Science Teacher Preparation in California: Standards of Quality and Effectiveness for Subject Matter Programs

A Handbook for Teacher Educators
&
Program Reviewers

(Revised September 2010)

Science Teacher Preparation in California: Standards of Quality and Effectiveness for Subject Matter Programs

Created and Recommended by the
Science Subject Matter Advisory Panel
(2001-2003)

Adopted and implemented by the
California Commission on Teacher Credentialing
State of California
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Sacramento, California 95814
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California Commission on Teacher Credentialing

Gray Davis, Governor
State of California

2003

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The Science Teacher Subject Matter Advisory Panel

California Commission on Teacher Credentialing
2001-03

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Part 1: Introduction to Science Teaching Standards

Standards and Credentials for Teachers of Science: A Foreword by the California Commission on Teacher Credentialing

One of the purposes of education is to enable students to learn the important subjects of the school curriculum to further their professional goals and to function effectively in work, society and family life. More than one million students enroll annually in science classes with teachers who are certified by the Commission on Teacher Credentialing to teach those classes in public schools. Students who are the future of California must learn to use science thoughtfully and skillfully. Their ability to do so depends substantially on the quality of teacher preparation in science and science teaching.

The Commission is the agency of California government that certifies the competence of teachers and other professionals who serve in the public schools. As the policy-making body that establishes and maintains standards for the education profession in the State, the Commission is concerned with the quality and effectiveness of the preparation of teachers and other school practitioners. On behalf of the education profession and the general public, one of the Commission's most important responsibility is to establish and implement strong, effective standards of quality for the preparation and assessment of credential candidates.

Teacher candidates in California are required to demonstrate competence in the subject matter they will be authorized to teach. Candidates for the Single Subject Credential have two options available for satisfying this requirement. They can either complete a Commission-approved subject matter preparation program or they can pass the appropriate Commission-adopted subject matter examination(s) (Education Code Sections 44280 and 44310). Because they satisfy the same requirement, these two options are to be as aligned and congruent as possible.

The substance and relevance of the single subject matter program standards and the validity of exam specifications (subject matter requirements) is not permanent, however. The periodic reconsideration of subject matter program standards and the need for periodic validity studies are directly related to one of the fundamental missions of the Commission: to provide a strong assurance that teaching credentials issued by the Commission are awarded to individuals who have the knowledge, skills, and abilities that are needed in order to succeed in public school teaching positions in California. Best professional practice related to the standards and the legal defensibility of the exam specifications require that the validity of Commission policies be periodically reviewed and rewritten, as job requirements and expectations change over time (Ed Code 44225i, j, 44257, 44288).

In the early 1990s the Commission developed and adopted (a) standards for single subject matter preparation programs and, at the same time, (b) specifications for the single subject matter examinations. This work was based on the advice of subject matter advisory panels and data from validity studies and resulted in program standards and examination specifications (defining the subject matter competence requirement) that were valid and closely aligned with each other. Those standards and specifications were adopted by the Commission in 1992 and are still in use today. They are now being replaced by the newly adopted (2002) subject matter requirements and single subject matter standards.

Establishing high standards for teachers is based, in part, on three major pieces of legislation. In 1988, 1992 and 1998 the Legislature and the Governor enacted legislation sponsored by the Commission that strengthened the professional character of the Commission and enhanced its authority to establish rigorous standards for the preparation and assessment of prospective teachers. As a result of these reform laws -- Senate Bills 148 (1988), 1422 (Bergeson 1992) and 2042 (Alpert/Mazzoni, Chapter 548, Statutes of 1998) -- the Commission has taken on new responsibilities for establishing high and acceptable levels of quality in teacher preparation and of competence among beginning teachers. To implement these three statutes, the Commission has developed new standards, subject matter requirements and other policies collaboratively with representatives of post-secondary institutions, teachers and administrators in public schools, and statewide leaders involved in public education.

In the late 1990s, the State Board of Education adopted K-12 Student Academic Content Standards in English, mathematics, science, and social science. These new standards have direct implications for the subject matter competence requirement of prospective teachers. This was recognized in SB 2042 (Alpert/Mazzoni, Chapter 548, Statutes of 1998), which requires the Commission to ensure that subject matter program standards and examinations are aligned with the K-12 student content standards adopted by the State Board.

In 1999 the Commission appointed four panels (English, mathematics, science, and social science) to begin the first of three phases to meet the SB 2042 mandate for single subject matter programs. The second and third phases will bring all 13 subject matter areas for credentials into alignment with K-12 student content standards by 2005. The first phase single subject matter panels (2001, 2002) spent considerable time to ensure that the new subject matter standards were grounded in, and aligned with the academic content standards for California K-12 students

Standards of Program Quality and Effectiveness

Over the past 15 years, CCTC has thoroughly redesigned its policies regarding the preparation of education professionals and the review of preparation programs in colleges and universities. In initiating these reforms, the Commission adopted the following principles regarding the governance of educator preparation programs. The Commission asked the Single Subject Panels to apply these general principles to the creation of standards for subject matter programs in English, mathematics, science and social science.

(1) *The status of teacher preparation programs in colleges and universities should be determined on the basis of standards that relate to significant aspects of the quality of those programs*.
(2) *There are many ways in which a teacher preparation program could be excellent*.
(3) *The curriculum of teacher education plays a central role in a program's quality*.
(4) *Teacher education programs should prepare candidates to teach the public school curriculum effectively*.
(5) *In California's public schools, the student population is so diverse that the preparation of educators to teach culturally diverse students cannot be the exclusive responsibility of professional preparation programs in schools of education*.
(6) *The curriculum of a teacher education program should be based on an explicit statement of purpose and philosophy. An excellent program also includes student services and policies such as advisement services and admission policies*.
(7) *The Commission is concerned about the high level of attrition among beginning teachers, and has successfully sponsored legislation to improve the conditions in which new teachers work*.
(8) *The assessment of each student's attainments in a teacher education program is a significant responsibility of the institution that offers the program*.

(9) *The Commission's standards of program quality allow quality to assume different forms in different environments*.
(10) *The Commission's standards of program quality are roughly equivalent in breadth and importance*.
(11) *Whether a particular program fulfills the Commission's standards is a judgment that is made by professionals who have been trained in interpreting the standards*.

The Commission fulfills one of its responsibilities to the public and the profession by adopting and implementing standards of program quality and effectiveness. While assuring the public that educator preparation is excellent, the Commission respects the considered judgments of educational institutions and professional educators and holds educators accountable for excellence. The premises and principles outlined above reflect the Commission's approach to fulfilling its responsibilities under the law.

Standards for Professional Teacher Preparation Programs

The effectiveness of the science curriculum in California schools does not depend entirely on the content knowledge of science teachers. Another critical factor is the teachers' ability to *teach* science. To address the *pedagogical* knowledge and effectiveness of science teachers, the Commission in September 1998 launched an extensive standards and assessment reform that led to the development of new teacher preparation standards. In January 2001, CCTC authorized an extensive field review of the draft standards, and in July a summary and analysis of the field review findings were presented to the Commission. During July and August 2001, the standards were amended, based on field review findings and direction from the Commission, and finally adopted by the Commission in September 2001.

The advisory panel that developed the standards was charged with developing the following three policy documents for review and consideration by the Commission:

- New standards of quality and effectiveness for professional teacher preparation programs.
- Teaching Performance Expectations that would serve as the basis for evaluating the competence of teacher candidates on teaching performance assessments embedded in preparation programs.
- New standards of quality and effectiveness for professional teacher induction programs.

These standards implement the structural changes in the teacher credentialing system that were called for in Senate Bill 2042 (Alpert/Mazzoni, Chapter 548, Statutes of 1998). Three significant changes enacted in this reform legislation are (1) alignment of all teacher preparation standards with the state-adopted academic content standards and performance levels for students and the California Standards for the Teaching Profession (CSTP), (2) the inclusion of a teaching performance assessment in preparation programs, and (3) a required induction period of support and formative assessment for all first and second year teachers.

