence and experimental data will be analyzed for reliability and possible sources of error. The use of well-designed, memorable laboratory experiences will facilitate this application of scientific knowledge and methodology and is essential in helping students to analyze the content critically. Students will learn how ethical considerations play an important role in modern chemistry-related fields and explore the importance of personal accountability in both individual and group work situations.

LITERACY
- Students will improve their ability to learn independently by researching and drawing generalizations from science related articles, books, graphs, charts, and diagrams. They will also learn the common scientific roots that make vocabulary in the context of chemistry more accessible. Regular opportunities are provided for students to clearly communicate their understanding through oral and written explanations of science concepts and laboratory experiences.

APPLICATIONS
- Students will study the applications of chemistry to ecological, medical, commercial, and ethical issues to develop critical thinking skills, as they apply to decision making in both societal and personal contexts. They will explore both the education and self-promotion skills needed for these professions. This will inspire students to consider pursuing advanced studies in science and the wide variety of related career choices.

COURSE PURPOSE: EXPECTED OUTCOMES

Students are expected to perform at a proficient level on a variety of tasks and assessments addressing both the content and skill standards for Chemistry. Levels of proficiency are defined near the end of this course outline under Performance Standards.

Grade 9-12 Chemistry:

from the Science Standards for California Public Schools, adopted by the California State Board of Education in October, 1998.

Atomic and Molecular Structure .... (10.0% of CST)

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.

Chemical Bonds .... (11.7% of CST)

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.

Conservation of Matter and Stoichiometry .... (16.7% of CST)

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.

Gases and Their Properties .... (10.0% of CST)

4. The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases.

Acids and Bases .... (8.3% of CST)

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions.

Solutions .... (5.0% of CST)

6. Solutions are homogenous mixtures of two or more substances.

Chemical Thermodynamics .... (8.3% of CST)

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter.

Reaction Rates .... (6.7% of CST)

8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules.

Chemical Equilibrium .... (6.7% of CST)

9. Chemical equilibrium is a dynamic process at the molecular level.

Organic Chemistry and Biochemistry .... (3.3% of CST)

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.

Nuclear Processes .... (3.3% of CST)

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.

Investigation and Experimentation .... (10% of CST)

1. 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, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data. (CST)
   b. identify and communicate sources of unavoidable experimental error. (CST)
   c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. (CST, LS10)
   d. formulate explanations using logic and evidence. (CST)
   e. solve scientific problems using quadratic equations and simple trigonometric, exponential, and logarithmic functions. (CST)
   f. distinguish between hypothesis and theory as science terms. (CST, LS10)
   g. recognize the usefulness and limitations of models and theories as scientific representations of reality. (CST)
   h. read and interpret topographic and geologic maps. (CST)
   i. analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem). (CST, LS10)
   j. recognize the issues of statistical variability and the need for controlled tests. (CST, LS10)
   k. recognize the cumulative nature of scientific evidence. (CST)
   l. analyze situations and solve problems that require combining and applying concepts from more than one area of science. (CST)
   m. 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. (CST)
   n. 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). (CST)

CST = Standards assessed on the California Standards Test
LS10 = Standards assessed on the 10th grade No Child Left Behind Biology/Life Science Test

COURSE PURPOSE: EXPECTED INTEGRATED OUTCOMES

Students are also expected to proficiently apply common skills that are relevant across curriculum areas and career pathways. The following are those skills most applicable to this science course.

CTE Foundation Standards:

from the California Career Technical Education Model Curriculum Standards, adopted by the California State Board of Education in May, 2005.

Foundation Standard 2: Communications

Students understand the principles of effective oral, written and multimedia communication in a variety of formats and contexts.

Reading (Grades 9-10)

- 1.3 Identify Greek, Roman, and Norse mythology and use the knowledge to understand the origin and meaning of new words.
- 2.2 Prepare a bibliography of reference materials for a report using a variety of consumer, workplace, and public documents.
- 2.3 Generate relevant questions about readings on issues that can be researched.
- 2.8 Evaluate the credibility of an author's argument or defense of a claim by critiquing the relationship between generalizations and evidence, the comprehensiveness of evidence, and the way in which the author's intent affects the structure and tone of the text (e.g., in professional journals, editorials, political speeches).

Writing (Grades 9-10)

- 1.3 Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.
- 1.5 Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).
- 2.3 Write expository compositions, including analytical essays and research reports:
  - 2.3.a Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
  - 2.3.b Convey information and ideas from primary and secondary sources accurately and coherently.
  - 2.3.c Make distinctions between the relative value and significance of specific data, facts, and ideas.
  - 2.3.d Include visual aids by employing appropriate technology to organize and record information on charts, maps, and graphs.
  - 2.3.e Anticipate and address readers' potential misunderstanding, biases, and expectations.
  - 2.3.f Use technical terms and notations accurately.
- 2.6 Write technical documents:
  - 2.6.a Report information and convey ideas logically and correctly.
  - 2.6.b Offer detailed and accurate specifications.
  - 2.6.c Include scenarios, definitions, and examples to aid comprehension (e.g., troubleshooting guide).
  - 2.6.d Anticipate reader's problems, mistakes, and misunderstandings.

Written and Oral English Language Conventions (Grades 9-10)

- 1.4 Produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization.

Listening and Speaking (Grades 9-10)

- 1.7 Use props, visual aids, graphs, and electronic media to enhance the appeal and accuracy of presentations.
- 2.3 Apply appropriate interviewing techniques:
  - 2.3.a Prepare and ask relevant questions.
  - 2.3.b Make notes of responses.
  - 2.3.c Use language that conveys maturity, sensitivity, and respect.
  - 2.3.d Respond correctly and effectively to questions.
  - 2.3.e Demonstrate knowledge of the subject or organization.
  - 2.3.f Compile and report responses.
  - 2.3.g Evaluate the effectiveness of the interview.
- 2.5 Deliver persuasive arguments (including evaluation and analysis of problems and solutions and causes and effects).
  - 2.5.a Structure ideas and arguments in a coherent, logical fashion.
  - 2.5.b Use rhetorical devices to support assertions (e.g., by appeal to logic through reasoning; by appeal to emotion or ethical belief; by use of personal anecdote, case study, or analogy).
  - 2.5.c Clarify and defend positions with precise and relevant evidence, including facts, expert opinions, quotations, expressions of commonly accepted beliefs, and logical reasoning.
  - 2.5.d Anticipate and address the listener's concerns and counterarguments.

Foundation Standard 3: Career Planning and Management

Students understand how to make effective decisions, use career information, and manage career plans.

3.5 Understand the past, present, and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning.

(3.6) Know important strategies for self-promotion in the hiring process, such as job applications, resume writing, interviewing skills, and preparation of a portfolio.

[*re: reaction rates, 8b; Le Chatelier's Principle, 9a; and carbon-based polymers, 10b*]

Foundation Standard 4: Technology

Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments.

4.2 Understand the use of technological resources to gain access to, manipulate, and produce information, products, and services.

4.3 Understand the influence of current and emerging technology on selected segments of the economy.

Foundation Standard 5: Problem Solving and Critical Thinking

Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem solving techniques.

5.1 Apply appropriate problems-solving strategies and critical thinking skills to work-related issues and tasks.

(5.3) Use critical thinking skills to make informed decisions and solve problems.

[*re: predicting molecular shapes and properties, 2f; Van der Waals effects on volatility, 2h; and % Yield calculations, 3f*]

Foundation Standard 6: Health and Safety

Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of hazardous materials.

6.1 Know the policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities.

6.2 Understand critical elements of health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.

Foundation Standard 7: Responsibility and Flexibility

Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings.

7.1 Understand the qualities and behaviors that constitute a positive and professional work demeanor.

(7.2) Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. [*re: % error calculations and analysis, 3c and 6f*]

7.3 Understand the need to adapt to varied roles and responsibilities.

7.4 Understand that individual actions can affect the larger community.

Foundation Standard 8: Ethics and Legal Responsibilities

Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms.

8.2 Understand the concept and application of ethical and legal behavior consistent with workplace standards.

(8.3) Understand the role of personal integrity and ethical behavior in the workplace. [*re: protection from radiation,11e*]

Foundation Standard 9: Leadership and Teamwork

Students understand effective leadership styles, key concepts of group dynamics, team and individual decision making, the benefits of workplace diversity, and conflict resolution.

9.1 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting.

9.2 Understand the ways in which pre professional associations and competitive career development activities enhance academic skills, promote career choices, and contribute to employability.

(9.3) Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals. [*re: analysis of any group lab work; Performance-Based Projects group work – see p. 45*]

9.4 Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others.

OUTLINE OF CONTENT AND RECOMMENDED TIME ALLOTMENT:

The Task Analysis and Key Vocabulary presented here are drawn from the Science Framework for California Public Schools, which defines the intent and scope of the Science Content Standards. For additional information on the context and the benchmark standards to assess, refer to the Blueprints for the Chemistry Content Standards Test (CST). *Standards without asterisks represent those that all students are expected to achieve in the course of their studies. These will be tested on the CST Chemistry Exam. Standards with asterisks represent those that all students should have the opportunity to learn. For this college-preparatory course, these standards should be included.*

Skill Standards designated **FS** refers to the Foundation Standards of the CA Career Technical Education Model Curriculum Standards [pages 3 and 4]. Content sequencing, Labs/Demos, and time allocations are only suggestions and may be adjusted to suit school site curriculum plans, available materials, and student needs.

Atomic and Molecular Structure *10% CST*

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.

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time

… how to relate the position of an element in the periodic table to its atomic number and atomic mass. **(1,a)**
 	
[CST]
	• Identify and locate protons, neutrons, and electrons in representations of atoms.
	• Provide evidence that protons determine the unique properties of an element, and that neutrons and electrons do not.
	  ◦ Explain how electrons can be gained and lost, which changes some properties, but can generally be easily reversed.
	  ◦ Explain how atoms with different numbers of neutrons but the same number of protons (isotopes) exhibit identical properties, except for mass.
	• Describe how the periodic table is organized in order of increasing atomic number
	  ◦ Identify places where the historical method of arranging elements by mass would place elements in the wrong group (i.e., tellurium and iodine).
	
	Skills Focus:
	model, analyze
	
	Analyze the locations and sequences that are characteristic of natural phenomena. **(I&E 1.i)**
		Key Assignments:
		• **Metal vs. Non-metal Properties** Lab [see p. 46]
		• **Historical Perspective Essay** (possible) [See description on p. 45, in Maj. Writ. Assig. section.]
		
		Suggested:
		•
		
		OES: pending
		PT: pending
			PH Chem Ch 4:3 & 6:1
			
			Supplemental Resources:
			• **Los Alamos Nat'l Lab Periodic Table** http://periodic.lanl.gov/
			• **ACS Periodic Table** http://acswebcontent.acs.org/games/pt.html
			• **Chemical Elements.com** http://www.chemicalelements.com/
			• **WebElements.com** http://www.webelements.com/
			
			Key Vocabulary:
			proton, atom
			neutron, ion
			electron, isotope
				1.5 Days (<1 Block)

… the nucleus of the atom is much smaller than the atom yet contains most of its mass. **(1,e)** [CST]	• Recall that virtually all of an atom's mass is contained in the densely packed nucleus. • Recall that the diameter of any given atom is about 10,000 to 100,000 times greater than the diameter of the nucleus. • Describe or construct analogies to show the true scale proportions of the <u>size</u> of the nucleus to the atom. • Describe or construct analogies to show the true scale proportions of the <u>mass</u> of the nucleus to the electrons of an atom. • Recall that in hydrogen, less than 0.1% of the mass occupies a trillion times more space than the rest of the mass. ***Skills Focus:*** model to scale Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • **Scale Atoms** As homework, have students bring in, diagram, or describe accurate proportional representations of size and mass of the nucleus to the electrons in an atom. OES: pending PT: pending	**PH Chem** Ch 4:2 ***Supplemental Resources:*** • PH Chem, Quick LAB, p 108, "Using Inference: The Black Box" ***Key Vocabulary:*** nucleus	1.5 Days (<1 Block)

<table>
<tr><th colspan="2">Content Standards</th><th rowspan="2">Perf. Std. Measures
How students DEMONSTRATE KNOWLEDGE and SKILL.</th><th rowspan="2">Instructional Support</th><th rowspan="2">Appx Time</th></tr>
<tr><th>(CONTENT)
"Students know…"</th><th>(SKILL)
"Students are able to …"</th></tr>
<tr>
<td>… 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. (1,g*)</td>
<td>∗ Explain that quantum mechanical calculations predict electron energy states.
° Identify the 7 principal quantum numbers that correspond to the periods (horizontal rows) of the periodic table.
° Recall the angular momentum quantum numbers associated with s, p, d, and f orbitals.
° Identify the shapes of the different types of atomic orbitals. (LBUSD)
° Apply the rules for the sequence of orbital filling to determine electron configurations.
∗ Explain how electron energy states justify the organization of the periodic table.
∗ Define valence electrons in terms of having the highest principal quantum number and representing the "surface" of an atom involved in chemical reactions.
∗ Explain that electron configurations are associated with regular patterns of chemical reactivity.
∗ Explain that elements that are one electron in excess (alkali metals) or short (halogens) of a full octet are the most reactive.

Skills Focus:
3-D visualization

Recognize the usefulness and limitations of models and theories as scientific representations of reality. (I&E 1.g)</td>
<td>Key Assignments:
• Quantum Structure of the Atom Lab (Flame Test) [see p. 46]

Suggested:
• <u>PH Chem</u>, Small-Scale Lab 10, p 73, "Electron Config's of Atoms and Ions"

OES: pending
PT: pending</td>
<td><u>PH Chem</u> Ch 5:1-2, 7:1-2, & 8:2

Supplemental Resources:
• Group I & II Activity
TEACHER demonstrates under carefully controlled conditions the reactivity of elemental Li, Na, Mg, and Ca in water with phenolphthalein. (If the teacher has not done this demonstration before, they should not attempt it without the supervision of a teacher experienced with the demo.) Students explain observations based atomic size and electron configuration.
• Atomic Orbitals
http://micro.magnet.fsu.edu/ electromag/java/atomicorbitals/

Key Vocabulary:
quantum numbers
energy state
orbitals
electron configuration
reactivity
octet
valence electrons</td>
<td>6 Days (3 Blocks)</td>
</tr>
<tr>
<td>… how to use the periodic table to determine the number of electrons available for bonding. (1,d)

[CST]</td>
<td>• Recall that all the elements in a group have the same number of valence electrons.
• Identify representative groups (also known as families) by number and name (for example: Group 17, also known as halogens, "formerly called" Group VII).
• Recall that only the valence shell electrons are available for bonding.
∗ Show valence electron configurations for individual atoms using electron dot diagrams. (LBUSD)
• Explain how unfilled energy levels (valence shell orbitals) are also available for bonding (for instance, the Group 16 chalcogens have room for two more electrons shared from another atom or atoms).
∗ Determine the number of electrons or unfilled energy levels available for bonding in atoms from combining ratios of compounds (i.e., $MgCl_2$ and NH_3).

Skills Focus:
predict, generalize

Formulate explanations by using logic and evidence. (I&E 1.d)</td>
<td>Key Assignments:
• Metal vs. Non-metal Properties Lab [see p. 46]
• Quantum Structure of the Atom Lab (Flame Test) [see p. 46]

Suggested:
• Family Trees
Pairs of students choose or are assigned a representative group (or family). They are to describe similarities and differences (both physical and chemical) among members of the family. They then describe both how and why they are different from each other.