In addition to these structural and thematic shifts in the Commission's credentialing system and standards, SB 2042 replaced the Professional Clear Credential course requirements in health, "mainstreaming" and technology with a requirement that essential preparation in these three areas be addressed in preparation and induction standards. Follow-up legislation in 1999 (Ducheney, Chapter 711, Statutes of 1999) required that new standards for preparation and induction programs include preparation for all teachers to teach English learners in mainstream classrooms. The subject matter standards in this handbook have been designed for subject matter programs, to complement the SB 2042 standards for programs of pedagogical preparation.

Subject Matter Preparation Programs for Prospective Teachers

In California, subject matter preparation programs for prospective teachers are not the same as undergraduate degree programs. Post-secondary institutions govern academic programs that lead to the award of degrees, including baccalaureate degrees in science. The Commission sets standards for academic programs that lead to the issuance of credentials, including the Single Subject Teaching Credential in Science. An applicant for a teaching credential must have earned a Bachelor's degree from an accredited institution, but the degree may be in a subject other than the one to appear on the credential. Similarly, degree programs for undergraduate students in science may or may not fulfill the Commission's standards for subject matter preparation. Completing an approved subject matter program that satisfies the standards enables a candidate to qualify for the Single Subject Credential in Science.

Subject Matter Advisory Panels

The Commission asked the Science Subject Matter Advisory Panel to create new standards of program quality and effectiveness that could be used to review and approve subject matter preparation programs. The Commission requested the development of standards that would emphasize the knowledge, skills and perspectives that teachers must have in order to teach science effectively in the public schools.

In January 2001 the Executive Director appointed subject matter panels in English, mathematics, science, and social science to advise Commission staff on the development of new subject matter program standards and examinations in these subject areas. Each panel consists of:

- Classroom teachers of the subject area,
- Subject area specialists in school districts, county offices of education, and postsecondary institutions,
- Professors in the subject area teaching in subject matter preparation programs,
- Teacher educators,
- Members of relevant professional organizations,
- Members of other relevant committees and advisory panels, and
- A liaison from the California Department of Education.

Eighteen panel members were appointed to the English panel; 17 members appointed to the mathematics panel; 20 appointed to the social science; and 23 appointed to the science panel. The panels began their work in March 2001 with a written "charge" describing their responsibilities in developing the Subject Matter Requirements (SMRs). The SMRs are the subject-specific knowledge, skills, and abilities which specify the content required in Commission-approved subject matter preparation programs for teacher candidates. The SMRs were approved by the Commission at a meeting on June 6, 2002

Essential Documents for Panel Use

From their first meeting in March 2001, the subject matter panels used a number of documents as primary resources for their work. The documents listed below were essential for the panels' use in developing the draft program standards that were adopted by the Commission.

- The K-12 Student Academic Content Standards and Frameworks that have been approved by the California State Board of Education (1998-2002).

- The Commission-approved (1992) Standards of Quality and Effectiveness for Subject Matter Programs in English, Mathematics, Science, and Social Science, and Handbooks for Teacher Educators and Program Reviewers in each of the four academic areas (1992).

- The Standards of Program Quality and Effectiveness for the Subject Matter Requirements for the Multiple Subject Teaching Credential (Sept., 2001).

- The Standards for Quality and Effectiveness for Professional Teacher Preparation Programs (Sept., 2001).

- The National Standards for the National Council for Teachers of Mathematics (NCTM), National Council for Teachers of English (NCTE), National Council for Social Science (NCSS), and National Science Teachers Association (NSTA).

- The panels also reviewed several other publications and research articles. Several panel members brought state and national studies and publications for each panels' use.

The State Board of Education adopted K-12 student academic content standards were the seminal documents used by the panels. In the 1992 documents the panels identified six standard areas that were common to each of the four sets of academic standards. This process was instrumental in assisting the panels in identifying the 10 "Standards Common to All" that were developed and apply to all 13 single subject areas. In 2010 these ten standards were revised and replaced by tow new Standards Common to All.

The Subject Matter Requirements for the Multiple Subject Teaching Credential were also an important document used by the panel. In many cases the Multiple Subject Standards language and organization of the standards and standard elements were adopted by the panels. The standards of the national professional organizations also served as a guide and provided a comprehensive perspective for panel members.

Field Review Survey

Early in August 2002 the draft Single Subject Matter Standards and the 10 "Standards Common to All" were mailed to all deans of education, directors of teacher education, and single subject coordinators at all Commission-accredited four-year institutions in California, learned societies and professional organizations, funded subject matter projects, teacher organizations, school districts, and county offices of education. Over 100 selected K-12 public school teachers and college/university professors were sent the draft standards. The standards were also placed on the Commission's web-site with instructions on how to download the standards and complete the field review survey and how to fax, email, or mail completed surveys to the Commission.

There were 717 responses submitted to the Commission in October, 2002. Over 80% of all responses fell in the "Essential" or "Important" categories. Fewer than 5% of all responses were scored as "Not Important", and less than 15% were scored as "Somewhat Important". The responses were evenly distributed among the five sets of standards.

Over 80% of all responses were from higher education faculty at colleges and universities in California. Over 70% of responses were received from academic departments or faculty in the California State University (CSU) system. Responses were received from all 23 CSU campuses, five University of California campuses, and 14 private or independent institutions. The CSU Academic Senate was instrumental in obtaining strong responses from academic departments in the CSU system.

Consultant staff tallied all responses and listed all comments on a master survey form for each subject matter area. The Single Subject Matter Panels made revisions in the language of certain standards, based on the 2002 field review, and the revised standards were recommended to the Commission for adoption at its December 5, 2002, meeting. The Commission also approved eight technical assistance meetings for spring 2003 and an implementation plan for the new standards.

Single Subject Science Teaching Credentials

When the previous Single Subject Science Panel conducted it's work (1989-91) there were two science credentials, a Single Subject Credential in Life Science and a Single Subject Credential in Physical Science. Both authorized individuals to teach science classes in departmentalized settings. Holders of these credentials were authorized to teach at any grade level, but the great majority of science teachers served in grades seven through twelve. The Life Sciences Credential authorized the teaching of life science classes and the Physical Science Credential authorized instruction in chemistry, physics, geoscience and physical science. Both credentials authorized the teaching of general science classes. The Science Panel (1989-91) was requested to recommend new policies to ensure that future science teachers were well prepared in the subjects that were most commonly taught in science classes. When the Single Subject Science Panel was formed (1989), 37% of all science classes in California's public schools were general courses in science for students in grades seven through twelve. Most of these classes included instruction in life science and physical science. In 1988-89 other classes taught in science were more specialized courses in the following subjects.

Biology and Advanced Biology	29% of All Science Classes
Physical Science Courses	13%
Chemistry and Advanced Chemistry	9%
Physics and Advanced Physics	4%
Earth and Environmental Science	4%

All Other Science Subjects 5%

On the recommendation of the (1989-91) Single Subject Science Panel and the Commission's Advisory Panel on streamlining the Credential System, the commission sponsored legislation in 1993 to streamline the structure of science teaching credentials by combining the Life Science and Physical Science Credentials into one Science Teaching Credential. Under this legislative provision, future science teachers were to verify their subject matter competence in science through the completion of:

(1) an advanced specialized concentration in biological science, or chemistry, or geoscience or physics, and completion of
(2) a breath of general science knowledge that included all four areas of science listed above.

The combined credential authorized science teachers to teach courses in general science, integrated of advanced study or concentration. The single subject standards and subject matter requirements in the 1992 Single Subject Science handbooks were designed to enable the prospective science teachers to qualify for the continued science credential.

One of the first activities of the new single Subject Science Panel (2001-2002) was to review and analyze the existing structure and requirements for the single subject science credential. The Panel spent considerable time reviewing the standards language of the 1992 Single Subject Handbook and the content of the science subject matter requirements. A major discussion involved the teaching of integrated science the number of units to be required for the general science or breadth requirement and the required number of units for the advanced study on concentration in science. The panel strongly supported provisions for the teaching of integrated science and provisions for the general science or breadth requirement. After considerable discussion and review of materials the panel unanimously supported the existing structure for the science credential. It includes no less than 45 semester units (or equivalent) for an approved single science programs that consists of no less than 24 semester units in general science or breadth requirements and no less than 18 semester units in advanced study or concentration in one of four science fields of biology, chemistry, physics or earth and planetary science (geoscience). The standards and subjects matter requirements in this science handbook (2003) are designed to enable prospective science teachers to be fully prepared to teach the science courses presently offered in California's public schools.