OES: pending
PT: pending</td>
<td><u>PH Chem</u> Ch 7:1

Supplemental Resources:
• Valence Electrons
http://dl.clackamas.cc.or.us/ch104-06/valence_electrons.htm
• Valence and Reactivity
http://www.khanacademy.org/ video/valence-electrons? playlist=Chemistry

Key Vocabulary:
valence shell (or valence shell of orbitals)
configuration
representative group</td>
<td></td>
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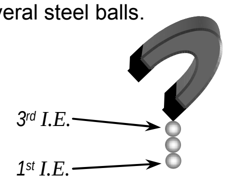
</table>

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to use the periodic table to identify metals, semimetals, non-metals, and halogens. **(1,b)** [CST]	• Identify the elements immediately to the left and right of the stepped line from boron to astatine (except for aluminum) as semimetals. • Describe semimetals as elements having properties intermediate between metals and nonmetals. • Identify where metals and nonmetals are located on the periodic table. • Distinguish properties of metals from nonmetals. • Identify the location of halogens on the periodic table. • Describe characteristic properties of halogens. ***Skills Focus:*** Classify Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Metal vs. Non-metal Properties** Lab [see p. 46] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 6:1-2 ***Supplemental Resources:*** • PH Chem, Lab 9, p 63, "Periodic Properties" ***Key Vocabulary:*** metal nonmetal semimetal (note: text uses "metalloids") halogen	1 Day (½ Block)

… 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. **(1,c)**
 	
[CST]
	• Identify and distinguish the properties of alkali metals (Group 1), alkaline earth metals (Group 2), and transition metals (Groups 3-12).
	• Explain how the properties of alkali, alkaline earth, and transition metals are related to their electron configurations.
	• Define **electronegativity** as the ability of an atom of an element to pull electrons toward itself in a chemical bond.
	  ◦ Identify small electronegativity values (such as the alkali metals have) as indicating a weak pull for electrons in a bond.
	  ◦ Identify large electronegativity values (such as the small chalcogens and halogens) as indicating a strong pull for electrons in a bond.
	• Define **ionization energy** as the amount of energy needed to remove an electron from an atom.
	• Explain why elements may have multiple ionization energies, and why they increase from 1^{st} to 2^{nd} to 3^{rd}, etc.
	• Identify the trends for ionization energy and electronegativity in the periodic table.
	  ◦ Explain how horizontal trends are controlled by the number of protons.
	  ◦ Explain how vertical trends are controlled by the distance between the electrons and the nucleus.
	  ◦ Explain how atomic and ionic sizes generally decrease left to right and increase top to bottom for the same reasons.
	  ◦ Identify exceptions to the trends and explain how these are caused by filled or half-filled subshells.
	
	Skills Focus:
	analyze trends
	
	Recognize the usefulness and limitations of models as representations of reality. **(I&E 1.g)**
		Key Assignments:
		- none -
		
		Suggested:
		• PH Chem, Small-Scale Lab 9, p 69, "A Periodic Table Logic Problem"
		
		OES: pending
		PT: pending
			PH Chem Ch 6:2-3
			
			Supplemental Resources:
			• **Modeling with Magnets** Students use strong and weak magnets to represent atoms with different electronegativities. A steel ball represents a valence electron. Represent ionization energy by having a magnet holding several steel balls.
			
			
			Note that it is easier to remove the first ball than to remove the last one. Students explain what causes the increasing ionization energy in atoms.
			• **Chem Guide – U.K.** http://www.chemguide.co.uk/atoms/bonding/electroneg.html
			• PH Chem, Quick LAB, p 175, "Periodic Trends in Atomic Radii"
			
			Key Vocabulary:
			alkali metals electronegativity
			alkaline earth metals
			transition metals trends
			ionization energy
				5 Days (2½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… 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. **(1,f*)**	* *Identify the location of the lanthanide series (rare earths) and actinide series elements.* * *Recall that all lanthanide and actinide elements are radioactive.* * *Explain that these elements are separated from the normal pattern of the periodic table for practical display size.* * *Recall that most of these elements appear to have three electrons available for bonding, forming compounds with halogens having the general formula MX_3.* * *Identify the transactinide elements, beginning with rutherfordium, element 104.* * *Recall that all transuranium elements (elements beyond ^{92}U) were first synthesized and identified in experiments using accelerators.* * *Explain how accelerators, using electromagnets to accelerate and collide positive atomic nuclei, have produced and identified the transuranium elements.* * *Explain how today some transuranium elements (such as plutonium) are produced commercially in nuclear reactors.* ***Skills Focus:*** Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 6:2, 25:2 ***Supplemental Resources:*** • **Transuranium Elements** http://en.wikipedia.org/wiki/Transuranium_element • **Ask a Scientist** http://www.newton.dep.anl.gov/askasci/chem99/chem99162.htm ***Key Vocabulary:*** lanthanide, transuranium, actinide, accelerator, nuclear reactor	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… 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. **(1,h*)**	* *Describe and/or diagram J. J. Thomson's 1887 cathode ray experiment.* * *Explain how the experiment demonstrated that cathode rays are composed of identical, negatively charged particles, which Thomson named electrons.* * *Describe and/or diagram Ernest R. Rutherford's 1913 experiment with alpha particles (helium nuclei) and gold foil.* * *Explain how the results of this experiment lead to new understanding about how atomic mass is condensed in a dense, charged nucleus.* * *Describe and/or diagram Robert A. Millikan's oil drop experiment.* * *Explain how Millikan's experiment confirmed Thomson's conclusions about electrons and determined their charge.* * *Explain how Albert Einstein explained the photoelectric effect by proposing that light consists of discrete bundles, called photons, capable of ejecting electrons from atoms if the light frequency is correct.* ° *Explain that the kinetic energy of an ejected electron equals the energy of a single photon minus the energy needed to free the electron from the metal.* ° *Explain that if the frequency of light is too low to free an electron, merely increasing the intensity of light (producing more photons) will not cause electrons to eject.* ***Skills Focus:*** analyze experiments Recognize the cumulative nature of scientific evidence. **(I&E 1.k)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 4:2 & 5:3 ***Supplemental Resources:*** • **Thomson's Cathode Exp** http://www.aip.org/history/electron/jj1897.htm • **Cathode Animation** http://highered.mcgraw-hill.com/sites/0072512644/student_view0/chapter2/animations_center.html# • **Rutherford's Gold Foil Exp** http://en.wikipedia.org/wiki/Ernest_Rutherford • **Millikan's Oil Drop Exp** http://webphysics.davidson.edu/applets/pqp_preview/contents/pqp_errata/cd_errata_fixes/section4_5.html • **Photoelectric Effect** http://www.colorado.edu/physics/2000/quantumzone/photoelectric.html • **Photoelectric Effect and Wave Particle Duality** http://hyperphysics.phy-astr.gsu.edu/hbase/mod1.html • **Nobelaureates** http://nobelprize.org/nobel_prizes/chemistry/laureates/ • PH Chem, Virtual Chem Lab 8, "Photoelectric Effect" ***Key Vocabulary:*** **electrons**, alpha particle, cathode ray, **photons**	4 Days (2 Blocks)

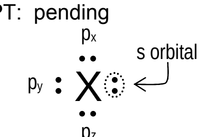
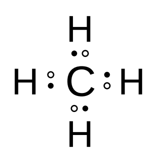
Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom. **(1,i*)**	∗ *Explain that Niels Bohr combined Rutherford's nuclear atom with Einstein's photons (along with other ideas) to develop a quantum model of the atom that successfully explains experimental observations not understood before.* ◦ *Explain that Bohr's quantum model explained the colors (wavelengths) of light emitted when excited electrons fall back to their ground state.* ◦ *Explain that, because in classical physics accelerating charges must emit energy, scientists could not explain why electrons did not gradually slow down until atoms collapsed.* ◦ *Explain that Bohr's quantum model proposed that electrons only gain or lose energy by transitioning from one discrete energy level to another.* ∗ *Explain that Louis de Broglie's quantum model proposed that particles have wave properties, for instance, that electrons "resonate" at particular energy levels just as sound waves resonate in a musical instrument.* ∗ *Recall that Erwin Shrödinger and others developed quantum mechanics, a theory that describes and predicts atomic and nuclear phenomena, including the shapes of atomic (s, p, d, and f) and molecular bond (σ and π) orbitals.* ***Skills Focus:*** visualize, explain Recognize the cumulative nature of scientific evidence. **(I&E 1.k)**	***Key Assignments:*** • **Quantum Structure of the Atom** Lab (Flame Test) [see p. 46] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 5:1,3 ***Supplemental Resources:*** • PH Chem, Lab 6, p 49, "Flame Tests for Metals" • PH Chem, Lab 7, p 53, "Energies of Electrons" • **Intro to Quantum Mechanics** http://www.hi.is/~hj/QuantumMechanics/quantum.html • **Visual Quantum Mechanics** http://phys.educ.ksu.edu/vqm/html/emission.html ***Key Vocabulary:*** quantum resonate	6 Days (3 Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… 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). **(1,j*)**	∗ *Explain that electrons lose energy when "falling" from higher energy levels to a lower ones by emitting photons of light, which produce an emission (or bright line) spectrum.* ∗ *Explain that the energy of each photon of light given off is exactly the same as the difference between two energy levels.* ∗ *Explain that atomic energy levels can also be determined by observing what energy of photons are absorbed to make electrons jump from a lower (ground state) energy level to a higher one, which produce absorption spectra.* ∗ *Demonstrate how to calculate the energy absorbed or emitted by electron jumps from the observed frequency (or color) of light using Planck's relationship:* $$E = h(c/\lambda)$$ *where E is the amount of energy, h is Planck's constant (6.626x10^{-34} Js), c is the speed of light, and is the wavelength of the light observed.* *or since $c/\lambda = \nu$,* *(where ν is the frequency of light observed) the equation can be shortened to* $$E = h\nu$$ ∗ *Explain that the quantum mechanical model describes a probabilistic nature for electron distribution that can be envisioned as random hits on a dartboard or the density of bees in the proximity of a beehive.* ***Skills Focus:*** measure, calculate Recognize the issues of statistical variability and the need for controlled tests. **(I&E 1.j)**	***Key Assignments:*** • **Quantum Structure of the Atom** Lab (Flame Test) [see p. 46] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 5:2-3 ***Supplemental Resources:*** • **Quantum Electron Darts** Using darts, or objects that leave a mark on a large paper, demonstrate the spread of "hits" when thrown from a short distance versus throwing from greater distances (representing higher quantum energy levels). Students explain how this relates to electron locations around atoms. Adapted from the CA Sci. Framework, p 190. • **Spectroscopy** Observe spectral lines for sodium flame and various gas tubes using a diffraction grating spectroscope. Calculate the wavelengths emitted using the Bragg equation. • **Visual Quantum Mechanics** http://phys.educ.ksu.edu/vqm/html/emission.html ***Key Vocabulary:*** **emission (bright line) spectra** **absorption spectra** probabilistic	4 Days (2 Blocks)

Chemical Bonds

11.7% CST

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.

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds. **(2,a)** [CST]	• Explain that non-metal atoms with similar electronegativities (equivalent pulls for the shared electrons) form covalent bonds to become molecules. • Describe a covalent bond as having a shared pair of electrons localized in a region of overlap between two atomic orbitals. • Explain that the valence electrons of metal atoms are not localized to individual atoms, but are easily pushed from one atom to another, allowing metals to conduct electricity well. • Explain that when an electron from a low electronegativity atom (like a metal) is removed by an atom with high electronegativity, it creates oppositely charged ions that attract each other, forming an ionic bond. • Identify various chemical bonds as covalent, ionic, or polar covalent. • Explain how "the octet rule" applies to the formation of ionic and covalent bonds. ***Skills Focus:*** model, justify properties Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Physical Properties** Lab [see p. 46] • **Molecular Modeling** Lab [see p. 46] ***Suggested:*** • PH Chem, Inquiry Activity, p 212, "Shapes of Molecules" OES: pending PT: pending	**PH Chem** Ch 7:2-3 & 8:1-2 ***Supplemental Resources:*** • **Conductivity Observations** Check the conductivity of various metal and nonmetallic objects, solutions, and comparing ionic crystals to ionic solution. Students explain their observations in terms of bonding and movement of charged particles. • **Types of Chemical Bonding** http://www.beyondbooks.com/psc92/3.asp ***Key Vocabulary:*** covalent bond metallic bond octet rule localized **polar covalent**	5 Days (2½ Blocks)
… how to draw Lewis dot structures. **(2,e)** [CST]	• Determine the number of valence electrons for elements from their position on the periodic table. • Draw Lewis dot diagrams for atoms and simple molecules. • Explain how electron pairs in the Lewis dot diagram are shared between two atoms. • Use Lewis dot diagrams to predict the combining ratios between atoms. • Use Lewis dot diagrams to determine if bonds will be ionic or covalent. • Use Lewis dot diagrams to determine where single, double, and triple bonds occur. ***Skills Focus:*** diagram, predict Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Molecular Modeling** Lab [see p. 46] ***Suggested:*** • OES: pending PT: pending   	**PH Chem** Ch 6:2-3 ***Supplemental Resources:*** • **Lewis Dot Tutorial** http://www.kentchemistry.com/links/bonding/lewisdotstruct.htm • **Lewis Dot Tutorial** http://web.chem.ucla.edu/~harding/lewisdots.html • **Lewis With Formal Charges and Resonance** http://www.science.uwaterloo.ca/~cchieh/cact/c120/dotstruc.html ***Key Vocabulary:*** Lewis dot diagrams	3 Days (1½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to predict the shape of simple molecules and their polarity from Lewis dot structures. **(2,f*)**	∗ *Determine the number of shared and unshared electron regions around atoms in a molecule from a correct Lewis dot diagram.* ∗ *Describe how atomic orbitals hybridize to form molecular orbitals that will overlap between atoms to form bonds. (LBUSD)* ∗ *Explain that valence electron pairs form negatively charged regions that repel each other, making covalently bonded atoms around a central atom position themselves as far apart as possible (a.k.a., Valence Shell Electron Pair Repulsion).* ∗ *Determine the correct three-dimensional geometry of molecules.* ∗ *Explain how unshared electron pairs and multiple bonds affect the geometry of molecules by occupying a "fatter" region of space than single covalent bonds. (LBUSD)* ∗ *Identify and molecular bond orbitals and how they form from atomic or hybrid orbitals. (LBUSD)* ∗ *Explain how symmetrical distribution of charge around a central atom leads to a nonpolar molecule in which charge is distributed evenly.* ***Skills Focus:*** analyze symmetry Use critical thinking skills to make informed decisions and solve problems. **(FS 5.3)** Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)**	***Key Assignments:*** • **Molecular Modeling** Lab [see p. 46] ***Suggested:*** • **Symmetry Symptoms** Given various examples, students are able to determine which molecules are symmetrical and which are not, and predict various properties of the substance based on these observations. Adapted from the <u>CA Sci. Framework</u>, p 193. OES: pending PT: pending	**<u>PH Chem</u>** Ch 8:3-4 ***Supplemental Resources:*** • <u>PH Chem</u>, Lab 11, p 73, "Molecular Models" • **VSEPR** http://www.meta-synthesis.com/webbook/45_vsepr/VSEPR.html • **VSEPR** http://chemlabs.uoregon.edu/GeneralResources/models/vsepr.html ***Key Vocabulary:*** repulsion 3-D geometry symmetry	5 Days (2½ Blocks)
… 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. **(2,b)** [CST]	• Recall that organic and biological molecules are primarily made of carbon, oxygen, hydrogen, and nitrogen. • Identify unpaired electrons in these atoms as available sites for covalent bonding. • Apply the octet rule to determine bonding patterns between carbon and hydrogen, nitrogen, and oxygen. • Explain how the great variety of bonding possibilities among carbon, nitrogen, oxygen, and hydrogen make a great diversity of organic and biological molecules possible. ***Skills Focus:*** investigate possible combinations Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Physical Properties** Lab [see p. 46] • **Molecular Modeling** Lab [see p. 46] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 8:1-4, 22:2 & 24:6 ***Supplemental Resources:*** • **Molecule Building** Use models (i.e., ball and stick or gumdrop and toothpick) to explore possible bonding combinations and simple organic molecules. (Make sure students are reinforcing VSEPR geometry principles if those have been addressed.) <u>CA Sci. Framework</u>, p 192 • **Organic Covalent Bonding** http://www.elmhurst.edu/~chm/vchembook/144Acovalent.html • **Molecular Models** http://www.molecularmodels.ca/molecule/molecule_index.html ***Key Vocabulary:*** organic molecules biological molecules	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction. **(2,c)** [CST]	• Explain that ionic compounds do not exist as neutral pairs, but as either separate ions (when dissolved) or as an ordered lattice of ions held together by "static cling" (in solid form). • Explain that ions form repeating patterns that minimize their energy state by reducing the distance between (+) and (-) charges and maximizing the distance between like charges. • Define lattice energy as the electrostatic attraction between cations (+) and anions (-) that holds ionic compounds together. ***Skills Focus:*** visualize Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Physical Properties** Lab [see p. 46] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 7:2 ***Supplemental Resources:*** • **Ionic Structures** http://www.chemguide.co.uk/atoms/structures/ionicstruct.html ***Key Vocabulary:*** **anion** lattice **cation** **lattice energy** **electrostatic attraction**	1 Day (½ Block)
… 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. **(2,d)** [CST]	• Explain that in any substance, at any temperature, the attractive forces holding the material together are opposed by the internal energy of particle motion. • Explain that solids exist when the attractive forces between atoms or molecules are stronger than the internal agitation of particle motion. • Explain that melting occurs when enough energy is added so that the internal kinetic energy of atoms or molecules overcomes the attractive forces. • Describe melting as releasing particles from a rigid lattice to a disordered, non-rigid state where particles move randomly although they remain in contact with each other and still experience some attraction to each other. ***Skills Focus:*** observe, model Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Physical Properties** Lab [see p. 46] ***Suggested:*** • **Melting Point** Observe and compare melting points in substances with sharp melting points and those, which gradually change from solid to liquid. Explain the difference based on intermolecular (inter-particle) attractions. OES: pending PT: pending	**PH Chem** Ch 13:2-3 ***Supplemental Resources:*** • **"Microscopic" View of States** http://www.chem.purdue.edu/gchelp/liquids/character.html ***Key Vocabulary:*** internal energy **melting**	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how electronegativity and ionization energy relate to bond formation. **(2,g*)** DISTRICT ASSESSMENTS: OES: pending PT: pending	* *Explain that as bonds form, atoms with large electronegativity values attract electrons away from lower electronegativity atoms so that the shared electrons are not shared equally.* * *Explain that if the electronegativity difference between two atoms is great enough (usually with a metal and a nonmetal), there will be essentially no electron sharing and the bond will be ionic.* * *Explain that when electronegativity differences are small (usually with two nonmetals), a covalent bond forms with more equal sharing of the electrons.* * *Define* ionization energy *(more precisely than with standard 1c) as the energy needed to remove an electron from an isolated gaseous atom, leaving a positively charged ion.* * *Explain that the forces that pull electrons in a bond (electronegativity) are usually directly related to the amount of energy needed to remove an electron (ionization energy).* ***Skills Focus:*** justify from data Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 6:3 & 8:4 ***Supplemental Resources:*** • **Bond Polarity & Electronegativity** http://www.mikeblaber.org/oldwine/chm1045/notes/Bonding/Polarity/Bond05.htm ***Key Vocabulary:*** electronegativity **ionization energy**	2 Days (1 Block)

<table>
<tr><th colspan="2">Content Standards</th><th rowspan="2">Perf. Std. Measures
How students DEMONSTRATE KNOWLEDGE and SKILL.</th><th rowspan="2">Instructional Support</th><th rowspan="2">Appx Time</th></tr>
<tr><th>(CONTENT)
"Students know…"</th><th>(SKILL)
"Students are able to …"</th></tr>
<tr>
<td>… 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.
(2,h*)</td>
<td>∗ Explain that solids may be held together by ionic bonds (like salts), covalent bonds (like minerals), or by weaker forces of attraction between molecules called van der Waals attractions (like sugar).
∗ Explain that van der Waals forces (a.k.a., London Dispersion forces) exist between all molecules, polar and nonpolar.
° Describe the strongest van der Waals forces, called hydrogen bonding, as the attraction between oppositely charged ends of two polar molecules.
° Explain that liquid water is an important example of hydrogen bonding, which is caused by its bent shape.
° Explain how when a polar molecule gets next to a nonpolar molecule, it can pull or push the electrons of nonpolar molecule, making it temporarily polar, so that the two molecules attract each other slightly. (LBUSD)
° Describe how the weakest van der Waals attraction occurs between two nonpolar molecules when one molecule's electrons and are found temporarily closer to one nucleus, making it slightly polar. This can induce a neighboring molecule to become slightly polar and they experience a very weak, very short attraction.
∗ Define volatility as the ability of a substance to evaporate at ordinary temperatures and pressures.
∗ Explain why solids held together by van der Waals forces have low to moderate melting points.
∗ Explain and cite examples of how the volatility and boiling temperature of liquids is affected by van der Waals forces.
∗ Explain that substances with large molecules have more electrons and experience greater van der Waals forces, increasing melting and boiling temperatures and decreasing volatility.

Skills Focus:
justify from observations

Use critical thinking skills to make informed decisions and solve problems. (FS 5.3)

Formulate explanations by using logic and evidence. (I&E 1.d)</td>
<td>Key Assignments:
• Physical Properties Lab [see p. 46]

Suggested:
• Drop Observations Students observe a drop of water and a drop of isopropyl alcohol on a clean microscope slide. They describe and explain drop shapes and evaporation based on intermolecular attractions.

OES: pending
PT: pending</td>
<td><u>PH Chem</u> Ch 8:4 & 13:2-3

Supplemental Resources:
• <u>PH Chem</u>, Small-Scale Lab, SE p 400, "The Behavior of Liquids and Solids"
• Van der Waals Forces http://antoine.frostburg.edu/chem/senese/101/liquids/faq/h-bonding-vs-london-forces.shtml
• Van der Waals Forces http://www.chemguide.co.uk/atoms/bonding/vdw.html

Key Vocabulary:
van der Waals attractions
hydrogen bonding polar
induce volatility
melting boiling</td>
<td>4 Days (2 Blocks)</td>
</tr>
</table>

Conservation of Matter and Stoichiometry

16.7% CST

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.

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to describe chemical reactions by writing balanced equations. **(3,a)** [CST]	• Describe a chemical formula in terms of atoms and elements. • Recall and apply basic rules of chemical nomenclature. (Rules for naming complex ions, acids, and organic and biological compounds will be added later as they are needed.) • Distinguish between reactants and products in a chemical reaction. • Write unbalanced equations to describe chemical reactions using correct formulas. • Explain the law of conservation of mass. • Explain how the law of conservation of mass applies to balancing equations. • Balance equations, determining correct coefficients for each reactant and product. ***Skills Focus:*** follow nomenclature rules, balance equations	***Key Assignments:*** • **Observing a Chemical Rxn** Lab [see p. 46] • **Stoichiometry** Lab [see p. 46] • **Solubility/Qual. Analysis** Lab [see p. 47] ***Suggested:*** • **Balanced Equation Posters** Small groups create posters to illustrate balanced equations using a different color for each element. Students will demonstrate understanding of conservation of mass. OES: pending PT: pending	**PH Chem** Ch 11:1,3 & 12:1 ***Supplemental Resources:*** • PH Chem, Lab 16, p 101, "ID of Anions and Cations in Soln." ***Key Vocabulary:*** nomenclature, subscript, element, chemical reaction, reactant, conservation of mass, product, balanced equation, coefficient	5 Days (2½ Blocks)
… the quantity *one mole* is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams. **(3,b)** [CST]	• Explain that one mole is a unit that measures a fixed number of atoms. • Explain that the purpose of the mole is to multiply (or "magnify") from the atomic scale to an amount we can easily measure. • Recall that carbon-12 (^{12}C) was chosen as the standard for defining a mole: one mole of ^{12}C atoms weighs exactly 12 grams. • Explain and give examples to show that the atomic mass of an element is the weighted average of one mole of that element based on the natural abundance of all its isotopes. ***Skills Focus:*** apply abstraction Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Empirical Formula of a Hydrate** Lab [see p. 46] ***Suggested:*** • PH Chem, Inquiry Activity, p 286, "Counting by Measuring Mass" OES: pending PT: pending	**PH Chem** Ch 10:1 ***Supplemental Resources:*** • PH Chem, Small-Scale Lab 13, p 91, "Measuring Mass: A Means of Counting" • **Mole Lab:** http://www.chemcoach.com ***Key Vocabulary:*** **mole**, atomic mass, **molar mass**, element	3 Days (1½ Blocks)
… one mole equals 6.02 x 10^{23} particles (atoms or molecules). **(3,c)** [CST]	• Explain that because atoms are so small, it takes an enormous number of them to have enough to measure and work with easily. • Recall that Avogadro's number (NA) is $6.02X10^{23}$, meaning that there are 602,000,000,000,000,000,000,000 ^{12}C atoms in 12 grams of pure ^{12}C. • Recall that Avogadro determined the number experimentally, and that today the number is known to a high degree of accuracy. ***Skills Focus:*** switch between atomic and visual perspectives, research Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 10:1 ***Supplemental Resources:*** • **Avogadro Research** Students research how Amadeo Avogadro determined N_A experimentally. ***Key Vocabulary:*** mole, Avogadro's number	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… 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. **(3,d)** [CST]	• Define the molar mass of a compound as the sum of the atomic masses of the elements represented, with each multiplied by the number of atoms represented. • Recall that molar mass may also be called molecular mass or molecular weight. • Explain that the units of molar mass are atomic mass units (amu – which is equivalent to the total number of proton and neutron masses) at the atomic level OR grams per mole (g/mol - which is the practical unit for larger, easily measurable amounts). • Apply molar mass as a conversion factor between grams and moles • Apply Avogadro's number, $6.02x10^{23}$, as a conversion factor between moles and particles. • Explain that one mole of any gas will occupy the same volume at a given temperature and pressure, regardless of the gas composition. • Define Standard Temperature and Pressure (STP) as 0^oC and 1 atm. • Apply the molar volume of a gas at STP (22.4 L/mol) as a conversion factor between liters of gas and moles of the gas. ***Skills Focus:*** switch between atomic and visual perspectives Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Empirical Formula of a Hydrate** Lab [see p. 47] • **Stoichiometry** Lab [see p. 46] ***Suggested:*** • **Mole Math Maps** Student groups design and present a visual to represent the use on moles in conversions to and from particles, grams, and liters. OES: pending PT: pending	**PH Chem** Ch 10:1-2 ***Supplemental Resources:*** • PH Chem, Lab 13, p 85, "Empirical Formula Determination" • **"Molptures"** Students calculate and measure out (to the nearest cg) 1 mole of aluminum for "Mole Sculptures". ***Key Vocabulary:*** chemical formula; mole; **molecular mass** ***(molecular weight)***; subscript	4 Days (2 Blocks)

… 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. **(3,e)**
 	
[CST]
	• Explain that since a balanced equation shows how many atoms interact in a chemical reaction, mole conversion will let you determine the masses (in grams) involved.
	• Set up and perform calculations to determine the amount of any product or reactant given the amount of just one.
	  ◦ Identify the given quantity and convert it to moles.
	  ◦ Use the coefficients from the balanced equation to write a mole ratio that converts from one substance in the reaction to another.
	  ◦ Choose an appropriate conversion factor to determine the amount of substance requested.
	  ◦ Demonstrate unit cancellation (dimensional analysis), even before plugging in numerical values.
	
	Skills Focus:
	lab skills, calculate
	
	Identify and communicate sources of unavoidable experimental error. **(I&E 1.b)**
	
	Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. **(FS 7.2)**
		Key Assignments:
		• **Stoichiometry** Lab [see p. 46]
		
		Suggested:
		• PH Chem, Lab 19, p 121, "Quantitative Analysis" (*See also note on standard 3f.*)
		
		OES: pending
		PT: pending
			PH Chem Ch 12:2
			
			Supplemental Resources:
			• PH Chem, **Lab 20 cannot be used** because $Pb(NO_3)$ is not permitted in California public schools.
			• **Stoichiometry** http://www.chem4kids.com/files/react_stoichio.html
			• **Stoichiometry Tutorial Video** http://www.chemcollective.org/stoich/reaction_stoi.php
			
			Key Vocabulary:
			coefficient; mole ratio; coefficient; stoichiometry; subscript
				5 Days (2½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to calculate percent yield in a chemical reaction. **(3,f*)**	* *Identify the calculated amount of a chemical product as the theoretical yield of a reaction.* * *Identify the amount of product measured after a chemical reaction as the actual yield of a reaction.* * *Recall that percents are always calculated as (part/whole) x 100.* * *Calculate percent yield as:* $\% \text{ Yield} = \left(\frac{\text{Actual Yield}}{\text{Theoretical Yield}}\right) \times 100$ **Skills Focus:** explain the implications of % error calculations Use critical thinking skills to make informed decisions and solve problems. **(FS 5.3)** Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. **(I&E 1.c)**	***Key Assignments:*** • **Stoichiometry** Lab [see p. 46] ***Suggested:*** • PH Chem, Lab 19, p 121, "Quantitative Analysis" (*% Yield can be added and contrasted to % Error calculation at the end of this lab.*) OES: pending PT: pending	**PH Chem** Ch 12:3 ***Supplemental Resources:*** • **Stoichiometry** http://www.chemcollective.org/stoich/percentyield.php ***Key Vocabulary:*** mole to mole ratio theoretical yield actual **yield** percent yield	2 Days (1 Block)
… how to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions. **(3,g*)**	* *Define* **oxidation** *as an increase in the oxidation number of an atom caused by a loss of electrons.* * *Define* **reduction** *as a decrease in the oxidation number of an atom caused by a gain of electrons.* * *Explain that oxidation numbers are assigned as if all of the electrons in a bond were located on the more electronegative element (as if all bonds were completely ionic).* * *Assign oxidation numbers to atoms found in free elements and in compounds.* * *Explain that oxidation numbers are assigned as if all of the electrons in a bond were located on the more electronegative element (as if all bonds were completely ionic).* * *Balance redox reactions by solving for reduction and oxidation half-reactions, and then recombining when the number of electrons gained and lost are balanced.* **Skills Focus:** balance and combine ½ rxns	***Key Assignments:*** • **Reduction - Oxidation** Lab [see p. 46] ***Suggested:*** • **Al^o Foil in Cu^{2+} Soln** Students observe and write balanced redox reaction to explain observations. May also be done by using a nail to scratch the plastic lining in an aluminum can. Scratch all the way around the midline of the can. Pour Cu^{2+} soln into can. When reaction is done, pour out the solution into chemical waste and the can is easily pulled apart to show Cu^o at the scratches. OES: pending PT: pending	**PH Chem** Ch 20:1-3 ***Supplemental Resources:*** • PH Chem, Lab46, p 275, "Oxidation-Reduction Reactions" • PH Chem, Small-Scale Lab 35, p 249, "Oxidation-Reduction Reactions" • PH Chem, Lab 47, p 279, "Corrosion" • **Redox Rxns** http://www.chemistry.co.nz/redox_begin.htm ***Key Vocabulary:*** oxidation number **oxidation** **reduction** oxidation-reduction reaction half-reaction redox	4 Days (2 Blocks)