According to the CDE statewide course enrollment and staffing data for 2002-03 the following science courses are presently being offered. In 2002-03 there were 74,048 science classes offered in California's public secondary schools. Following are the number and types of classes offered in science.

Science Area	**Number of Classes**	**Percent of Total**
Life Science	19,846	27%
Earth & Planetary	4,964	6%
Physics	2,941	4%
Chemistry	6,238	9%
General Science	27,716	37%
Integrated/Coordinated	5,251	7%
Other Science Courses	7,094	10%

On a number of occasions, during the year-long work of the science panel, it reviewed the CDE-CBEDS data for 1999-2000, 2000-2001 and 2001-2002. These data were used as a reference point by the panel as it deliberated and prepared recommendations for consideration by the Commission.

Alignment of Program Standards and Performance Assessments

The Teacher Preparation and Licensing Act of 1970 (Ryan Act) established the requirement that candidates for teaching credentials verify their knowledge of the subjects they intend to teach. Candidates for teaching credentials may satisfy the subject matter requirement by completing approved subject matter programs or passing subject matter examinations that have been adopted by the Commission. In 1998 Senate Bill 2042 required that subject matter programs and examinations for prospective teachers be aligned with K-12 student standards and frameworks.

To achieve this alignment and congruence in science, the Commission asked the Science Subject Matter Advisory Panel to develop subject matter requirements that would be consistent in scope and content with the K-12 standards and frameworks. Following extensive research and review, the Commission adopted a detailed set of *Subject Matter Requirements for Prospective Teachers of Science*, which follow the standards in this handbook. College and university faculty and administrators are urged to examine these requirements as a source of information about content that is essential to include in subject matter preparation programs.

The Commission sought to align the subject matter requirements with the program standards in each subject area. Each subject matter advisory panel is asked to develop standards and subject mater requirements that are as congruent with each other as possible, to maximize the equivalence between credentials that are earned by completing programs and ones that are earned by passing examinations. Standards and examinations were developed from the same set of subject matter requirements.

New Subject Matter Assessments

The Commission has used a variety of assessments to satisfy the examination option for various subject areas. In the early 1990s, the Commission developed and adopted (a) standards for subject matter preparation programs and, at the same time, (b) specifications for the subject matter examinations. The validity of the subject matter competence requirement (i.e., program standards and examination specifications) is not permanent, however. The need for periodic validity studies of the subject matter requirement is directly related to one of the Commission's most fundamental missions: to provide a strong assurance that teaching credentials are awarded to individuals who have learned the most important knowledge, skills, and abilities that are actually needed in order to succeed in California public school teaching positions.

In the late 1990s, the State Board of Education adopted K-12 student content standards in English, mathematics, science, and social science. Beginning in early 2001, the Commission began the process of developing assessments that were aligned with these new standards. In the spring of 2002, the Commission contracted with National Evaluation Systems, Inc. (NES®) to implement a new examination program called the California Subject Examinations for Teachers (CSET). In the four subject areas, multiple-choice and constructed-response items were drafted based on the subject matter requirements, and reviewed and revised as needed by both the Bias Review Committee and the appropriate subject matter advisory panel.

The CSET for English, mathematics, science, and social science were first administered in January 2003, and by June 2003, fully replaced the SSAT and Praxis II examinations as the new subject matter examinations in these areas. From January through June 2003, teacher candidates in these

subject areas were allowed to use the either the new CSET or the combination of appropriate SSAT and Praxis II examinations.

Overview of the Science Standards Handbook

This introduction to the handbook concludes with a statement by the Science Advisory Panel regarding science teaching and teacher preparation in California. Part 2 of the handbook includes the sixteen standards as well as the Subject Matter Requirements for Prospective Teachers of Science. Part 3 provides information about implementation of the new standards in California colleges and universities.

Contributions of the Science Advisory Panel

The Commission on Teacher Credentialing is indebted to the Science Teacher Subject Matter Advisory Panel for the successful creation of *Standards of Program Quality and Effectiveness for the Subject Matter Preparation of Prospective Teachers of Science*. The Commission believes strongly that the standards in this handbook will improve the teaching and learning of science in California's public schools.

Request for Assistance from Handbook Users

The Commission periodically reviews its policies, in part on the basis of responses from colleges, universities, school districts, county offices, professional organizations and individual professionals. The Commission welcomes all comments and questions about the standards and other policies in this handbook, which should be addressed to:

California Commission on Teacher Credentialing
Professional Services Division
1900 Capitol Avenue
Sacramento, California 95814-4213

Science Teaching and Teacher Preparation: Introduction by the Science Advisory Panel

The State of California has a responsibility to educate its citizens to be scientifically and technologically literate. Science and technology impact every facet of contemporary life; a good science education empowers students to participate fully in contemporary society. Science is both a body of knowledge and the process of human observation, identification, description, experimental investigation and theoretical explanation of natural phenomena. People practicing science make inferences based on observations, and use existing concepts and theories to build new hypotheses which can be tested, verified, challenged or modified by further experiments. Science has its own character as an intellectual activity; science aims to be testable, objective, and consistent.

A scientifically literate person recognizes this unique character of science and appreciates the contributions of science to society. A technologically literate person recognizes the interrelationships among science, technology and society, and understands the origins, history, and continuing development of our technological society. Effective science teachers are a critical part of an education system that can produce such citizens.

A significant challenge is to develop science programs that prepare students to enter credential programs and teaching careers with excitement about the potential of being an active part of a science education system that serves all the people of the State of California.

Needs of California Elementary and Secondary School Students

As a part of their broad-based education, California students should graduate from high schools with an awareness of the scientific endeavor leading to an understanding of how the natural world functions. Students should understand how science has been translated into the ideas and products they use everyday. They must be able to apply science in their own lives.

In science classes at all grade levels, students should learn in environments that encourage scientific thinking. They should also have practice in developing laboratory and problem-solving skills that are inquiry-based and have real life applications.

Science education should build understanding of the major strands of scientific thought. Students should be encouraged to develop favorable attitudes toward science, to appreciate its coherence, history, logic, and beauty, to enjoy their own practice of its processes, to admire its technological achievements, and to recognize its limitations.

Contributions from diverse cultures to the construction of scientific understanding and to technological development should be recognized by students. Given the increasing role of science in society, all students, regardless of gender or ethnicity, must have equal access to future careers involving science and technology. Science oriented students should have opportunities to further their scientific education with the goal of eventually pursuing careers in pure or applied science, or science education.

As part of becoming scientifically literate, all students should be aware that science and its applications are human enterprises that have strengths and limitations, and they should appreciate that there are benefits and burdens inherent in the use of technology. Moreover, students must be aware of the ethical issues in science and technology, and must understand concepts of science sufficiently to be able to make informed decisions as members of society.

Characteristics of Future Science Teachers in California

For the state to educate its students to become scientifically and technologically literate citizens, California's science teachers must possess many complex skills that will enable them to communicate and demonstrate concepts, principles, processes, attitudes and appli-cations of science and technology equally well to students of both sexes and of diverse ethnic and cultural backgrounds.

To reflect the cooperative nature of progress in science, and to understand the common bases of the science fields, future teachers must be broadly prepared in all major discip-lines of science. Furthermore, to be well-prepared to teach their future students how science operates in detail, participants in subject matter preparation programs must study at least one science discipline in considerable depth.

Science teachers should also be creative, innovative, flexible, and enthusiastic about their own appreciation of science. They need to be knowledgeable about laboratory and field practices, safety concerns, and the history and philosophy of science. Science teachers should be informed about the applications of science, and about careers based on science.

Science teachers in California face an exciting challenge. State agencies, universities and colleges should establish excellent preparation programs and, in collaboration with school districts, provide ongoing support to teachers. Efforts to raise student expectations and performance in science must be a collaboration between practicing teachers and those who prepare new ones.