Gases and Their Properties *10% CST*

4. The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases.

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the random motion of molecules and their collisions with a surface create the observable pressure on that surface. **(4,a)** [CST]	• Describe both gases and liquids as fluids in which the molecules move freely past each other in random directions. ° Explain that the atoms and/or molecules of liquids are held close to each other by intermolecular forces. ° Explain that the atoms and/or molecules of gases are spaced far apart and reasonably free to move at high speeds, near the speed of sound. • Define pressure as force exerted per unit area. • Explain that the force of the pressure in fluids comes from the sum of all the particles (atoms and /or molecules) colliding against a surface. ° Describe how air pressure is created by gravity pulling air molecules toward the Earth's surface where they strike objects. This is sometimes referred to as the weight of air. ° Explain that air pressure decreases with altitude. ° Describe how gravity creates water pressure in the same way as air, but that the pressures are much greater because water is much denser. ° Explain that water pressure increases with depth. • Explain that pressure is felt equally in all directions because of the random motion of the particles. ***Skills Focus:*** define, apply Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 13:1 ***Supplemental Resources:*** • **Bell Jar Demos** Demonstrate pressure effects on marshmallows, shaving cream, balloons, etc. • See **"Drop Observations"** described for standard 2h*. • **Pressure in Fluids** http://www.school-for-champions.com/science/fluid_pressure.htm • **Fluid Pressure Measurement** http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html ***Key Vocabulary:*** fluid, weight, **pressure**, altitude, gravity	3 Days (1½ Blocks)
… the random motion of molecules explains the diffusion of gases. **(4,b)** [CST]	• Explain and demonstrate how the random motion of molecules causes gases to diffuse into each other to form homogeneous mixtures. • Explain that particles with large masses will have smaller velocities and particles with small masses will have larger velocities at the same temperature. (This relates to standard 7a.) • Predict which gases will diffuse faster when given sample molecules of gaseous substances. ***Skills Focus:*** compare, predict Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 14:4 ***Supplemental Resources:*** • **Perfume** Have students raise their hands as they smell a perfume or cologne opened in one corner of the class to show diffusion in the room. • PH Chem, Lab 25, p 163, "Diffusion of Gases" • **NH_4Cl Ring** Observe the white ring formed when $NH_{3\ (g)}$ and $HCl_{(g)}$ are simultaneously placed at opposite ends of a glass tube and diffuse toward one another. (Add Daltons Law calculations to connect to standard 4i*.) CA Sci. Framework, p 199 ***Key Vocabulary:*** homogeneous, **diffusion**	3 Days (1½ Blocks)

<table>
<tr><th colspan="2">Content Standards</th><th rowspan="2">Perf. Std. Measures
How students DEMONSTRATE KNOWLEDGE and SKILL.</th><th rowspan="2">Instructional Support</th><th rowspan="2">Appx Time</th></tr>
<tr><th>(CONTENT)
“Students know…”</th><th>(SKILL)
“Students are able to …”</th></tr>
<tr>
<td>… how to apply Dalton's law of partial pressures to describe the composition of gases and Graham's law to predict diffusion of gases. (4,i*)</td>
<td>∗ Define diffusion as the process of mixing atoms or molecules by random motion.
∗ Define effusion as the process by which gas molecules pass from one container to another at low pressure through a small opening.
∗ Estimate the rates of diffusion of gases by calculating effusion rates with the Graham’s law equation.
$$\frac{u_B}{u_A} = \sqrt{\frac{M_A}{M_B}}$$
∗ Explain how the combination of observations, Graham’s law calculations, and the kinetic molecular theory demonstrate the inverse relationship between the mass of gas particles and their speed.
∗ Explain why the properties of ideal gases depend only on the number of particles present, and not on the chemical identity of the gases.
∗ Calculate partial pressures of component gases using Dalton’s law of partial pressures.
$$P_{TOT} = P_A + P_B + P_C \ldots$$
$$P_A = X_A \cdot P_{TOT}$$
Skills Focus:
calculate, analyze

Solve scientific problems using simple exponential functions. (I&E 1.e)</td>
<td>Key Assignments:
• Gas Laws Lab [see p. 46]
Suggested:
• NH_4Cl Ring
Students observe the white ring formed when $NH_{3\,(g)}$ and $HCl_{(g)}$ are simultaneously placed at opposite ends of a glass tube and diffuse toward one another. They then use Daltons Law to confirm the ratio of molar masses and explain the diffusion and effusion behavior of various gases.
<u>CA Sci. Framework</u>, p 199

OES: pending
PT: pending</td>
<td><u>PH Chem</u> Ch 14:4
Supplemental Resources:
• (See activities described for standard 4b.)
• Diffusion of Gases
http://polymer.bu.edu/projects2/06_jw_ez/
• Partial Pressures
http://www.khanacademy.org/video/partial-pressure?playlist=Chemistry
Key Vocabulary:
effusion inverse
partial pressure component gas</td>
<td>5 Days (2½ Blocks)</td>
</tr>
<tr>
<td>… 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. (4,c)

[CST]</td>
<td>• Identify the symbols and units used for pressure, volume, and temperature when working with ideal gases.
• Explain and give practical examples of how gas properties affect one another as shown in the following table:
<table>
<tr><th>Expression of Gas Law</th><th>Fixed Values</th><th></th><th>Relationship of Variables</th></tr>
<tr><td>PV = constant</td><td>n, T</td><td>(Boyle's Law)</td><td>Inverse</td></tr>
<tr><td>V/T = constant</td><td>n, P</td><td>(Charles' Law)</td><td>Direct</td></tr>
<tr><td>P/T = constant</td><td>n, V</td><td></td><td>Direct</td></tr>
</table>
• Predict and calculate the changes that will occur (to a fixed number of moles, n, of an ideal gas) when one or more of the physical variables above is altered.
Skills Focus:
prove mathematical relationships from observations

Formulate explanations by using logic and evidence. (I&E 1.d)</td>
<td>Key Assignments:
• Gas Laws Lab [see p. 46]
Suggested:
•
OES: pending
PT: pending</td>
<td><u>PH Chem</u> Ch 14:2-3
Supplemental Resources:
• <u>PH Chem</u>, Lab 23, p 147, “P-V Relationships for Gases”
• <u>PH Chem</u>, Lab 24, p 155, “T-V Relationships for Gases”
• <u>PH Chem</u>, Virtual Chem Lab 11, “P-V Relationships for Gases”
• <u>PH Chem</u>, Virtual Chem Lab 12, “T-V Relationships for Gases”
• Elastic Gas Containers
Students observe balloon behavior in a bell jar (changing pressure) and under different temperature conditions. Adapted from the <u>CA Sci. Framework</u>, p 199-200
• Virtual Lab
http://jersey.uoregon.edu/vlab/Piston/
Key Vocabulary:
ideal gas fixed number</td>
<td>5 Days (2½ Blocks)</td>
</tr>
</table>

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the values and meanings of standard temperature and pressure (STP). **(4,d)** [CST]	• Recall that scientists have agreed upon 0°C as the standard temperature and 1 atmosphere (760 mm Hg) as the standard pressure for comparing gases. • Explain that when volumes are being compared, the temperature and pressure must be specified. ***Skills Focus:*** define, recall	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 10:2 & 13:1 ***Supplemental Resources:*** • **Standard Weather** Students convert STP into standard units used to report weather. Then use the internet or national newspaper to locate and describe conditions at places experiencing STP in the day or at night. ***Key Vocabulary:*** standard	1 Day (½ Block)
… there is no temperature lower than 0 Kelvin. **(4,f)** [CST]	• Explain that the greater the atomic and molecular motion, the greater the observed temperature of a substance. • Explain that the theoretical lowest temperature, or absolute zero, occurs when all molecular motion stops. • Explain that it is impossible to have a negative absolute temperature, because molecules cannot move slower than a dead stop. • Recall that absolute zero has been experimentally determined to be –273.15°C by lowering the temperature of objects to within a fraction of a degree of that value. • Explain that the Kelvin scale (K) is an absolute temperature scale, because it starts at absolute zero (0 K). ***Skills Focus:*** model, justify Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • **Temperature Skit** Have a group of students imitate gas particles by bouncing around. Ask them to demonstrate what happens when the temperature increases, then decreases. Have them demonstrate colder and colder temperatures (include phase changes) until they stop. Ask them how to get colder. OES: pending PT: pending	**PH Chem** Ch 13:1 ***Supplemental Resources:*** • **Temperature & Absolute Zero** http://www.colorado.edu/physics/2000/bec/temperature.html ***Key Vocabulary:*** absolute zero	3 Days (1½ Blocks)
… how to convert between the Celsius and Kelvin temperature scales. **(4,e)** [CST]	• Explain that the units of change on the Kelvin scale are the same size as degrees on the Celsius scale. • Convert between Kelvin and Celsius scales by appropriately adding or subtracting 273.15 (or rounded off to 273). ***Skills Focus:*** calculate	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 3:2 ***Supplemental Resources:*** • **Temperature Scales** http://cryo.gsfc.nasa.gov/introduction/temp_scales.html ***Key Vocabulary:*** convert	½ Day (<½ Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms. **(4,g*)**	∗ *Explain that the average kinetic energy of particles in an ideal gas is directly proportional to its Kelvin temperature.* ∗ *Explain that the effects of average kinetic energy can be observed as changes in pressure and volume that accompany temperature changes.* ∗ *Explain that, by definition, at 0 K all motion in an ideal monatomic gas ceases, meaning that the average kinetic energy equals zero. (Note that since a particle cannot have a negative kinetic energy – move slower than stop – the average kinetic energy cannot be zero unless all particles have zero kinetic energy. So it is not your typical mathematical average at this extreme value!)* ***Skills Focus:*** model, mathematic reasoning Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 13:1 & 14:4 ***Supplemental Resources:*** (See activities and links for standards 4c and 4e.) ***Key Vocabulary:*** average kinetic energy directly proportional	2 Days (1 Block)
… how to solve problems by using the ideal gas law in the form PV = nRT. **(4,h*)**	∗ *Identify the ideal gas law,* ***PV=nRT****, as a way to determine the relationships among pressure, volume, and temperature for a fixed mass of gas.* ∗ *Identify* ***R*** *as the universal gas constant (a mathematical correction to take into account the units of measurement), which is 0.0821 liter-atmospheres per mole-Kelvin. These can also be abbreviated as (L·atm)/(mol·K) or L atm mol^{-1} K^{-1}.* ∗ *Solve practical and theoretical problems using the ideal gas law* ***Skills Focus:*** dimensional analysis, algebraic rearrangement Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Gas Laws** Lab [see p. 46] ***Suggested:*** • **Hydrolysis** Separate H_2O into H_2 and O_2 gas using a Hoffman apparatus (or the set up described in Exp 12 on p 39). Students explain whether it is the size of the molecules or the number of molecules that determines how much is produced and use this reasoning to identify each gas. Test using a glowing wood splint to verify. (OR, may be used for standard 8a) OES: pending PT: pending	**PH Chem** Ch 14:3 ***Supplemental Resources:*** • PH Chem, Quick LAB, p 428, "CO_2 from Antacid Tablets" • PH Chem, Virtual Chem Lab 13, "Deviation from the Ideal Gas Law" • PH Chem, Virtual Chem Lab 14, "Ideal vs Real Gases" • **Gas Laws** http://legacyweb.chemistry.ohio-state.edu/betha/nealGasLaw/ • **Gas Law Simulation Program** http://intro.chem.okstate.edu/1314F00/Laboratory/GLP.htm ***Key Vocabulary:*** pressure temperature volume	4 Days (2 Blocks)

Solutions *5% CST*

6. Solutions are homogenous mixtures of two or more substances.

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the definitions of *solute* and *solvent.* **(6,a)** [CST]	• Define homogeneous as describing substances that have the same makeup throughout, down to the molecular level. • Define simple solutions as homogeneous mixtures of two substances. • Define and identify solutes as the dissolved substances in solutions. • Define and identify solvents as the larger components in the solutions by quantity. ***Skills Focus:*** define, identify	***Key Assignments:*** • **Solubility/Qual. Analysis** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 15:2 ***Supplemental Resources:*** • **Virtual Chembook: Solutions** http://www.elmhurst.edu/~chm/vchembook/170Asolubility.html ***Key Vocabulary:*** homogeneous **solvent** **solute** **solution**	1 Day (½ Block)

… how to describe the dissolving process at the molecular level by using the concept of random molecular motion. **(6,b)**
 	
[CST]
	• Explain that solutions are similar to gases in that the solute and solvent particles are in constant random motion.
	• Explain that the kinetic energy of this constant motion causes diffusion of the solute into the solvent, resulting in a homogeneous solution.
	• Explain that when a solid solute is placed in a liquid, at least some small part of the surface will dissolve.
	• Explain that the amount of solute that dissolves depends on the interactions of the molecules of solute and solvent.
	  ◦ Explain that an equilibrium is reached when the process of solute particles breaking off into the solvent occurs as quickly as the process of solute particles running into the solute surface and becoming reattached.
	  ◦ Explain the competing processes that create this equilibrium: (1) the tendency of molecules to spread out randomly, (2) the competing strength of bonds and (3) attractions among solute molecules, among solvent molecules, and between solute and solvent molecules.
	  ◦ Describe how these processes apply to salt dissolving in water with positive and negative ions separated and surrounded by polar water molecules.
	  ◦ *Explain why a nonpolar solvent (like oil) will not dissolve salt. (LBUSD)*
	
	Skills Focus:
	visualize and predict atomic level behavior
	
	Formulate explanations by using logic and evidence. **(I&E 1.d)**
		Key Assignments:
		• **Solubility/Qual. Analysis** Lab [see p. 47]
		
		Suggested:
		•
		
		OES: pending
		PT: pending
			<u>PH Chem</u> Ch 15:2
			
			Supplemental Resources:
			• <u>PH Chem</u>, Lab 27, p 173, "The Solvent Properties of Water"
			• **"Colorization"** Observe the spread of food coloring in beakers of cold, ambient, and hot water. Explain what this indicates about molecular motions.
			• **Dissolving Ionic Compounds** http://www.northland.cc.mn.us/biology/Biology1111/animations/dissolve.html
			
			Key Vocabulary:
			equilibrium
				4 Days (2 Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… temperature, pressure, and surface area affect the dissolving process. **(6,c)** [CST]	• Define solubility as the maximum amount of a solute that can be dissolved in a particular solvent at a given temperature. • Explain that chemical reactions that produce bubbles or precipitates have exceeded the solubility of the solvent. • Recall that increasing the temperature of a solvent usually increases the solubility of solid solutes, but always decreases the solubility of gaseous solutes. • Explain that the solubility of a gas is directly proportional to the pressure of that gas above the solution, because high pressure will lead to more particles diving into the solution. ***Skills Focus:*** visualize and predict atomic level behavior Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • **Super Saturation** Pour enough salt into a (~250 mL) beaker of water to leave a small amount of un-dissolved solid at the bottom. Explain (1) what causes the dissolving, (2) what prevents the rest of the solid from dissolving, and (3) how to dissolve more. Test the hypotheses for #3. OES: pending PT: pending	**PH Chem** Ch 16:1 ***Supplemental Resources:*** • PH Chem, Lab 30, p 189, "Factors Affecting Solution Formation" • PH Chem, Lab 31, p 195, "Supersaturation" • **Sodas and Gas Solubility** Fill two large test tubes with a cold, brown soda of your choice. Place one-hole stoppers in the top of both. Covering the holes with your fingers, quickly invert both into 1L beakers, one chilled with ice, the other warm. Students explain what their observations tell them about how the solubility of the CO_2 gas is affected by temperature and give practical applications. ***Key Vocabulary:*** **solubility** precipitate	4 Days (2 Blocks)
… how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition. **(6,d)** [CST]	• Recognize all concentration units as a measure of the amount of solute compared to the amount of solution: ° grams per liter ≡ mass of solute divided by the volume of solution. ° molarity ≡ moles of solute divided by liters of solution. ° parts per million ≡ ratio of parts of solute to million parts of solution (solute and solvent together) and multiplied by 10^6. This is used with very dilute solutions. May also be calculated as (mg solute/kg solution) or (μg solute/g solution). Since the solute unit is one million times smaller, its numerical value will be a million times bigger. ° percent composition ≡ mass of solute divided by mass of solution (solute and solvent together) and multiplied by 100. ***Skills Focus:*** dimensional analysis, conversion	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 15:3 & 16:2,4 ***Supplemental Resources:*** • PH Chem, Small-Scale LAB, p 497, "Making a Solution" ***Key Vocabulary:*** concentration **molarity**	5 Days (2½ Blocks)
… the relationship between the molality of a solute in a solution and the solution's depressed freezing point or elevated boiling point. **(6,e*)**	∗ *Define molality as moles of solute divided by kilograms of solvent (not liters of solution).* $m = \frac{\text{mol solute}}{\text{kg solvent}}$ ∗ *Explain why molality is not affected by temperature, while molarity is.* ∗ *Calculate and explain how the concentration of solute can depress the freezing point of a solution.* ∗ *Explain why sodium chloride (salt) is sprinkled on icy roads.* ***Skills Focus:*** dimensional analysis, conversion	***Key Assignments:*** - none - ***Suggested:*** • **A Depressing Activity** Measure the temperature of a freezer in or near the classroom. Have students calculate the minimum amount of salt needed to prevent freezing at that temperature. Test the hypothesis. OES: pending PT: pending	**PH Chem** Ch 16:4 ***Supplemental Resources:*** • **Colligative Property Simulations** http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/propOfSoln/colligative.html ***Key Vocabulary:*** **molality** freezing point depression	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how molecules in a solution are separated or purified by the methods of chromatography and distillation. **(6,f*)**	∗ *Explain that separating substances from solutions depends on differing attraction forces between molecules.* ***CHROMATOGRAPHY*** ∗ *Describe various ways to set up chromatography separation.* ∗ *Identify the moving solvent and the moving substrate.* ∗ *Explain separation results in terms of solute particle attractions for the substrate compared to attractions for the solvent.* ***DISTILLATION*** ∗ *Explain that distillation separates substances based on differences in the forces holding molecules in the liquid state.* ∗ *Predict which components in a mixture will leave the liquid state first and explain why.* ∗ *Explain how the catalytic reaction called "cracking" that occurs in oil refineries separates crude oil into kerosene, gasoline, & heavier oils.* ***Skills Focus:*** analyze lab techniques Identify and communicate sources of unavoidable experimental error. **(I&E 1.b)** Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. **(FS 7.2)**	***Key Assignments:*** • **Distillation & Chromatography** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 2:2, 8:4, & 10:3 ***Supplemental Resources:*** • PH Chem, Lab 26, p 167, "Distillation" • **Paper Chromatography** Use paper chromatography to separate ink/dye/coloring mixtures. Explain the process in terms of attractions to moving phase versus the stationary substrate. CA Sci. Framework, p 206 • PH Chem, Lab 32, p 199, "Intro. to Chromatography" • **Paper Chromatography** http://www.yesmag.bc.ca/ projects/paper_chroma.html • **Liquid Chromatography** http://www.chemguide.co.uk/ analysis/chromatography/hplc .html ***Key Vocabulary:*** **chromatography** **distillation** substrate catalytic	4 Days (2 Blocks)

Acids and Bases

8.3% CST

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions.