Part 2: Standards of Program Quality in Science

Definitions of Key Terms

California state law authorizes the California Commission On Teacher Credentialing (CCTC) to set standards and requirements for preparation programs (Ed Codes 44225a,i,j, 44310, 44311).

Precondition

A precondition is a requirement for initial and continued program approval. Unlike standards, preconditions specify requirements for program compliance, not program quality. The Commission determines whether a program complies with the adopted preconditions on the basis of a program document provided by the college or university. In the program review sequence, a program that meets all preconditions is eligible for a more intensive review to determine if the program's quality satisfies the Commission's standards. Preconditions for the approval of subject matter programs in science are on following pages.

Standards

Standards are statements of program quality adopted by the Commission on Teacher Credentialing to describe acceptable levels of quality in programs of subject matter study offered by regionally-accredited colleges and universities that award baccalaureate degrees. Each standard is elaborated by Program Guidance for that standard. Programs must meet all of the applicable standards for both initial and continuing approval of a subject matter program by the Commission. The Commission determines whether a program satisfies a standard on the basis of an intensive review of all available information provided by the program sponsor related to the standard.

Program Guidance

Program guidance is provided for each standard to help institutions in developing programs that meet the standards, and are also used by program review panels in judging the quality of a program in relation to a given standard. Within the overall scope of a standard, Program Guidance identifies what the Commission believes are the important dimensions of program quality with respect to each standard. In determining whether a program meets a given standard, the review panel considers the information provided by the program in response to each statement of that standard.

Preconditions for the Approval of Subject Matter Programs in Science

To be approved by the Commission, a Subject Matter Program in Science must comply with the following preconditions.

(1) Each Program of Subject Matter Preparation for the Single Subject Teaching Credential in Science shall include (a) a minimum of 24 semester units (or 36 quarter units) of core coursework in science subjects and related subjects that are commonly taught in departmentalized classes in California public schools, and (b) a minimum of 18 semester units (or 27 quarter units) of coursework that provides extended study of the subject, and (c) 3 semester units (or 5 quarter units) in the subject. These requirements are elaborated in Preconditions 2 and 3.

(2) The core of the program (Breadth of Study) shall include coursework in (or directly related to) biological sciences, chemistry, geosciences and physics as commonly taught in departmentalized science classes in California public schools.

(3) Extended studies in the program (Depth of Study) shall include at least one concentration of the four science areas. Each concentration shall comprise at least 18 semester units or 27 quarter units. In addition the program shall include at least 3 semester units (5 quarter units) of additional extended study, either designated as breadth or depth studies at the discretion of the institution.

In addition to describing how a program meets each standard of program quality in this handbook, the program document by an institution shall include the course titles, unit designations, catalog descriptions and syllabi of all courses in the program that are used to meet the standards. Program documents must include a matrix chart that identifies which courses meet which subject matter requirements.

Institutions may determine whether the standards are addressed through one or more courses for each commonly taught subject or courses offering integrated study of these subjects. Institutions may also define the program in terms of required or elective coursework. However, elective options must be equivalent in meeting the standards. Coursework offered by any appropriate department(s) of a regionally accredited institution may satisfy the preconditions and standards in this handbook. Programs may use general education courses in meeting the standards.

Standards of Program Quality and Effectiveness

Category I: Standards Common to All Single Subject Matter Preparation Programs

Standard 1: Program Design
Subject matter programs are based on an explicit statement expressing the purpose, design, and expected outcomes of the program. The program curriculum builds on the K-12 State-adopted academic content standards, with student outcomes and assessments aligned to the subject matter requirements. The program provides prospective teachers with conceptual knowledge of the subject matter, develops academic literacy and discipline-based fluency, addresses issues of equity and diversity, and exposes prospective teachers to a variety of learning experiences appropriate for the discipline.

Standard 2: Program Resources and Support
The program sponsor allocates resources to support effective program coordination, which includes advising students, facilitating collaboration among stakeholders, and overseeing program review. Ongoing review processes use assessments of the prospective teachers and a variety of data such as input from stakeholders and other appropriate measurements for review and evaluation of the subject matter program.

Category II: Program Standards for Science

Standard 3: The Vision for Science

The institution articulates a philosophical vision of science and the education of prospective science teachers. Each program references the current Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) as part of its vision statement.

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

- The program includes a code of ethics that can be applied to the practice of science.
- The program examines ethical, moral, social, and cultural implications of significant issues and ideas in science and technology.
- The program explores practical solutions to challenging important and relevant problems.

Standard 4: General Academic Quality

The program is academically rigorous and intellectually stimulating. It provides opportunities for students to experience and practice analyzing complex situations to make informed decisions and to participate in scientific problem solving. In the program, each prospective teacher develops effective written and oral communication skills with a focus on concepts and methodologies that comprise academic discourse in science.

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

- The program requires sufficient practice in written and oral communication skills that enable prospective teachers to express scientific ideas, concepts, and methods accurately.

- The program promotes the use of quantitative reasoning and encourages prospective teachers to analyze complex situations, make informed decisions, and participate in scientific problem solving.

- The program regularly requires prospective teachers to participate in scientific investigations.

- The program allows prospective teachers to gain experience in critically analyzing and reviewing scientific writings and research.

- The program provides opportunities for prospective teachers to examine conceptual and physical models and their evolution over time.

Standard 5: Integrated Study of Science

The program reflects science as an integrated entity and examines interrelationships among the disciplines, and variations in the structures, content, and methods of inquiry in the disciplines are studied. Each prospective single subject teacher gains an understanding of how the conceptual foundations of the scientific disciplines are related to each other.

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

- Each integrative study component develops the prospective single subject teacher's understanding of how the conceptual foundations of the scientific disciplines are related to each other.
- Each integrative study component provides opportunities for prospective teachers to examine the interconnections between different fields of science.
- The integrative study component(s) of the program require that prospective teacher use higher-level thinking skills while involved in coursework and research in each science discipline.
- Faculty teaching in the program and prospective teachers in various disciplines of science meet regularly to exchange ideas and perspectives.
- The program includes courses and/or projects that integrate science as a whole.

Standard 6: Breadth of Study in Science

The science program is organized to provide prospective teachers a sufficiently broad understanding of science so that, as future literate science teachers, they have the necessary knowledge, skills, and abilities to develop scientific literacy among their students. A breadth of study provides familiarity with the nature of science and major ideas foundational to all the sciences and provides a basis for prospective teachers to engage in further studies of a scientific discipline. The program is aligned with the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998).

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

- The program encompasses the general science specifications for subject matter knowledge and competence, which includes the following general areas of study aligned with the K-12 student academic content standards.

- The program addresses the subject matter skills and abilities applicable to the content domains in science listed below:
    - A- Astronomy
    - B- Dynamic Processes of the Earth (Geodynamics)
    - C- Earth Resources
    - D- Ecology
    - E- Genetics/Evolution
    - F- Molecular Biology and Biochemistry
    - G- Cell and Organismal Biology
    - H- Waves
    - I- Forces and Motion
    - J- Electricity and Magnetism
    - K- Heat Transfer and Thermodynamics
    - L- Structure and Properties of Matter

Standard 7: Depth of Study in a Concentration Area

Each candidate for the Single Subject Teaching Credential in Science must complete a subject matter program that includes Concentration 7A, 7B, 7C, or 7D. Concentration in the identified discipline prepares prospective teachers to teach a full range of courses authorized by the single subject credential authorization. Depth within a discipline is essential for teaching advanced and specialized courses.

Standard 7A: Depth of Study in Biological Sciences

The Concentration in Biological Sciences includes a depth of study of biology that is significantly greater than that required for a general understanding of science as described in Standard 6. The depth of study in Concentration 7A should provide conceptual foundations distributed across the discipline. Integral to the concentration are conceptual foundations that include cell biology and physiology, genetics, evolution, and ecology. Concentration 7A includes in-depth study and field/laboratory experiences in biology; achievement of an appropriate level of understanding in chemistry, mathematics and physics, use of methods employed by scientists in the generation knowledge; and application of biological sciences to technological and societal issues including ethical considerations. Candidates for the Science Credential with a Concentration in Biological Science will be able to teach a wide variety of biology courses in their teaching assignments. The program is aligned with the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998). The Concentration in Biological Sciences will prepare prospective teachers to teach the full range of biology courses authorized by this credential.