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the observable properties of acids, bases, and salt solutions. **(5,a)** [CST]	• Observe and recall the properties of acids: sour taste, litmus reaction, universal indicator paper range, reaction with certain metals (mossy zinc, for instance) to produce H_2 gas. • Observe and recall the properties of bases: bitter taste, slippery feeling, litmus reaction, universal indicator range, lack of reaction with metals. • Demonstrate and explain how acids and bases react to neutralize each to produce water and salt (and occasionally, CO_2). ***Skills Focus:*** observe	***Key Assignments:*** • **Properties of Acids/Bases** Lab [see p. 46] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 19:1,5 ***Supplemental Resources:*** • PH Chem, Inquiry Activity, p 586, "Effect of Foods on Baking Soda" • PH Chem, Demo, TE p 588, "Reactive Acids" • PH Chem, Lab 41, p 251, "Reactions of Acids" • PH Chem, Lab 42, p 255, "Neutralization Reactions" • **Acid Observations** Select students to volunteer. Give each a small cup of orange juice, grapefruit juice, and lemon juice. Have them taste each. Pour a teaspoon of baking soda into each cup. Record observations. Have students explain the results. • **Playing with Vinegar and Ammonia** Students observe the reactions of various household substances with red cabbage juice. They should also set up a test to explore various concentrations of vinegar and ammonia. CA Sci. Framework, p 202 ***Key Vocabulary:*** **acid** indicator **base** **salt**	3 Days (1½ Blocks)
… acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances. **(5,b)** [CST]	• Define Brønsted-Lowry acids as substances that donate hydrogen ions, H^+ (a.k.a., protons). • Define Brønsted-Lowry bases as substances that accept hydrogen ions. • Explain that acids formed from nonmetals (halogens), in the first two rows easily dissociate to produce hydrogen ions because of their strong electronegativity compared to hydrogen. • *Explain that the oxygens and nitrogen of nitrate create enough of an electronegativity to easily dissociate and produce hydrogen ions, like the F of HF and Cl of HCl. (LBUSD)* • Identify and explain various reactions involving Brønsted-Lowry acids and bases. ***Skills Focus:*** define, apply Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 19:1 ***Supplemental Resources:*** • **Arrhenius & Brønsted-Lowry** http://www.newton.dep.anl.gov/askasci/chem00/chem00145.htm ***Key Vocabulary:*** hydrogen ion = proton donate **dissociate** accept	3 Days (1½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… strong acids and bases fully dissociate and weak acids and bases partially dissociate. **(5,c)** [CST]	• Explain that some acids and bases dissociate or ionize almost completely, and others do so only partially. • Explain that near complete dissociation makes a strong acid or base, because it produces lots of the active ions. • Explain that partial dissociation is a property of weak acids or bases. • Explain why the strength of an acid or base (amount of dissociation) can be affected by temperature and concentration. ***Skills Focus:*** Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Acid/Base Titration** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 19:3 ***Supplemental Resources:*** • **Acid Comparisons** Calculate how to prepare equal molarities (or normalities, if one of the acids is polyprotic) of a strong acid (HCl or HNO_3) and a weak acid. Compare pHs by measurement. Recheck after diluting each. Recheck after raising the temperature. Written to address the <u>CA Sci. Framework</u>, p 203 • **Strong & Weak Acid Animations (Chemtoons)** http://www.chembio.uoguelph.ca/educmat/chm19104/chemtoons/chemtoons1.htm ***Key Vocabulary:*** **strong** acid/base ionize **weak** acid/base strength	4 Days (2 Blocks)
… how to use the pH scale to characterize acid and base solutions. **(5,d)** [CST]	• Identify the pH scale as a measure of the hydrogen ion concentration that defines the acidic or basic nature of a solution. • Explain that the pH scale is a logarithmic scale meaning, for example, that a pH 2 solution has ten times more hydrogen ions than a pH 3 solution. • Identify pH 0 as very acidic, 14 as very basic. • Identify pH 7 as neutral, any pH greater than 7 as acidic, and any pH less than 7 as basic. ***Skills Focus:*** explain log scale Solve scientific problems using logarithmic functions. **(I&E 1.e)**	***Key Assignments:*** • **Acid/Base Titration** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 19:2,4 ***Key Vocabulary:*** pH neutral logarithmic ***Supplemental Resources:*** • <u>PH Chem</u>, Lab 40, p 247, "Estimation of pH" using pH meter • **The pH Factor** http://www.miamisci.org/ph/index.html ***Key Vocabulary:*** pH neutral logarithmic	1 Day (½ Block)
… how to calculate pH from the hydrogen-ion concentration. **(5,f*)**	∗ *Identify [H⁺] as indicating the molar concentration of H⁺ ions in a solution.* ∗ *Calculate the pH of a solution as $-\log_{10}[H^+]$.* ∗ *Calculate [H⁺] from a given pH value.* *(pOH is presented in standard 5g.)* ***Skills Focus:*** explain log scale Solve scientific problems using logarithmic functions. **(I&E 1.e)**	***Key Assignments:*** • **Acid/Base Titration** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 19:2 ***Supplemental Resources:*** • <u>PH Chem</u>, Lab 43, p 259, "Acid-Base Titrations" • **Virtual Titration** http://www.wfu.edu/~ylwong/chem/titrationsimulator/ • **Virtual Titration** http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/acid_base.html ***Key Vocabulary:*** inverse log (antilog)	3 Days (1½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the Arrhenius, Bronsted-Lowry, and Lewis acid-base definitions. **(5,e*)**	∗ *Define and cite examples of Arrhenius bases as containing hydroxide, such as KOH.* ∗ *Explain why NH_3 fits the definition of a Brønsted-Lowry base, but not an Arrhenius base.* ∗ *Define Lewis acids as electron pair acceptors and Lewis bases as electron pair donors.* ∗ *Explain how the Lewis definition applies to various acids and bases.* ∗ *Explain that the benefit of the Lewis definition is that is extends the concept of acid-base reactions to nonaqueous systems.* ∗ *Explain how BF_3 works as an acid, even though it would not be considered an acid by the* ∗ *Brønsted-Lowry definition.* ***Skills Focus:*** compare and contrast definitions	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 19:1 ***Supplemental Resources:*** • **The Lewis Acid-Base Concept** http://facultyfp.salisbury.edu/dfrieck/htdocs/212/rev/acidbase/lewis.htm ***Key Vocabulary:*** Arrhenius (acid/base) Brønsted-Lowry (acid/base) Lewis (acid/base) nonaqueous	3 Days (1½ Blocks)
… buffers stabilize pH in acid-base reactions. **(5,g*)**	∗ *Explain that a buffer is a solution that stabilizes $[H^+]$ (or pH) by releasing H^+ ions if the pH rises or consuming H^+ is the pH decreases.* ∗ *Recall that an extremely important and complicated example of a buffered system is the is the equilibria between CO_2, H_2CO_3, HCO_3^-, CO_3^{2-}, and solid $CaCO_3$ keeps the world's oceans at a nearly constant pH of about 8.* ∗ *Calculate and interpret pOH values.* ∗ *Recall that the sum of pH and pOH is always 14.0 for a given solution at 25°C.* ***Skills Focus:*** explain application of log scale Solve scientific problems using logarithmic functions. **(I&E 1.e)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 19:5 ***Supplemental Resources:*** • PH Chem, Lab 45, p 271, "Buffers" • PH Chem, Small-Scale Lab 33, p 235, "Buffers" • **Buffer Animation (Chemtoons)** http://www.chembio.uoguelph.ca/educmat/chm19104/chemtoons/chemtoons7.htm ***Key Vocabulary:*** buffer stabilize pOH	5 Days (2½ Blocks)

Chemical Thermodynamics *8.3% CST*

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter.

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to describe temperature and heat flow in terms of the motion of molecules (or atoms). **(7,a)** [CST]	• Define **temperature** as the average kinetic energy of molecular motion in a sample. ◦ Explain that some molecules move slower than the average and some move faster. ◦ Explain that particles with larger mass will have less speed than small particles to have the same kinetic energy (same temperature). • Define **heat** as the energy transferred from a sample at higher temperature to one at lower temperature. • Identify, for given examples, the <u>system</u> and the <u>surroundings</u> between which heat flows. ***Skills Focus:*** model, analyze Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 13:1 & 17:1 ***Supplemental Resources:*** • <u>PH Chem</u>, Inquiry Activity, p 504, "Observing Heat Flow" • **Heat is Not Temperature** Have students touch something metal and something plastic, wood, or rubber at the same time. Since both objects will be at room temperature when first touched, have students explain the sensation of the metal "feeling colder" in terms of heat flow. • **Heat & Temperature** http://zonalandeducation.com/ mstm/physics/mechanics/energy/ heatAndTemperature/heatAnd Temperature.html ***Key Vocabulary:*** **temperature** system **heat** surroundings	3 Days (1½ Blocks)
… chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.**(7,b)** [CST]	• Explain that **endothermic processes** absorb heat, and their equations can be written with heat as a reactant. • Explain that **exothermic processes** release heat, and their equations can be written with heat as a product. • Explain that breaking bonds always requires energy and that forming bonds always releases energy. • Explain that the amount of energy per bond depends on the strength of the bond. • Explain how the energy released or absorbed affects the internal motion of atoms and molecules in the system. • Draw and interpret potential energy graphs showing the different reaction stages: reactants, transition states, and products. ◦ Indicate that reactants are at a lower potential energy than products for endothermic reactions. ◦ Indicate that reactants are at a higher potential energy than products for exothermic reactions. ◦ Explain that a higher energy transition state usually exists between the reactant and product energy states. (This will be addressed further in 8d*.) ***Skills Focus:*** observe, measure, explain Select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data. **(I&E 1.a)**	***Key Assignments:*** • **Endo-/Exothermic Rxns** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 17:1,4 ***Supplemental Resources:*** • <u>PH Chem</u>, Lab 35, p 217, "Heats of Reaction" • **Hot & Cold Pack Chemistry** Observe examples of spontaneous exothermic and endothermic reactions. • **Endo- and Exothermic Rxns** http://www.chem.umn.edu/ outreach/EndoExo.html ***Key Vocabulary:*** **endothermic** potential energy **exothermic** transition state	4 Days (2 Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts. **(7,c)** [CST]	• Explain that changes in physical state either absorb or release heat. • Explain that evaporation and melting require energy to be put in to overcome bonds of attraction in the liquid or solid state. • Give examples from personal observations to validate this. • Explain that condensation and freezing release heat to the surroundings as internal energy is reduced and bonds of attraction are formed. ***Skills Focus:*** research, analyze Analyze situations and solve problems that require combining and applying concepts from more than one area of science. **(I&E 1.l)**	***Key Assignments:*** • **Specific Heat/Calorimetry** Lab [see p. 47] ***Suggested:*** • **Stormy Weather Story** Students use energy transfer at the molecular level to explain why winter rain storms raise the local temperature (condensation effect), but a person getting hit by the rain is will find themselves cooling off (relative temperatures and evaporation effect). OES: pending PT: pending	**PH Chem** Ch 17:3 ***Supplemental Resources:*** ***Key Vocabulary:*** physical state, evaporation, melting, condensation, freezing	3 Days (1½ Blocks)

… how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change. **(7,d)**
 	
[CST]
	• Define **specific heat** as the energy needed to change the temperature of one gram of substance by one degree Celsius. *(Unit = joule/gram-degree)*
	• Explain that **latent** (or hidden) **heat** is the energy added or removed during phase changes that causes no temperature change. *(Unit = joule/gram or kilojoule/mole)*
	  ◦ Describe the latent heat of vaporization (ΔH_{vap}) as the energy needed to vaporize one mole of a liquid at its boiling point.
	  ◦ Describe the latent heat of fusion (ΔH_{fus}) as the energy needed to melt one mole of a liquid at its melting point.
	  ◦ Explain that these also represent the amount of energy released during the processes of condensing and freezing.
	• Diagram and explain the temperature changes that occur when sub-zero ice is steadily heated to superheated steam (above 100°C), indicating where latent heat is being added.
	