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

The program:

- Encompasses the biological science requirements for subject matter knowledge and competence, which are aligned with the K-12 student academic content standards.
- Encompasses the subject matter skills and abilities applicable to the content domains in science as stated in the SMR Part II section.

Standard 7B: Depth of Study in Chemistry

The Concentration in Chemistry includes a depth of study within chemistry significantly greater than that required for a general understanding of science as described in Standard 6. The depth of study in Concentration 7B should provide conceptual foundations that include atomic and molecular structure, chemical reactions, kinetic molecular theory, solution chemistry, chemical thermodynamics, organic chemistry and biochemistry, and nuclear processes. Concentration 7B includes in-depth study and field/laboratory experiences in chemistry, achievement of an appropriate level of understanding in mathematics and physics, use of methods employed by scientists in the generation of scientific knowledge, and application of chemistry to technological

and societal issues including ethical considerations. Candidates for the Science Credential with a Concentration in Chemistry will be able to teach a wide variety of chemistry courses in their teaching assignments. The program is aligned with the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998).

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

The program:

- Encompasses the subject matter skills and abilities applicable to the content domains in science as stated in the SMR Part II section.
- Includes demonstration of mathematical skills and other scientific knowledge needs to complete studies that are required by advanced courses in chemistry.
- Encompasses the chemistry specifications for subject matter knowledge and competence on pages 39 through 44 that are aligned with the K-12 student academic content standards.

Standard 7C: Depth of Study in Geosciences (Earth and Planetary Sciences)

The Concentration in Geosciences (Earth and Planetary Sciences) includes a depth of study greater than that required for a general understanding of science as described in Standard 6. The depth of study in Concentration 7C should provide conceptual foundations in the earth and planetary sciences and should provide conceptual foundations that include the Earth's place in the universe, planet Earth, energy in the Earth System, biochemical cycles, and California geology. Concentration 7C includes in-depth study and field/laboratory experiences in earth and planetary sciences, achievement of an appropriate level of understanding in mathematics, use of methods employed by scientists in the generation of scientific knowledge, and application of earth and planetary sciences to technological and societal issues including ethical consideration. Candidates for the Science Credential with a Concentration in Geosciences will be able to teach a wide variety of courses in their teaching assignments. The program is aligned with the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998).

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

The program:

- Encompasses the earth and planetary sciences specifications for subject matter knowledge and competence that are aligned with the K-12 student academic content standards.

- Encompasses the subject matter skills and abilities applicable to the content domains in science as stated in the SMR Part II section.

- Includes demonstration of mathematical skills needed to complete studies that are required by advanced courses in the earth and planetary sciences.

Standard 7D: Depth of Study in Physics

The Concentration in Physics includes a depth of study of physics significantly greater than that required for a general understanding of science as described in Standard 6. The depth of study in Concentration 7D should provide conceptual foundations in physics and should provide conceptual foundations distributed across the discipline of physics. Integral to the concentration are conceptual foundations that include motion and forces, conservation of energy and momentum, heat and thermodynamics, waves, electromagnetism, and quantum mechanics and the standard model of particles. Concentration 7D includes in-depth study and laboratory experiences in physics, achievement of an appropriate level of understanding in mathematics and use of methods employed by scientists in the generation of scientific knowledge. Candidates for the Science Credential with a Concentration in Physics will be able to teach a wide variety of physics courses in their teaching assignments. The program is aligned with the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998)

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

The program:

- Encompasses the physics specifications for subject matter knowledge and competence that are aligned with the K-12 student academic content standards.

- Encompasses the subject matter skills and abilities applicable to the content domains in science in the SMR Part II section.

- Include demonstration of mathematical skills needed to complete studies that are required by advanced courses in physics.

Standard 8: Laboratory and Field Experiences

Laboratory and field experiences constitute a significant portion of coursework in a program that includes open-ended, problem solving experiences. Prospective teachers have the opportunity to design a variety of laboratory experiments. Data are collected, analyzed, and processed using statistical analysis and current technology (where appropriate).

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

- The program includes required laboratory components in no less than one-third of its courses.
- The program includes periodic open-ended, problem solving experiences in its coursework.
- The program requires prospective teachers to organize, interpret, and communicate observation data collected during laboratory or field experiences using statistical analysis when appropriate.
- The program requires prospective teachers to design and evaluate laboratory experiments and/or fieldwork.
- The program involves prospective teachers in research and collection of data that requires utilization of current technology.

Standard 9: Safety Procedures

The program instructs prospective teachers in proper safety procedures prior to laboratory and field experiences. This includes instruction in emergency procedures and proper storage, handling and disposal of chemicals and equipment. The program provides facilities equipped with necessary safety devices and appropriate storage areas. When the program provides experiences with live organisms, they are observed, captured, and cared for both ethically and lawfully.

The following statements no longer require a direct response but should be used for guidance in responding to the standards directly. Each statement of the standard should be responded to instead, by providing a brief description, a few examples and evidence citations for how the program meets the standard. Please limit the total response to the standard to 1-2 pages.

- The program instructs prospective teachers in proper safety procedures (safe uses of chemicals, specimens, and specialty equipment) prior to laboratory and field experiences, and implements current safety guidelines and regulations.

- The program provides facilities that are equipped with appropriate safety devices.

- The program provides instruction in, and demonstrates emergency procedures and proper storage, handling, and disposal of chemicals, specimen, and equipment.

Subject Matter Requirements for Prospective Teachers General Science

Part I: Content Domains for Subject Matter Understanding and Skill in General Science

Domain 1. Astronomy

Candidates demonstrate an understanding of the foundations of the astronomy contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of astronomy and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that knowledge of the structure and composition of the universe can be learned from studying stars and galaxies and their evolution. They recognize that objects in the sky move in regular and predictable patterns. Candidates explain how and why the moon's appearance changes during the four-week lunar cycle. They understand how telescopes magnify the appearance of distant objects in the sky, including the moon and the planets. They realize that the solar system consists of planets and other bodies that orbit the sun in predictable paths.

1.1 Astronomy

a. Describe the chemical composition and physical structure of the universe
b. Describe the structure of the solar system and its place in the Milky Way galaxy
c. Distinguish between stars and planets
d. Recognize that stars vary in color, size, and luminosity
e. Describe a simple model of how fusion in stars produces heavier elements and results in the production of energy, including light
f. Describe the regular and predictable patterns of stars and planets in time and location
g. Explain and predict changes in the moon's appearance (phases)
h. Describe the use of astronomical instruments in collecting data, and use astronomical units and light years to describe distances

(Science Content Standards for California Public Schools, Grades 3:4a-e; Grade 5: 5a-c; Grade 6: 7a; Grade 7: 6d, 7a; Grade 8:4a-e; Grades 9-12, Earth Sciences: 1a, 1e, 1g, 2a, 2c, 2e-f)

Domain 2. Dynamic Processes of the Earth (Geodynamics)

Candidates demonstrate an understanding of the foundations of the geodynamics contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of geodynamics and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that Earth's features can be explained by a variety of dynamic processes that have occurred in the past and continue to occur. They understand that plate tectonics account for most of the important features of Earth's surface and major geologic events. Candidates explain how surficial processes and agents such as waves, wind, water, and ice are slowly modifying Earth's land surface. They understand how weathering, transport, and deposition of sediment are related to this reshaping. Candidates are familiar with evidence from rocks that allows us to understand geologic history and the evolution of life on Earth. They can use observed properties of

rocks and minerals to determine their processes of formation. Candidates understand that most of the energy on the Earth comes from the sun. They know that energy from the sun heats Earth unevenly, causing air movements that result in changing weather patterns. They use their understanding of heat to explain the many phenomena on Earth's surface that are affected by the transfer of energy through radiation and convection.