	Skills Focus:
	graph, analyze
	
	Formulate explanations by using logic and evidence. **(I&E 1.d)**
		Key Assignments:
		• **Specific Heat/Calorimetry** Lab [see p. 47]
		
		Suggested:
		•
		
		OES: pending
		PT: pending
			PH Chem Ch 17:2-3
			
			Supplemental Resources:
			• PH Chem, Lab 34, p 211, "The Specific Heat of a Metal"
			• **Melting the Ice**
			Observe the temperature as water with a great deal of ice in it is heated. Continue recording the temperature until it reaches room temperature. Explain how latent heat can explain the observations.
			• **Heating Curve**
			http://www.chm.davidson.edu/ChemistryApplets/PhaseChanges/HeatingCurve.html
			
			Key Vocabulary:
			specific heat, **latent heat**, (latent) heat of vaporization, (latent) heat of fusion, superheated
				3 Days (1½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to apply Hess's law to calculate enthalpy change in a reaction. **(7,e*)**	∗ *Explain that the* **standard enthalpy of formation**, *H_f, for a substance is the heat absorbed or released when forming one mole of that substance from elements (all substances begin and end at standard temperature, 25°C (not 0°C like gas law STP), under standard pressure, 1 atm).* ∗ *Recall that H_f is positive if heat is absorbed and negative if heat is released.* ∗ *Explain that Hess' law states that the net enthalpy change (heat absorbed) for a chemical reaction is the sum of the individual enthalpy changes needed to form or break apart each substance involved.* ∗ *Express Hess' law for the equation* $aA + bB \rightarrow cC + dD$ *as* $\Delta H_r^o = [cH_f^o(C) + dH_f^o(D)] - [aH_f^o(A) + bH_f^o(B)]$ *where ΔH_r^o is the standard enthalpy for the entire reaction.* ∗ *Explain that the reactants are subtracted because they are pictured as being torn apart into elements, instead of being formed from elements like the products.* ∗ *Calculate the heat absorbed or released when a given quantity of a reactant is consumed in a chemical reaction.* ***Skills Focus:*** use references, calculate	***Key Assignments:*** • **Endo-/Exothermic Rxns** Lab [see p. 47] • **Specific Heat/Calorimetry** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 17:4 & 18:4 ***Supplemental Resources:*** • PH Chem, Lab 35, p 217, "Heats of Reaction" • **Hess's Law** http://www.dartmouth.edu/~chemlab/info/resources/deltah/deltah.html ***Key Vocabulary:*** **enthalpy** net enthalpy change **standard enthalpy of formation**	4 Days (2 Blocks)
… how to use the Gibbs free energy equation to determine whether a reaction would be spontaneous. **(7,f*)**	∗ *Explain that since endothermic reactions can occur spontaneously (under standard conditions of temperature and pressure), releasing heat to end up at a lower energy state cannot be the only force driving chemical reactions.* ∗ *Define entropy as the tendency toward disorder.* ∗ *Explain that the creation of disorder (entropy) and the heat of the reaction (enthalpy) together determine if chemical reactions will be spontaneous.* ∗ *Recall the Gibbs free-energy equation and the appropriate units for each variable:* $\Delta G = \Delta H - T\Delta S$ ∗ *Calculate Gibbs free-energy for chemical reactions.* ∗ *Explain why a negative Gibbs free-energy predicts spontaneous formation of products (a spontaneous reaction), while a positive value favors formation of reactants (a nonspontaneous reaction).* ***Skills Focus:*** use references, calculate, predict	***Key Assignments:*** - none - ***Suggested:*** • **Getting the Chemical Cold Shoulder** Research an endothermic reaction and use reference books to find values to calculate ΔG for the reaction. Describe the increase in entropy that allows the reaction to occur spontaneously. OES: pending PT: pending	**PH Chem** Ch 18:4 ***Supplemental Resources:*** • PH Chem, Teacher Demo, TE p 572, "Observing a Spontaneous Reaction" • **Gibbs Free Energy** http://www.khanacademy.org/video/gibbs-free-energy-and-spontaneity?playlist=Chemistry ***Key Vocabulary:*** spontaneous entropy Gibbs free energy	3 Days (1½ Blocks)

Reaction Rates

6.7% CST

8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules.

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time. **(8,a)** [CST]	• Define **reaction rate** as the rate of decrease in the concentration of reactants. • Explain that because of conservation of matter, the reaction rate may also be defined as the rate of increase in the concentration or products. • Explain that from the balanced equation for a reaction, the reactants must decrease and the products must increase in proportion to their mole ratios. ***Skills Focus:*** model Recognize the usefulness and limitations of models as scientific representations of reality. **(I&E 1.g)**	***Key Assignments:*** • **Reaction Rates** Lab [see p. 47] ***Suggested:*** • PH Chem, Small-Scale Lab 28, p 197, "Factors Affecting the Rate of a Chem Rxn" • OES: pending PT: pending	**PH Chem** Ch 18:1 ***Supplemental Resources:*** • PH Chem, Lab 36, p 225, "Factors Affecting Reactions Rates" • **Hydrolysis** Using a Hoffman apparatus to separate H_2O into H_2 and O_2, students can observe that the rate of H_2 production is double that of O_2 production because of the proportion of mole ratios. (OR, may be used for standard 4h*) ***Key Vocabulary:*** **reaction rate**	2 Days (1 Block)
… how reaction rates depend on such factors as concentration, temperature, and pressure. **(8,b)** [CST]	• Explain that anything that affects the collision of reactant molecules will affect the rate of a chemical reaction. • Explain that increasing the concentration of reactants will increase the number of collisions per unit time, because the distance between collisions is shorter. • Explain that increasing the temperature (kinetic energy of molecules) will increase the number of collisions per unit time and dramatically increase the likelihood that the collisions will cause the chemical reaction (Arrhenius effect). • Explain that increasing the pressure on gaseous reactants is the same as increasing the concentration and results in an elevated reaction rate. • Explain that increasing pressure only affects reaction rates if one or more of the reactants or products are gases. ***Skills Focus:*** research, present Know important strategies for self-promotion in the hiring process, such as job applications, resume writing, interviewing skills, and preparation of a portfolio. **(FS 3.6)** Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Reaction Rates** Lab [see p. 47] ***Suggested:*** • **Reaction Rates in Reality** In groups of three, students research real applications of using concentration, pressure, and temperature to control reaction rates. OES: pending PT: pending	**PH Chem** Ch 18:1-2 ***Supplemental Resources:*** • **Reaction Rates** http://www.physchem.co.za/ ***Key Vocabulary:*** collision	4 Days (2 Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… the definition and role of activation energy in a chemical reaction. **(8,d*)**	* *Explain that even spontaneous reactions must usually pass through a transition state (or activated transition complex) that has a higher energy than either the reactants or products.* * *Define the energy needed to form this transition state as the* activation energy*, or* activation barrier*.* * *Explain that the activation energy is related to such factors as the strength of the bonds in the reactants.* * *Explain why a higher activation energy will lead to a slower reaction (by connecting to the idea of average kinetic energy and the number of particles with sufficient energy to form the activated transition complex).* ***Skills Focus:*** Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena. **(I&E 1.i)**	***Key Assignments:*** • **Reaction Rates** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 18:1 ***Supplemental Resources:*** • **Endo- & Exothermic Rxn Activation Energy Animations** http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/activa2.swf ***Key Vocabulary:*** activated transition complex **activation energy** (activation barrier)	2 Days (1 Block)
… the role a catalyst plays in increasing the reaction rate. **(8c)** [CST]	• Define a catalyst as a substance that increases the rate of a chemical reaction without taking part in (or being consumed by) the reaction. • Explain that a catalyst lowers the energy barrier between reactants and products by providing a more favorable pathway for the reaction. • Explain that catalysts commonly function by providing a surface that temporarily holds onto one of the reactants and may weaken its bonds so that another substance can react with it more easily. • Cite examples of biological (enzymes) and non-biological (i.e., catalytic converters) catalysts. ***Skills Focus:*** Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Reaction Rates** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 18:1 ***Supplemental Resources:*** • PH Chem, Teacher Demo, TE p 546, "Use of Heat & Catalyst in a Reaction" • **MnO_2 Catalysis** Observe and explain how MnO_2 greatly increases the rate of decomposition of H_2O_2 to H_2O and O_2. Note that the MnO_2 continues to function in this way with fresh H_2O_2 because it is not changed itself. ***Key Vocabulary:*** **catalyst** **enzyme** energy barrier	3 Days (1½ Blocks)

Chemical Equilibrium

6.7% CST

9. Chemical equilibrium is a dynamic process at the molecular level.

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… equilibrium is established when forward and reverse reaction rates are equal. **(9,b)** [CST]	• Describe and give analogies of dynamic equilibrium where changes are always occurring, but overall numbers remain constant. • Explain that equilibrium occurs in chemical reactions when forward and reverse reactions are both occurring at the same rate. • Explain that even though reactants and products are still being formed and consumed, the concentrations of each reactant and product remain constant over time at equilibrium. ***Skills Focus:*** model Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Equilibrium & Le Chatlier's Principle** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 18:2 ***Supplemental Resources:*** • <u>PH Chem</u>, Lab 38, p 237, "Disturbing Equilibrium" • **Equilibrium Java Applet** http://mc2.cchem.berkeley.edu/Java/equilibrium/ ***Key Vocabulary:*** dynamic **equilibrium** forward reaction reverse reaction	1 Day (½ Block)
… how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure. **(9,a)** [CST]	• Explain that LeChatelier's principle states that when an equilibrium is stressed or disturbed, the system will shift to relieve the stress and create a new equilibrium balance. • Cite ways to disturb equilibrium and the corrective shifts that occur. ◦ Explain that if the concentration of a reactant in a system at dynamic equilibrium is decreased, products will be consumed to produce more of that reactant. ◦ Explain that since heat is a reactant in endothermic reactions, increasing the temperature (adding heat) will shift an endothermic reaction toward the products. ◦ Explain that endothermic reactions are exothermic in the reverse direction. ◦ Explain that for reactions with gaseous reactants or products, an increase in pressure will shift the equilibrium toward the smaller number of moles of gas, alleviating the pressure stress. ◦ Explain that if both sides of an equilibrium have an equal number of moles of gas, changing the pressure will not affect the equilibrium. ◦ Explain that increasing pressure by adding an inert gas, such as argon, will not change the partial pressures of reactant or product gases and will therefore have no effect on the equilibrium. ***Skills Focus:*** apply concepts to diverse situations Know important strategies for self-promotion in the hiring process, such as job applications, resume writing, interviewing skills, and preparation of a portfolio. **(FS 3.6)** Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** • **Equilibrium & Le Chatlier's Principle** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**<u>PH Chem</u>** Ch 18:2 ***Supplemental Resources:*** • <u>PH Chem</u>, Small-Scale Lab 29, p 203, "Le Chatlier's Principle and Chemical Equilibrium" • **Le Chatelier's Principle** http://www.ausetute.com.au/lechatsp.html ***Key Vocabulary:*** stressed (or disturbed) equilibrium equilibrium shift	4 Days (2 Blocks)

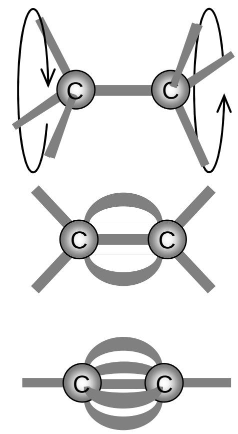
Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to write and calculate an equilibrium constant expression for a reaction. **(9,c*)**	∗ *Explain that since concentrations remain constant in a system at chemical equilibrium, a mathematical constant can be used to describe the equilibrium.* ∗ *Write an equilibrium expression for the balanced equation of a system at equilibrium:* $aA + bB \rightleftharpoons cC + dD$ *in the following form:* $K_{eq} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$ ∗ *Recall that when calculating K_{eq}, only gaseous substances and aqueous solutions are considered.* ∗ *Explain that a large K_{eq} means that there are more products than reactants, which shows that the forward reaction goes nearly to completion and little reverse reaction occurs.* ∗ *Explain that a small K_{eq} means that the reverse reaction goes almost to completion, or little forward reaction occurs.* ∗ *Explain the K_{sp} is the solubility product that describes equilibrium for salts in solution.* ***Skills Focus:*** connect numerical constants to observable rxn behavior Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 18:2 ***Supplemental Resources:*** • PH Chem, Lab 39, p 243, "A Solubility Product Constant" ***Key Vocabulary:*** equilibrium expression equilibrium constant (K_{eq}) solubility product (K_{sp})	5 Days (2½ Blocks)

Organic Chemistry and Biochemistry 3.3% CST

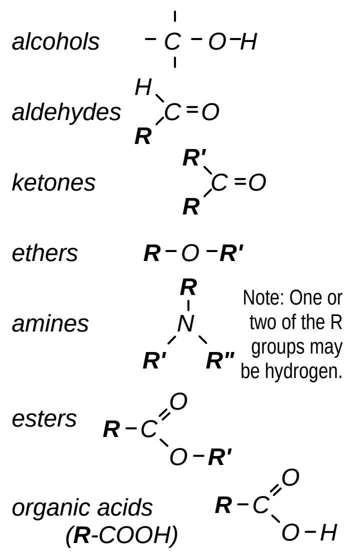
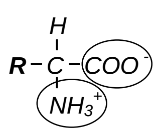
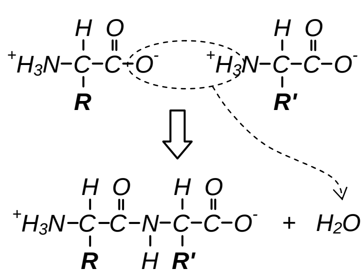
10. The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life.

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits. **(10,a)** [CST]	• Define polymers as large molecules made up of smaller groups of atoms, including carbon, connected together. • Recall that proteins, nucleic acids, and starch are polymeric molecules. • Explain that all polymeric molecules are made up of various combinations of a relatively small number of simple subunits. • Identify specific polymeric molecules and the subunits that comprise them (i.e., starch and its simple sugar subunits). ***Skills Focus:*** recall identifying subunits	***Key Assignments:*** • **Organic Synthesis** Lab [see p. 47] ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 23:4 & 24:2-3,5 ***Supplemental Resources:*** • PH Chem, Teacher Demo, TE p 751, "Making Nylon" • PH Chem, Small-Scale LAB, p 753, "Polymers" • **Polymers by David A. Katz** http://www.chymist.com/Polymers.pdf ***Key Vocabulary:*** polymer subunit (monomer)	2 Days (1 Block)
… 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. **(10,d*)**	* *Recall that each name for an organic molecule is made up of a prefix and a suffix.* ° *Recall that the prefix tells the number of carbons in the longest continuous chain within the molecule.* ° *Recall the prefixes for the first ten simple hydrocarbons:* *meth- .... one carbon* *eth- .... two carbons* *prop- .... three carbons* *but- .... four carbons* *(etc.)* ° *Recall that the suffix indicates the kind of bond between carbon atoms:* *-ane .... single bonds* *-ene .... double bonds* *-yne .... triple bonds* * *Explain that benzene, C_6H_6, is a flat hexagonally shaped molecule of six carbons bonded by alternate single and double bonds.* * *Explain that many compounds can be built by substitutions on straight-chain hydrocarbons and benzene rings.* ***Skills Focus:*** recall and apply nomenclature rules Analyze the sequences that are characteristic of natural phenomena. **(I&E 1.i)**	***Key Assignments:*** - none - ***Suggested:*** • PH Chem, Class Activity, p 727, "Halocarbon Structures and Names" OES: pending PT: pending	**PH Chem** Ch 22:1-4 ***Supplemental Resources:*** ***Key Vocabulary:*** prefix suffix substitution	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time

… 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. **(10,b)**
 	
[CST]
	• Explain that carbon's four bonding electrons and four vacancies available to form bonds give it the ability to form stable covalent bonds – single or multiple – with other carbon atoms and with atoms of other elements.
	• Explain how the presence of single, double, and triple bonds determines the geometry (and flexibility) of carbon-based molecules.
	• Recall that there is an enormous diversity of carbon-based compounds: over 16 million are known.
	  ◦ Recall simple hydrocarbon molecules, like methane and ethane.
	  ◦ Recall biological polymers, like proteins and nucleic acids.
	  ◦ Recall manufactured polymers, like polyester, nylon, and polyethylene.
	