2.1 Tectonic Processes and Features

a. Diagram the features that provide evidence for plate tectonics
b. Summarize the thermal processes driving plate movement
c. Explain how density and buoyancy are related to plate tectonics
d. Describe types of plate boundaries
e. Relate the causes of volcanoes, earthquakes, and earth resources to tectonic processes
f. Summarize earthquake processes in terms of epicenter, focal mechanism, distance, and materials, and the role various factors play in the amount of damage caused by an earthquake

(Science Content Standards for California Public Schools, Grade 6: 1a-g; Grade 8: 4a-e; Grades 9-12, Earth Sciences: 1e, 1g, 2c, 3b, 3d)

2.2 Rock Formation

a. Diagram and explain the rock cycle
b. Describe relative and absolute dating techniques, including how half-lives are used in radiometric dating

(Science Content Standards for California Public Schools, Grade 4: 4a; Grade 7: 3c, 4a–e; Grades 9-12, Chemistry: 11f)

2.3 Shaping Earth's Surface: Surficial Processes and Features

a. Describe the dynamic processes of erosion, deposition, and transport
b. Describe coastal processes including beach erosion and natural hazards
c. Describe the effects of natural hazards, including earthquakes, volcanic eruptions, landslides, and floods, on natural and human-made habitats and environmental and human responses to those events

(Science Content Standards for California Public Schools, Grade 4: 5c; Grade 6: 1e, 1f, 2a–d)

2.4 Energy in the Earth System

a. Diagram the water cycle and describe interrelationships of surface and sub-surface reservoirs
b. Explain daily and seasonal changes in the sky (i.e., the sun's position and the intensity and duration of sunlight)
c. Analyze the uneven heating of Earth by the sun
d. Discuss the effects of air movements on weather
e. Describe the energy transfer processes of convection, conduction, and radiation in relation to the atmosphere/ocean and Earth's interior structure
f. Interpret weather maps to predict weather patterns

(Science Content Standards for California Public Schools, Grade 3: 4e; Grade 5: 3a-d, 4a-e; Grade 6: 4a-e; Grades 9-12, Earth Sciences: 5a-b)

Domain 3. Earth Resources

Candidates demonstrate an understanding of the Earth resources contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of Earth resources and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates know there are many different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable. They realize that sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. Candidates understand that the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process. They know the natural origin of the materials used to make common objects.

3.1 Earth Resources

a. Describe a variety of energy resources, including fossil fuels, nuclear fuels, solar, and biomass
b. Recognize earth materials as resources (e.g., rocks, minerals, soils, and water)
c. Identify resources as renewable vs. nonrenewable
d. Compare extraction and recycling in relation to energy, cost, and demand
e. Explain sustainable uses of resources with respect to utility, cost, human population, and environmental consequences

(Science Content Standards for California Public Schools, Grade 2: 3e; Grade 6: 6a-c; Grades 9-12, Earth Sciences: 9a, 9c)

Domain 4. Ecology

Candidates demonstrate an understanding of the foundations of the ecology contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of ecology and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand how organisms in ecosystems exchange energy and nutrients among themselves and with the environment. They can identify factors that affect organisms within an ecosystem, including natural hazards and human activity.

4.1 Ecology

a. Explain energy flow and nutrient cycling through ecosystems (e.g., food chain, food web)
b. Explain matter transfer (e.g., biogeochemical cycles) in ecosystems
c. Distinguish between abiotic and biotic factors in an ecosystem
d. Compare the roles of photosynthesis and respiration in an ecosystem
e. Describe interrelationships within and among ecosystems (e.g., predator/prey)
f. Identify and explain factors that affect population types and size (e.g., competition for resources, niche, habitats, species and population interactions, abiotic factors)

(Science Content Standards for California Public Schools, Grade 4: 2a-c, 3a-c; Grade 5: 2f-g; Grade 6: 5a-e)

Domain 5. Genetics and Evolution

Candidates demonstrate an understanding of the foundations of the genetics and evolution contained in the Science Content Standards for California Public Schools Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of genetics and evolution and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that a typical cell of any organism contains genetic instructions that specify its traits. They can explain how biological evolution accounts for the diversity of species that developed through gradual processes over many generations. Candidates can describe evidence used to explain the evolution of life on Earth.

5.1 Genetics and Evolution

Explain the inheritance of traits which are determined by one or more genes, including dominance, recessiveness, sex linkage, phenotypes, genotypes, and incomplete dominance
Solve problems that illustrate monohybrid and dihybrid crosses
Compare sexual and asexual reproduction
Explain how the coding of DNA (deoxyribonucleic acid) controls the expression of traits by genes
Define mutations and explain their causes
Explain the process of DNA replication
Describe evidence, past and present, that supports the theory of evolution, including diagramming relationships that demonstrate shared characteristics of fossil and living organisms
Explain the theory of natural selection, including adaptation, speciation, and extinction
List major events that affected the evolution of life on Earth (e.g., climate changes, asteroid impacts)

(Science Content Standards for California Public Schools, Grade 7: 2a-e, 3a-e; Grades 9-12, Biology/Life Sciences: 4c, 7c, 8a)

Domain 6. Molecular Biology and Biochemistry

Candidates demonstrate an understanding of the foundations of the molecular biology and biochemistry contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of molecular biology and biochemistry and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand and apply the principles of chemistry that underlie the functioning of biological systems. They describe the properties of biochemical compounds that make them essential to life.

6.1 Biology and Biochemistry

a. Demonstrate understanding that a small subset of elements (C, H, O, N, P, S) makes up most of the chemical compounds in living organisms by combining in many ways
b. Recognize and differentiate the structure and function of molecules in living organisms, including carbohydrates, lipids, proteins, and nucleic acids
c. Describe the process of protein synthesis, including transcription and translation
d. Compare anaerobic and aerobic respiration
e. Describe the process of photosynthesis

(Science Content Standards for California Public Schools, Grade 5: 2f-g; Grade 6: 5a; Grade 8: 6b-c; Grades 9-12, Biology/Life Sciences: 1d, 1f, 1g, 1h, 4a, Chemistry: 10c)

Domain 7. Cell and Organismal Biology

Candidates demonstrate an understanding of the foundations of the cell and organismal biology contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of cell and organismal biology and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that all living organisms are composed of cells and explain important cellular processes. They describe and give examples of how the anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. Candidates demonstrate understanding of physical principles that underlie biological structures and functions. They apply these principles to important biological systems.

7.1 Cell and Organismal Biology

a. Describe organelles and explain their function in the cell
b. Relate the structure of organelles and cells to their functions
c. Identify and contrast animal and plant cells
d. Explain the conversion, flow, and storage of energy of the cell
e. Identify the function and explain the importance of mitosis and meiosis as processes of cellular and organismal reproduction
f. Compare single-celled and multicellular organisms, noting the role of cell differentiation in the development of multicellular organisms
g. Describe the levels of organization (e.g., cells, tissues, organs, systems, organisms) in plants and animals
h. Describe the structures and functions of human body systems, including, but not limited to, the skeletal, reproductive, nervous, and circulatory systems
i. Explain the major structures and their functions in vascular and nonvascular plants
j. Describe the life processes of various plant groups, including, but not limited to, reproduction, photosynthesis, respiration, and transpiration
k. Explain the reproductive processes in flowering plants

(Science Content Standards for California Public Schools, Grade 3: 1b, 1c; Grade 5: 2a, 2e; Grade 7: 1a-f, 5a-g, 6d, 6h-j)

Domain 8. Waves

Candidates demonstrate an understanding of the foundations of waves as contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of waves and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that all waves have a common set of characteristic properties. They apply their knowledge of these properties to describe and predict the behavior of waves, including light waves, sound waves, and seismic waves. Candidates apply the simple principles of optics to explain how various lenses work.