	Skills Focus:
	create an analyze models
	
	Know important strategies for self-promotion in the hiring process, such as job applications, resume writing, interviewing skills, and preparation of a portfolio. **(FS 3.6)**
	
	Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)**
		Key Assignments:
		• **Organic Synthesis** Lab [see p. 47]
		
		Suggested:
		•
		
		OES: pending
		PT: pending
		
		
		
			PH Chem Ch 22:1-4
			& 24:2-5
			
			Supplemental Resources:
			• **Polymer Properties**
			Use molecular models to investigate how single bonds can rotate and double bonds lock a specific geometry. Investigate the structures of soft and rigid plastics, noting how the type carbon bonding present causes those properties.
			• **Material Science & Technology**
			http://matse1.matse.illinois.edu/polymers/polymers.html
			
			Key Vocabulary:
			hydrocarbon
				1 Day (½ Block)

… amino acids are the building blocks of proteins. **(10,c)** [CST]	• Recall that proteins are large, single-stranded polymers often made up of thousands of relatively small subunits called amino acids. • Explain that the bond attaching two amino acids, known as a peptide bond, is identical for any pair of amino acids. • Explain that the variation in the composition of different amino acids and the order in which they are connected gives protein molecules their unique shapes and properties. • Explain that the shape and properties of a protein determine its functions, which are essential to the life of an organism. • Recall that the blueprint for building protein molecules is deoxyribonucleic acid (DNA). • Explain that biotechnology and molecular biology are advancing rapidly as more is learned about DNA, amino acid sequences, and the resulting shapes and functions of proteins. ***Skills Focus:*** research Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. **(I&E 1.m)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 24:3 ***Supplemental Resources:*** • **Peptide Bond Formation** http://www.elmhurst.edu/~chm/vchembook/564peptide.html ***Key Vocabulary:*** **amino acid** **peptide bond** deoxyribonucleic acid molecular biology biotechnology	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids. **(10,e*)**	∗ *Explain that organic molecules are grouped into classes based on patterns of bonding between carbon and non-carbon atoms.* ∗ *Explain that groups based on unique patterns of bonding are called **functional groups**.* ∗ *Identify significant functional groups:*  **Skills Focus:** recall and identify functional games	**Key Assignments:** • **Organic Synthesis** Lab [see p. 47] • **Ethical Analysis Essay or Debate of Current Issue** (possible) [See description on p. 45, in Maj. Writ. Assig. and Perf-Based Projects sections.] **Suggested:** • **Creating Structures** Given names of various organic compounds, like ethylenediaminetetraacetate (EDTA), pairs of students compete to come up with the correct structures. OES: pending PT: pending	**PH Chem** Ch 23:1-4 & 24:3 **Supplemental Resources:** • PH Chem, Lab 50, p 299, "Esters of Carboxylic Acids" **Key Vocabulary:** **functional group**	1 Day (½ Block)
… the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins. **(10,f*)**	∗ *Identify the amino and acid groups common to all amino acids.*  ∗ *Explain that the differences in the **R-group** create the differences between amino acids.* ∗ *Recall that bonding between two amino acids creates a dipeptide, between three creates a tripeptide, and between more creates a polymer called a polypeptide.*  ∗ *Recall that polypeptides formed biologically are called proteins.* **Skills Focus:** demonstrate molecular rearrangement	**Key Assignments:** - none - **Suggested:** • OES: pending PT: pending	**PH Chem** Ch 24:3 **Supplemental Resources:** • **Denature of De Beast** Research how proteins denature when over-heated (cooking) or exposed to acids (ceviche). **Key Vocabulary:** **R-group**, protein, dipeptide, tripeptide, **polypeptide**	½ Day (<½ Block)

Nuclear Processes *3.3% CST*

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.

Content Standards (CONTENT) "Students know…"	Content Standards (SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons. **(11,a)** [CST]	• Explain why there must be a very strong force holding the protons and neutrons of an atomic nucleus together. • Explain that the **strong nuclear force** must be stronger that electrostatic repulsion. • Explain that the strong nuclear force acts protons, between neutrons, and between protons and neutrons. • Explain that the strong nuclear force has a very limited range (comparable to the size of an atomic nucleus) so that the attraction only occurs when protons and neutrons are next to each other as they are within a nucleus. ***Skills Focus:*** model Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 25:2 ***Supplemental Resources:*** • **ABCs of Nuclear Science** http://www.lbl.gov/abc/Basic.html ***Key Vocabulary:*** **strong nuclear force** nucleus electrostatic repulsion	½ Day (<½ Block)

… 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. **(11,b)**
 	
[CST]
	• Explain how atomic nuclei can be changed by natural or human means.
	  ◦ Describe **fusion** reactions as two nuclei coming together and merging to form a heavier nucleus.
	  ◦ *Explain that fusion occurs naturally in stars or in man-made particle accelerators. (LBUSD)*
	  ◦ Describe **fission** reactions as a heavy nucleus splitting apart to form two (or more) lighter nuclei.
	  ◦ *Explain that fission occurs naturally during the radioactive decay of unstable elements or in man-made fission reactors. (LBUSD)*
	• Explain that although the total number of nucleons (protons and neutrons) remains the same after a fission or fusion reaction, there is a small loss of mass, which is converted into energy.
	• Explain that the equation, $E=mc^2$, gives the relationship between the "lost " mass and the energy released by a nuclear reaction.
	• Explain that nuclear reactions involve more than one million times greater energy than chemical reactions.
	• Define the <u>binding energy</u> of a nucleus as the amount of energy released when a nucleus is formed from protons and neutrons, *OR* the amount of energy that would be required to separate all the nucleons in a nucleus.
	
	Skills Focus:
	model
	
	Formulate explanations by using logic and evidence. **(I&E 1.d)**
		Key Assignments:
		- none -
		
		• **Ethical Analysis Essay or Debate of Current Issue** (possible)
		[See description on p. 45, in Maj. Writ. Assig. and Perf-Based Projects sections.]
		
		Suggested:
		•
		
		OES: pending
		PT: pending
			PH Chem Ch 25:3
			
			Supplemental Resources:
			• **Fusion Basics** http://www.jet.efda.org/fusion-basics/
			
			Key Vocabulary:
			nuclear reaction **nucleon**
			fusion binding energy
			fission
				2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions. **(11,c)** [CST]	• Define isotopes of an element as atoms with the same number of protons (and therefore the same element), but different numbers of neutrons (giving them different masses). • Explain that isotopes occur in nature and can be made by humans. • Explain that isotopes can be stable or unstable. • Explain that less stable isotopes (parent isotopes) undergo radioactive decay to produce more stable isotopes of another element (daughter products), which can be either stable or radioactive. • Explain that radioactive isotopes found in nature either have a long half-life, or are the daughter product of a parent with a long half-life. • Identify the naturally occurring radioactive isotopes. *(Note: Standard 11f* may be appropriate at this point.)* ***Skills Focus:*** Formulate explanations by using logic and evidence. **(I&E 1.d)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 25:1-2 ***Supplemental Resources:*** • **Radionuclide (Radioisotope)** http://en.wikipedia.org/wiki/Radioisotope ***Key Vocabulary:*** **parent isotope** · stable **daughter product** · unstable half-life · radioactive	2 Days (1 Block)
… the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay. **(11,d)** [CST]	• Explain that high energy, radioactive isotopes transform to more stable isotopes by emitting particles from the nucleus. • Identify the three most common types of radioactive decay: helium-4 nuclei ....alpha radiation electrons or positrons.......beta radiation high energy electromagnetic rays ......gamma radiation • Write equations and determine the products for radioactive decay. ° Explain that alpha decay produces nuclei with two fewer protons and two fewer neutrons. For example: $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}\alpha$ (or $^{4}_{2}He$) ° Explain why beta decay produces nuclei with the same number of nucleons, but with one more proton or one less proton. For example: $^{234}_{90}Th \rightarrow ^{234}_{91}Pa + ^{0}_{-1}\beta$ (or $^{0}_{-1}e$) $^{234}_{91}Pa \rightarrow ^{234}_{92}U + ^{0}_{-1}\beta$ (or $^{0}_{-1}e$) • Explain that the nuclei produced by alpha and beta decay often emit gamma rays, which do not change the number of nucleons in the isotope, but bring the nucleus to a lower energy state. ***Skills Focus:*** balance nuclear equations	***Key Assignments:*** - none - ***Suggested:*** • **Decay Race** Groups of students select one member to compete for them. Teacher gives a starting element and rapidly gives a series of α, β, and the occasional γ emission. Students are rewarded who determine the final product correctly the most times. OES: pending PT: pending	**PH Chem** Ch 25:1 ***Supplemental Resources:*** • **Radioactive Basics** http://www.arpansa.gov.au/RadiationProtection/Basics/index.cfm ***Key Vocabulary:*** radioactive decay · **alpha particle** radiation · **beta particle** decay · positron **gamma ray**	3 Days (1½ Blocks)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations. **(11,e)** [CST]	• Explain that alpha, beta, and gamma rays are ionizing radiation because they produce trails of ions of atoms and molecules as they pass through. • Explain that these changes at the atomic level can cause damage in the surrounding materials. • Recall that the energy of particles emitted by radioactive decay is typically on the order of 1MeV (equal to 1.6×10^{-13} joule), which is enough energy to ionize up to a half million atoms. α • Recall that alpha particles ($^{4}_{2}\alpha$) have the shortest ranges and are stopped by matter that is only a few millimeters thick or even paper. • Explain that alpha particles deposit all their energy along a relatively short path, creating a great deal of ionization damage along that short path. • Explain that alpha radiation is dangerous if ingested or inhaled. • Recall that radon-222 is a naturally occurring alpha radiation hazard in some regions. β • Recall that beta particles ($^{0}_{-1}\beta$ or $^{0}_{+1}\beta$) have longer ranges than alpha particles and typically penetrate several centimeters into matter. • Recall that beta particles are about 2000 times smaller than protons and are either negatively charged electrons or their antimatter counterpart, positively charged positrons. • Explain that beta particles are high-energy electrons that are moving too fast to be constrained by the normal principles of electrical conductivity until matter stops them. • Explain that the longer ranges of beta particles mean that beta particles will deposit their energy and spread ionization over a greater distance of material. γ • Recall that gamma rays can penetrate matter up to several meters thick. • Recall that gamma rays are high-energy photons with no electric charge and no rest mass. • Explain that gamma rays travel unimpeded until they strike an electron or nucleus, which absorbs all or some of its energy and ionizes neighboring atoms. • Explain that living organisms can be protected from ionizing radiation by shielding and increasing distance from radiation sources ***Skills Focus:*** Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. **(I&E 1.m)** Understand the role of personal integrity and ethical behavior in the workplace. **(FS 8.3)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 25:1 ***Supplemental Resources:*** • PH Chem, Lab 52, p 311, "Radioactivity and Radiation" • **Risks & Benefits** Students research and discuss the risks and benefits of medical and industrial uses made from the ionizing radiation of nuclear reactions. CA Sci. Framework, p 218 • **Penetration and Shielding Observations** Use video to demonstrate the penetration ability of the different forms of ionizing radiation and how proper shielding is engineered. This can be accompanied by Geiger counter observations and measurements using weak radiation sources. CA Sci. Framework, p 218 • **Ionizing Radiation** http://www.epa.gov/radiation/understand/ionize_nonionize.html ***Key Vocabulary:*** **ionizing radiation**, ingest penetrate, emit inhale, shielding	2 Days (1 Block)

Content Standards (CONTENT) "Students know…"	(SKILL) "Students are able to …"	Perf. Std. Measures How students DEMONSTRATE KNOWLEDGE and SKILL.	Instructional Support	Appx Time
… how to calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed. **(11,f*)**	∗ *Explain that radioactive decay transforms the initial (parent) nuclei of a substance into more stable (daughter) nuclei at a rate that gives a characteristic half-life.* ∗ *Define half-life as the time required for one-half of the parent atoms to decay to daughter atoms.* ∗ *Explain that one-half of the remaining parent atoms at any given observation point will decay to produce daughter atoms in the next half-life period.* ∗ *Explain that it is only possible to predict the proportion of atoms that will undergo decay, not the actual number of atoms (i.e., 50% of parent atoms remain after one half-life, 25% remain after two half-lives).* ∗ *Explain that the intensity of radiation coming off of a radiation source is related to the half-life and can be used to extrapolate the number of radioactive parent atoms originally present.* ***Skills Focus:*** Recognize the issues of statistical variability and the need for controlled tests. **(I&E 1.j)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 25:2 ***Supplemental Resources:*** • PH Chem, Small-Scale Lab, p 287, "Half Lives and Reaction Rates" • PH Chem, Inquiry Activity, p 798, "Simulating Radioactive Decay" • **Decay** http://lectureonline.cl.msu.edu/~mmp/applist/decay/decay.htm ***Key Vocabulary:*** **half-life**	2 Days (1 Block)
… protons and neutrons have substructures and consist of particles called quarks. **(11,g*)**	∗ *Recall that protons and neutrons are made up of particles called* **quarks**. ∗ *Recall that quarks come in six different types, but only the up quark and the down quark are involved in normal matter.* ∗ *Recall that all common matter in the material is made up of just three fundamental particles: the up quark, the down quark, and the electron.* *BEYOND THE STANDARD:* ◆ *Recall that quarks have fractional charges: up quark = $+^2/_3$; down quark = $-^1/_3$* ◆ *Recall that a proton consists of 2 up quarks and 1 down quark.* ◆ *Recall that a neutron consists of 2 down quarks and one up quark.* ◆ *Recall that it is believed that it is not possible to isolate a free quark.* ***Skills Focus:*** Distinguish between hypothesis and theory as science terms. **(I&E 1.f)**	***Key Assignments:*** - none - ***Suggested:*** • OES: pending PT: pending	**PH Chem** Ch 4:2 ***Supplemental Resources:*** • **Interactive Atom Builder** http://www.pbs.org/wgbh/aso/tryit/atom/# ***Key Vocabulary:*** **quark** **down quark** **down quark**	1 Day (½ Block)

KEY ASSIGNMENTS / ASSESSMENTS:

Key Laboratory Activities	Lab activities are selected to illustrate the key concepts of chemistry. Student lab reports for **Key Labs** record the investigation of a testable question. While these labs are generally hands-on experiences making observations of real materials, some activities involving dangerous reagents or conditions, or those for which testing multiple variables becomes impractical, high quality virtual labs may also be used as inquiry experiences to extend the hands-on laboratory experience. In all cases, students either generate or follow procedures to make observations and collect data. They then analyze the data using calculations and graphs/diagrams as appropriate in order to answer the posed question. Student comprehension of the underlying concepts is verified by responses to questions (using key scientific vocabulary), display of complete calculations, and reasoned error analysis. Students then summarize their critical observations and conclusions in an abstract. *(See the specific Key Laboratory descriptions on the next pages.)*
Major Written Assignments	Students complete one or two writing assignments. *[Writing associated with Performance-Based Projects listed below may replace the second assignment.]* This paper requires students to gather information from various reliable sources. The purpose of the paper is to reinforce the content and/or extend the applications of topics presented in chemistry class. Possible topics include: • Practical Applications of Chemistry [FS 5.3, 9.3] (e.g. hair care products, cosmetics, racing fuels, car finishes) • Current Event Analysis [FS 7.2, 8.3] (e.g. toxic products from China, global climate change and greenhouse gas emissions, advances in nanotechnology) • Historical Perspective Essay (e.g. evolution of the periodic table [1a-d,f*-i*], development of the current atomic model [1g*,h*,i*], cultural influences on chemical research [FS 9.3], development of chemical warfare, development of chemical dyes) • Ethical Analysis of a Current Topic (e.g. toxic contamination [1g*,10e*], nuclear energy issues [11b-e], use of phthalates [10a,b,e*])
Performance-Based Projects	<u>Performance-based Content Projects</u>: Chemistry students complete a project requiring research, analysis, and presentation of data using graphs, diagrams, demonstrations, or other visual means. This project should incorporate research from multiple sources with critical analysis of the information in the sources. Students then synthesize the information in a final product such as an oral presentation, poster presentation, or other format, such as computer animation or video presentation. Possible topics can encompass any topics covered within the course. The following are possible examples: ✓ "Student Teaching" – video demonstration, animation, and/or electronic presentation illustrating a major chemistry concept ✓ TV News Show – illustrating a chemistry topic through analogies, e.g. atomic theories, acid-base models, oxidation-reduction reactions ✓ Debate of a Current Issue – student-designed, student-lead debate performed live or recorded on a current topic, e.g. use of fuel additives, possible alternative fuels, bus/car idling policies, acceptable levels of water/air contamination, global chemical production and safety, bottled versus tap water Chemistry students also contribute to cross-curricular projects developed by and for their Small Learning Community which may serve the intended purpose of this project. Possible examples that might connect to SLC themes might include: ✓ Environmental Chemistry – presentation of research or experimental data collection on an environmental issue, e.g. comparing the water or air quality at various locations in and around the Long Beach area with analyses of reasons for differences ✓ Chemistry in Art – presentation of research into pigments and dyes, cosmetics, properties and durability of sculpture materials, conservation or artwork, or detection of forgeries ✓ Chemistry in the Human Body – presentation of advances in medicine, understanding physiology, or effects of microgravity

Unit Tests	Unit tests include selected response questions based primarily on conceptual understanding (including data and graph interpretation), not merely factual recall. Unit tests also include short answer free-response or essay questions connecting key concepts. For example, students may predict shifts in a system based on applications of LeChâtlier's principle. As applicable, teachers also include skill-based practical exams (i.e., use of measuring devices).
Comprehensive Semester Finals	Chemistry has comprehensive semester finals. The second semester final covers content from the entire year.