8.1 Waves

a. Compare the characteristics of sound, light, and seismic waves (e.g., transverse/longitudinal, travel through various media, relative speed)
b. Explain that energy is transferred by waves without mass transfer and provide examples
c. Explain how lenses are used in simple optical systems, including the camera, telescope, microscope, and the eye
d. Explain and apply the laws of reflection and refraction
e. Compare transmission, reflection, and absorption of light in matter

(Science Content Standards for California Public Schools, Grade 3: 1d, 2a-d, 4c; Grade 6: 3a; Grade 7: 6a, 6c-g; Grades 9-12, Physics: 4a-b, 4d, 4f)

Domain 9. Forces and Motion

Candidates demonstrate an understanding of the foundations of forces and motion as contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of forces and motion and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates describe the motion of an object and understand the relationships among its velocity, speed, distance, time, and acceleration. They understand the relationship among force, mass, and acceleration. Candidates use Newton's laws to predict the motion of objects.

9.1 **Forces and Motion**

a. Discuss and apply Newton's laws (i.e., first, second, third, and law of universal gravitation)
b. Define pressure and relate it to fluid flow and buoyancy (e.g., heart valves, atmospheric pressure)
c. Describe the relationships among position, distance, displacement, speed, velocity, acceleration, and time, and perform simple calculations using these variables for both linear and circular motion
d. Identify the separate forces that act on a body (e.g., gravity, pressure, tension/compression, normal force, friction) and describe the net force on the body
e. Construct and analyze simple vector and graphical representations of motion and forces (e.g., distance, speed, time)
f. Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and explain their roles in nature, such as the role of gravity in maintaining the structure of the universe
g. Explain and calculate mechanical advantages for levers, pulleys, and inclined planes

(Science Content Standards for California Public Schools, Grade 7: 6h-j; Grade 8: 1a-f, 2a-g)

Domain 10. Electricity and Magnetism

Candidates demonstrate an understanding of the foundations of the electricity and magnetism contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of electricity and magnetism and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that electric and magnetic phenomena are related. They use knowledge of electricity and magnetism to explain many practical applications.

10.1 Electricity and Magnetism

a. Describe and provide examples of electrostatic and magnetostatic phenomena
b. Predict charges or poles based on attraction/repulsion observations
c. Build a simple compass and use it to determine direction of magnetic fields, including the Earth's magnetic field
d. Relate electric currents to magnetic fields and describe the application of these relationships, such as in electromagnets, electric current generators, motors, and transformers
e. Design and interpret simple series and parallel circuits
f. Define and calculate power, voltage differences, current, and resistance in simple circuits

(Science Content Standards for California Public Schools, Grade 4: 1a-g; Grade 9-12, Physics: 5a-c)

Domain 11. Heat Transfer and Thermodynamics

Candidates demonstrate an understanding of the foundations of heat transfer and thermodynamics as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of heat transfer and thermodynamics and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates explain how heat flows in a predictable manner. They understand that energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. Candidates apply their knowledge to explain how many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents.

11.1 Heat Transfer and Thermodynamics

a. Know the principle of conservation of energy and apply it to energy transfers
b. Discuss how the transfer of energy as heat is related to changes in temperature
c. Diagram the direction of heat flow in a system
d. Describe the methods of heat transfer by conduction, convection, and radiation, and provide examples for each
e. Explain how chemical energy in fuel is transformed to heat
f. Design and explain experiments to induce a physical change such as freezing, melting, or boiling
g. Distinguish between physical and chemical changes and provide examples of each

(Science Content Standards for California Public Schools, Grade 6: 3a-d, 4d; Grade 8: 3b, 3d-e, 5c-d; Grade 9-12, Physics: 3a-c, Chemistry: 7a-c)

Domain 12. Structure and Properties of Matter

Candidates demonstrate an understanding of the structure and properties of matter contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of matter and its underlying structures, candidates have a deep conceptual knowledge of the content area. Candidates know that more than 100 elements of matter exist, each with distinct properties and a distinct atomic structure. They describe both macroscopic and microscopic properties of matter including intermolecular and intramolecular forces. They know that the organization of the periodic table is based on the properties of the elements and reflects the structure of atoms. Candidates understand how the periodic table is constructed and the periodic trends in chemical and physical properties that can be seen in the table. They recognize chemical reactions as processes that involve the rearrangement of electrons to break and form bonds with different atomic partners. Candidates demonstrate understanding of the principles of chemistry that underlie the functioning of biological systems.

12.1 Structure and Properties of Matter

a. Identify, describe, and diagram the basic components within an atom (i.e., proton, neutron, and electron)
b. Know that isotopes of any element have different numbers of neutrons but the same number of protons, and that some isotopes are radioactive
c. Differentiate between atoms, molecules, elements, and compounds
d. Compare and contrast states of matter and describe the role energy plays in the conversion from one state to another
e. Discuss the physical properties of matter including structure, melting point, boiling point, hardness, density, and conductivity
f. Recognize that all chemical substances are characterized by a unique set of physical properties
g. Define and calculate density, and predict whether an object will sink or float in a fluid
h. Explain that chemical changes in materials result in the formation of a new substance corresponding to the rearrangement of the atoms in molecules
i. Explain and apply principles of conservation of matter to chemical reactions, including balancing chemical equations
j. Distinguish among acidic, basic, and neutral solutions by their observable properties
k. Describe the construction and organization of the periodic table
l. Based on position in the periodic table, predict which elements have characteristics of metals, semi-metals, non-metals, and inert gases
m. Explain chemical reactivity using position on the periodic table
n. Predict and explain chemical bonding using elements' positions in the periodic table
o. Recognize that inorganic and organic compounds (e.g., water, salt, carbohydrates, lipids, proteins, nucleic acids) are essential to processes within living systems
p. Explain the central role of carbon in living system chemistry

(Science Content Standards for California Public Schools, Grade 8: 3a-c, 5a-e, 6a, 6c, 7a-c, 8a-d; Grades 9-12, Chemistry: 7b, 11c)

Biology/Life Science Subject Matter Requirements

Part I: Content Domains for Subject Matter Understanding and Skill in Biology/Life Science

Domain 1. Cell Biology and Physiology

Candidates demonstrate an understanding of the foundations of the cell biology and physiology contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of cell biology and physiology and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate an understanding of the fundamental life processes of plants and animals that depend on a variety of chemical reactions that occur in specialized areas of an organism's cells. They recognize the coordination of organ systems and the relationship of structure to function. They use this understanding to apply the concepts of homeostasis and its mechanisms to the regulation of human body systems.

1.1 Prokaryotic and Eukaryotic Cells

a. Compare prokaryotic cells, eukaryotic cells, and viruses in terms of complexity, general structure, differentiation, and their requirements for growth and replication

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 1c, 1d)

1.2 Cellular Reproduction

a. Describe the stages of the cell cycle
b. Diagram and describe the stages of the mitotic process

(Science Content Standards for California Public Schools, Grades 7: 1e)

1.3 Plant and Animal Cell Anatomy and Physiology

a. Diagram the structure of the cell membrane and relate the structure to its function
b. Explain methods of transport across the membrane (e.g., diffusion, active transport, endocytosis and exocytosis)
c. Explain the role of semipermeable membranes in cellular communication
d. Explain the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins
e. Explain the role of chloroplasts in obtaining and storing usable energy
f. Explain the role of mitochondria in cellular respiration
g. Explain the role of enzymes in chemical reactions and describe an experiment to test the catalytic role of enzymes and factors that affect enzyme activity (e.g., levels of protein organization, temperature, ionic conditions, concentration of enzyme and substrate, pH)
h. Explain anabolic and catabolic pathways involved in the metabolism of macromolecules (e.g., polysaccharides, nucleic acids, proteins, lipids)

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 1a-b, 1d-j)

1.4 Integration and Control of Human Organ Systems

a. Relate the complementary activity of major body systems (e.g., circulatory, digestive, respiratory, excretory) to provide cells with oxygen and nutrients and remove waste products
b. Explain and analyze the role of the nervous system in mediating communication between different parts of the body and the body's interactions with the environment
c. Explain the homeostatic role of the major organs (e.g., kidneys, heart, brain)
d. Explain the function of feedback loops in the nervous and endocrine systems to regulate conditions in the body and predict the effects of disturbances on these systems
e. Explain the role of hormones (e.g., digestive, reproductive, osmoregulatory) in providing internal feedback mechanisms for homeostasis at the cellular level and in whole organisms
f. Describe the role of the musculo-skeletal system in providing structure, support, and locomotion to the human organism

(Science Content Standards for California Public Schools, Grade 7: 5a-b; Grades 9-12, Biology/Life Sciences: 9a-i)

1.5 Physiology of the Immune System

a. Explain the humoral response to infection
b. Compare cell mediated and humoral responses to infection
c. Explain how vaccination works and distinguish among variables affecting success rate
d. Predict the consequences of a compromised immune system [e.g., AIDS (Acquired Immune Deficiency Syndrome)]

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 10b-f)

Domain 2. Genetics

Candidates demonstrate an understanding of the foundations of the genetics contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of genetics and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate understanding of the structure and function of genetic material. They understand the genetic coding of DNA (deoxyribonucleic acid) and how this coding specifies the sequence of amino acids in proteins characteristic of the organism. Candidates know that a multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. They understand the roles of mutation and sexual reproduction in genetic variation within populations. They know how new biotechnology methods incorporate exogenous DNA into cells to alter their genetic composition, and the resulting ethical implications of using such methods. Candidates also understand the relationship of genetics to evolution and how the frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time.