KEY LABORATORY ACTIVITIES (Key Labs):

A minimum of 30 laboratories is recommended for this course. Our district recommends that approximately 40% of instructional time be devoted to hands-on laboratory and project-based activities. Core experiences for this course include detailed Key Laboratories with complete write-ups on the following topics:

1. **Metal vs. Non-Metal Properties** **(1a,b,d)**

Students compare various representative samples of metals, non-metals, and metalloids. Observations may include conductivity testing, reaction to acids, and critical observations of texture, shape, and malleability or brittleness. Students then make conclusions about the position of each sample on the periodic table, connecting observed properties to atomic properties, especially electronic arrangement, as a basis for understanding the regions representing each group.

2. **Quantum Structure of the Atom [Flame Test]** **(1d,g*,i*,j*)**

Students observe evidence of the quantum nature of electron energy levels by performing spectroscopic analysis of various elements and recording spectral line patterns and wave lengths. Samples might be gas tubes, ions in solution, or computer simulations available from the internet. Students connect the observed color (frequency) to electron jumps between energy levels. They then identify unknown elements using flame techniques with comparisons to known samples, comparing their method to how astronomers study luminous objects. *[PH Chem Labs 6 & 7]*

3. **Physical Properties** **(2a,b,c,d,h*)**

Students examine the differences between ionic and covalent compounds by measuring physical properties such as melting point/boiling point, volatility, and solubility. Students connect observations to the nature of the bonding between the atoms, ions, and molecules. *[partially with PH Chem Lab 22]*

4. **Molecular Modeling** **(2a,b,e,f*)**

As an activity, students use available household or classroom resources to construct accurate representations of molecules. Understanding of VSEPR theory is reinforced by examining relative bond lengths and angles in the structures. Students then analyze their molecule (or ionic formula unit) to predict properties of the compound, such as polarity (and behaviors based on polarity), acid/base potential, and physical state. They also connect their 3-dimensional representation to 2-dimensional Lewis structures, written formulas, and when appropriate, nomenclature. *[related to PH Chem Lab 11]*

5. **Observing a Chemical Rxn** **(3a)**

Students perform a laboratory involving an observable change from reactants to products. Analysis includes specific evidence of a chemical change, as well as identification of initial reactants and new products. The law of conservation of mass is inferred by comparing reactants to products and may be proven by quantitative measurements. *[PH Chem Lab 2, parts B & C]*

6. **Empirical Formula of a Hydrate** **(3b,d)**

Students use serial heating to drive water from a hydrate and serial weightings to show that the process is complete. Comparing the final anhydrous mass to the original hydrate mass, students determine the formula of a hydrate using proportional ratios of molar mass. This lab demonstrates the application of the molar mass in determining an empirical formula. *[PH Chem Lab 28]*

7. **Stoichiometry (with % Yield Calculations)** **(3a,d,e,f)**

Students perform a chemical reaction in which the reactant and product masses are readily determined. They then apply stoichiometric calculations to predict the amount of product expected from the reaction (theoretical yield). Using their measurement of the actual yield, students then calculate the percent yield. The percent yield is then used to analyze avoidable and unavoidable errors that could explain the percent yield outcomes. *[PH Chem Lab 19]*

8. **Reduction-Oxidation** **(3g*)**

Students perform a simple red-ox reaction from which they determine half reactions and ultimately, the balanced overall reaction. This might be done using copper wire with silver nitrate or aluminum foil with ionic copper. Or, students may create an activity series using different metals and their reactions in acid. Students will connect their observations to the structure of voltaic cells or to various practical methods used to prevent oxidation of metals. *[PH Chem Labs 46, 47, and/or 48]*

9. **Gas Laws** **(4c,h*,i*)**

Students perform an experiment (or series of experiments) where they manipulate gas samples to observe how pressure, temperature, and volume affect each other. Students graph the data comparing the two variables at a time, correctly identifying the independent and dependent variables. From the data, students explain the relationship between the two variables manipulated using data to support their conclusions. *[PH Chem Labs 23 & 24]*

10. **Properties of Acids and/or Bases** **(5a)**

Students investigate the chemical properties of acids and methods of neutralization. Under controlled conditions, various metals and carbonates are reacted with acid. Products are collected and identified to determine details of the chemical processes that took place. Complete neutralization of HCl with NaOH is also performed carefully with product measurements made to verify stoichiometry. *[PH Chem Labs 41 & 42]*

11. **Acid/Base Titration** **(5c,d,f*)**

Students perform a titration with a strong base of known molarity and an unknown strong acid. (Note: Standardization of the base is not required in general Chemistry 1-2 classes.) They then graph a titration curve and identify the equivalence point. In their analysis, students relate the reaction between the acid and base to the change in ion concentrations. Students use the data collected to deduce the concentration (normality) of the unknown acid. *[PH Chem Lab 43]*

12. **Solubility / Qualitative Analysis** **(6a,b 3a)**

Students determine the various bonding strengths of ions based on their ability to create precipitates in aqueous solution. They arrange and systematically record reactions observed by mixing pairs on 0.1M ionic solutions. From these observations, trends are observed and common spectator ions identified. Students then make hypotheses about combinations of ionic solutions not yet tested. These hypotheses may then be supported or rejected based on further experimentation or researched evidence. Solubility, or other properties, may also be used in a pre-planned battery of chemical tests used to identify an unknown substance. *[PH Chem Lab 17, 18, Small-Scale Lab 22]*

13. **Distillation & Chromatography** **(6f*)**

Students investigate physical means of separating mixtures. By observing separation based on volatility using condenser collection of the volatile products, and application of mobile phase solubility versus stationary phase affinity in chromatography, students deduce how molecular structure and the resulting intermolecular attractions allow for these methods of separation. *[PH Chem Labs 26 & 32]*

14. **Endo- and Exothermic Rxns (with Calorimetry)** **(7b,e*)**

Students use a simple calorimeter to measure the heat change occurring in chemical reactions. Through calculations, they may also verify the additive nature of heats of reactions expressed in Hess' Law. Students connect large heats of reaction to engine fuels and smaller values to chemical-based heating and cooling pouches. *[PH Chem Lab 35 and an endothermic rxn]*

15. **Specific Heat / Calorimetry** **(7c,d,e*)**

Students determine the specific heat of metal samples and confirm results calculated from experimental values to accepted theoretical values by calculating % error. Students then analyze potential benefits or drawbacks of using various materials for practical purposes: i.e., drink containers made of glass, plastic, coated paper, or aluminum. Or, students may make applications to clothing materials or discuss the importance of water protection in cold weather. *[PH Chem Lab 34 with additional metals and/or an unknown metal tested]*

16. **Reaction Rates** **(8a,b,c,d*)**

Students examine the role of temperature, concentration, and catalysts in changing the rates of chemical reactions. Students can be involved in the experimental design of a lab to measure the impact of changing one of these variables. They then present data in tables and graphs that correctly present both the independent and dependent variables. In the analysis, students connect the data to their understanding of kinetic theory and identify potential errors in their experimental design. *[PH Chem Lab 36]*

17. **Equilibrium & Le Châtelier's Principle** **(9a,b)**

Students observe a chemical system in equilibrium and investigate methods of shifting the equilibrium. Effects of temperature and concentration of common ions are tested. Students connect principles learned to a commercial application of adjusting equilibrium to maximize chemical production. *[PH Chem Lab 38]*

18. **Organic Synthesis** **(10e*,a,b)**

Students study the unique bonding characteristics of carbon by creating simple organic polymers using the "slime" recipe or synthesis of nylon. Alternately, students might perform synthesis of organic compounds like aspirin or esters. Or, they may apply enzymatic techniques like Polymerase Chain Reaction (PCR) and DNA fingerprinting. Students point out how properties of carbon make these processes possible. *[PH Chem Lab 50]*

MATERIALS:

Basic Textbook: ☑ Read in entirety ☐ Excerpts used — Prentice Hall Chemistry, Wilbraham, et. al., Pearson Prentice Hall, © 2007

Safety Equipment:	goggles, aprons, gloves, fire extinguisher, fire blanket, eye wash station, emergency shower, spill kit
Measuring Devices:	centigram balances, analytical balance, volumetric and graduated cylinders, pipettes, burettes
Other Laboratory Equipment:	Bunsen burners, oven, fume hoods, standard materials and equipment comparable to a professional or college laboratory *(Minimum basic lab equipment list available through Science Office.)*
Laboratory Supplies:	chemical reagents, desiccants, indicators, beakers and flasks, test tubes and racks
Other:	Computer-based software and hardware, including probeware, computer labs, internet access, word processing and presentation programs, and student tutorials/practice

❖ Many items are shared in your science department or may be available through Science/Math Resource Center (SMRC).

METHODS:

Learning styles of students may be addressed by implementing combinations of the following:

Significant, Proven Science Strategies for ALL Science Students

- ❑ Hands-On Lab's
- ❑ Inquiry Activities
- ❑ Short/Long-term projects
- ❑ Student Presentations
- ❑ Peer Teaching
- ❑ Summarization
- ❑ Essential Questions
- ❑ Thematic Units
- ❑ Field Experiences
- ❑ Current Events
- ❑ Career Choices
- ❑ Guest Speakers

Reading Strategies in Science

- ❑ Learning Logs
- ❑ Pre-teaching
- ❑ Vocabulary
- ❑ Pre-reading
- ❑ Text Structures
- ❑ Trail Markers
- ❑ Reciprocal Teaching
- ❑ Functional Text

SDAIE Strategies for English Learners

- ❑ Tapping/Building Prior Knowledge (Graphic Organizers, Schema)
- ❑ Grouping Strategies
- ❑ Multiple Intelligences
- ❑ Adapt the Text
- ❑ Interactive Learning (Manipulatives, Visuals)
- ❑ Acquisition Levels
- ❑ Language Sensitivity
- ❑ Lower the Affective Filter (including Processing Time)
- ❑ Home/School Connection (including Cultural Aspects)

Differentiation for Advanced Learners

- ❑ Curriculum Compacting
- ❑ Tiered Assignments
- ❑ Flexible Grouping
- ❑ Acceleration
- ❑ Depth and Complexity
- ❑ Independent Study

Please note that these strategies often overlap and should not be limited to specifically defined courses or student populations.

RESOURCES:

Documents

- ❑ Science Framework: .... http://www.cde.ca.gov/re/pn/fd/sci-frame-dwnld.asp
- ❑ CST / NCLB Test Blueprints: .... http://www.cde.ca.gov/ta/tg/sr/blueprints.asp
- ❑ CST Reference Sheets: .... http://www.cde.ca.gov/ta/tg/sr/cstsciref.asp
- ❑ National Science Standards: .... http://www.nap.edu/readingroom/books/nses/html/
- ❑ Science Safety Handbook for CA Public Schools (1999) can be ordered from the CDE at ....http://www.cde.ca.gov/re/pn/rc/
- ❑ LBUSD Approved Chemicals List, Chemical Hygiene Plan, and Science Fair Resources: http://www.lbusd.k12.ca.us/curriculum/Curriculum%20Services/Science/science.htm

District Offices

- ❑ Science Curriculum Office (562) 997-8000 (ext. 2963)
  - o K-12 science standards, curriculum, professional development, science fair
- ❑ Science / Math Resource Center (562) 997-8000 (ext. 2964)
  - o hands-on materials, consumable material orders, alternative standards-based curriculum packets
- ❑ Office of Multimedia Services (OMS) (562) 997-8000 (ext. 7145)
  - o videos for check out to fit the curriculum (see your librarian for current catalogs)
  - o district TV channels programming
- ❑ PALMS Office — Program Assistance for Language Minority Students (562) 997-8000 (ext. 8031)
  - o technical assistance and professional development for English Language Development (ELD) and Specially Designed Academic Instruction In English (SDAIE)
  - o assistance in the implementation and maintenance of programs addressing the needs of English Language Learners (ELLs)

ASSESSMENT METHODS AND/OR TOOLS:

Student achievement in this course will be measured using multiple assessment tools including but not limited to:

Suggested Evaluation Tools:

Source	Diagnostic	Formative	Summative
District Level Assessments		Constructed Response Questions	Chemistry End of Course Exam
Prentice Hall: CA Chemistry	Inquiry Activity	Progress Monitoring Assessments Reading & Study Workbook Section Assessments & Checkpoint questions Conceptual Problems Quick LABS	Chapter Assessments Lab Analysis and Conclusions
Teacher Developed Assessments	Active Participation strategies pretest / pre-quiz / brainstorming homework assessment notebook organization and note-taking skills	lab-based performance tasks cooperative group assessment peer evaluation written reports with oral presentations open-ended written assessment	portfolios research projects and essays selected response and short answer testing

PERFORMANCE STANDARDS:

Defines how good is good enough on which measures to demonstrate achievement of content standards.

State Performance Standards:

The California State Board of Education has identified the following performance levels for the California Standards Test (CST) in Chemistry. The objective of Long Beach Unified School District is to have all students achieve at or above the Proficient Performance Standard (Level). The table below indicates the number correct, the estimated percent correct (based on 2009 data) and the Reported Scaled Score (SS) on the Content Standards Test.

Far Below Basic	Below Basic	Basic	Proficient	Advanced Proficient
SS 150 – 275	**SS 276 – 299**	**SS 300 – 349**	**SS 350 – 393**	**SS 394 – 600**
0-21 Correct	**22-28 Correct**	**29-41 Correct**	**42-50 Correct**	**51-60 Correct**
Less than 37%	**37% - 47%**	**48% - 68%**	**70% - 83%**	**85% - 100%**

District Performance Standards:

The Long Beach Unified School District has common assessments and key assignments that are required for Biology. The Performance Standard Criteria for district-wide and classroom setting are shown in the table below.

	Not Proficient	Partial Proficient	Proficient	Advanced Proficient
End-Of-Course Exam	**Less than 60%**	**60% - 69%**	**70% - 84%**	**85% - 100%**
Constructed Response	(6 pt rubric) **1-2** (4 pt rubric) **1**	(6 pt rubric) **3** (4 pt rubric) **2**	(6 pt rubric) **4** (4 pt rubric) **3**	(6 pt rubric) **5-6** (4 pt rubric) **4**

Classroom Performance Standards:

The objective of instruction is to help all students achieve at or above the Proficient Level and receive a C or better in the course. Performance level is determined by the average of the assessments or assignments.

	Not Proficient	Partial Proficient	Proficient	Advanced Proficient
Graded Student Work	**Rubric Avg. of 1 or less than 60%**	**Rubric Avg. of 2 or 60% - 69%**	**Rubric Avg. of 3 or 70% - 84%**	**Rubric Avg. of 4 or 85% - 100%**
Labs, Written Assignments, Perf. Tasks, and Projects	(6 pt rubric) **1-2** (4 pt rubric) **1**	(6 pt rubric) **3** (4 pt rubric) **2**	(6 pt rubric) **4** (4 pt rubric) **3**	(6 pt rubric) **5-6** (4 pt rubric) **4**
Teacher/Dept-developed Tests and Exams	**Less than 60%**	**60% - 69%**	**70% - 84%**	**85% - 100%**

SUGGESTED GRADE WEIGHTING:

(with some possible examples)

1. Assessment ~30%
    - objective tests including comprehensive finals
    - practical exams / perf. tasks (rubric scored)
    - open-ended questions (rubric scored)
    - portfolios
    - peer evaluations
2. Homework ~10%
    - discovery assignments
    - assignments reinforcing class lesson
    - essays
    - organization
3. Labs ~20%
    - lab reports / demo observations & analysis
    - active participation
4. Projects ~20%
    - science fair projects
    - research-based reports and projects
5. Class Work ~20%
    - note taking skills
    - organization skills
    - oral presentations
    - individual and group projects and assessments

Note: Extra credit should only be given for content-based activities that go beyond normal class assignments. It should not be used as compensation credit for missed assignments. Also, extra credit should not be given in exchange for tasks performed (such as cleaning, decorating, or grading papers) or for materials donated.

STANDARD GRADING SCALE:

STANDARD GRADING SCALE:

Advanced Proficient	A	90 – 100%
Proficient	B	80 – 89%
	C	70 – 79%
Partial Proficient	D	60 – 69%
Not Proficient	F	0 – 59%

Submitted by: Eric Brundin
School: Science Office
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