2.1 Chromosome Structure and Function

a. Relate the structure and function of DNA, RNA (ribonucleic acid), and proteins to the concept of variation in organisms
b. Describe chromosome structure as a sequence of genes each with a specific locus

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 1d, 3d, 4a-c, 4e, 5a-b)

2.2 Patterns of Inheritance

a. Explain the necessity of both meiosis and fertilization in promoting variation
b. Describe the role of chromosomes in determining phenotypes (e.g., sex determination, chromosomal aberrations)
c. Predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (e.g., autosomal or X-linked, dominant or recessive, co-dominance)
d. Explain the genetic and cellular bases for Mendel's laws of dominance, segregation and independent assortment

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 2a-g, 3b-c, 8a)

2.3 Gene Expression

a. Explain how random chromosome segregation explains the probability that a particular allele will be in a gamete
b. Recognize that specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences among the genes themselves
c. Describe how alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool
d. Distinguish when and why mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 3a, 4c-d, 7b-c)

2.4 Biotechnology

a. Recognize how genetic engineering (biotechnology) produces biomedical and agricultural products
b. Describe the construction of recombinant DNA molecules by basic DNA technology including restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 5c-e)

2.5 Bioethics

a. Discuss issues of bioethics including genetic engineering, cloning, the human genome project, gene therapy, and medical implications

(Science Content Standards for California Public Schools, Grades 9-12, Investigation and Experimentation:1m)

Domain 3. Evolution

Candidates demonstrate an understanding of the foundations of the evolution contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of evolution and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates explain that evolution is the result of genetic changes that occur in constantly changing environments. They know that the frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. Based on available evidence, they relate evolutionary theory to the history of life on Earth.

3.1 Natural Selection

a. Explain why natural selection acts on the phenotype rather than the genotype of an organism
b. Predict the survival potential of various groups of organisms based on the amount of diversity in their gene pools

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 7a-d)

3.2 Evolutionary Patterns

a. Analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction
b. Analyze the effects of evolutionary patterns on the diversity of organisms (e.g., genetic drift, convergent evolution, punctuated equilibrium, patterns of selection)
c. Explain the conditions for Hardy-Weinberg equilibrium and why they are unlikely to appear in nature, and solve equations to predict the frequency of genotypes in a population

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 7e-f, 8b-c, 8e)

3.3 Mechanisms for Speciation

a. Distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change
b. Describe a scenario that demonstrates the effects of reproductive or geographic isolation on speciation

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 6g, 8d)

3.4 History and Origin of Life

a. Explain the theoretical origins of life on Earth
b. Construct a branching diagram (cladogram) from a variety of data sources illustrating the phylogeny between organisms of currently identified taxonomic groups

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 8f-g)

Domain 4. Ecology

Candidates demonstrate an understanding of the foundations of the ecology contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of ecology and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate understanding that stability in an ecosystem is a balance among competing effects. They understand the interrelationships within ecosystems, the flow of matter and energy through ecosystems, and how humans impact the environment.

4.1 Biodiversity

a. Define biodiversity and describe the effects on biodiversity of alteration of habitat

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 6a-b)

4.2 Energy Flow and Nutrient Cycles

a. Evaluate the importance of stability of producers, consumers, and decomposers

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 6e-f)

4.3 Interrelationships and Change in Ecosystems

a. Describe various species interactions (e.g., predator/prey, parasitism, mutualism, commensalism, competition)
b. Analyze the fluctuations in population size in an ecosystem due to the relative rates of birth, immigration, emigration, and death
c. Analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, and changes in population size

(Science Content Standards for California Public Schools, Grades 9-12, Biology/Life Sciences: 6b-c)

Chemistry Subject Matter Requirements

Part I: Content Domains for Subject Matter Understanding and Skill in Chemistry

Domain 1. Atomic and Molecular Structure

Candidates demonstrate an understanding of atomic and molecular structure as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of atomic and molecular structure, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate understanding of how periodicity of physical and chemical properties of the elements relates to atomic structure. They base this on a demonstrated understanding of current models of atomic, molecular, and subatomic structure.

1.1 Periodic Table and Periodicity

a. Differentiate periodic groups and families of elements and their properties
b. Relate valence electrons and the electron shell structure (s, p, d, f orbitals) to an element's position in the periodic table
c. Predict periodic trends including electronegativity, ionization energy, and the relative sizes of ions and atoms

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 1c-d, 1f-g)

1.2 Atomic Structure

a. Analyze the evolution of the atomic model (including, but not limited to, the historical importance of the Bohr model and the development of the quantum structure of the atom)
b. Relate atomic spectroscopy and the photoelectric effect to the quantum structure of the atom
c. Illustrate the position and describe the properties of quarks, protons, neutrons, and electrons within atoms

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: h-j, 11g)

1.3 Molecular Structure and Chemical Bonds

a. Compare types of molecular bonds including ionic, covalent and hydrogen bonds
b. Draw Lewis dot structures for compounds and ions
c. Predict molecular geometries using Lewis dot structures and hybridized atomic orbitals, e.g., valence shell electron pair repulsion model (VSEPR)
d. Relate intermolecular electrostatic forces, including Van der Waals, polar and induced polar, and ionic, to their expected states of matter and their characteristic physical properties.

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 2a-h)

Domain 2. Chemical Reactions

Candidates demonstrate an understanding of the foundations of chemical reactions as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of chemical reactions and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate an understanding of the principles that underlie the conditions governing chemical reactions. They apply the principle of conservation of matter and are able to quantify the mass of products and reactants. Candidates understand that chemical reaction rates depend on factors that affect the frequency of collisions and reactivities of reactant molecules. They explain and predict the behavior of chemical systems by applying the principle of chemical equilibrium as a dynamic process at the molecular level.

2.1 Conservation of Matter and Stoichiometry

a. Calculate molar mass, mass, number of particles, and volume, at standard temperature and pressure (STP) for elements and compounds
b. Calculate the masses of reactants and products, and percent yield using balanced chemical equations, including problems with a limiting reagent
c. Distinguish reaction types, including single replacement, double replacement, synthesis, decomposition, and combustion
d. Utilize the rules of oxidation states to balance oxidation-reduction reactions

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 3a-g)

2.2 Reaction Rates and Chemical Equilibrium

a. Predict the effect of temperature, pressure, and concentration on chemical equilibrium (LeChatelier's principle) and the reaction rate
b. Interpret a diagram showing activation energy along the reaction pathway
c. Identify and predict the role of catalysts on the reaction rate
d. Write and calculate an equilibrium constant expression for a given reaction
e. Know that equilibrium is established when the reaction rates of the forward and reverse reactions are equal

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 8a-d, 9a-c)

Domain 3. Kinetic Molecular Theory

Candidates demonstrate an understanding of the foundations of the kinetic molecular theory contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of kinetic molecular theory and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand kinetic molecular theory and use it to generate a description of the motion of atoms and molecules. They use kinetic molecular theory to explain and predict the properties and behaviors of gases.

3.1 Gases and Their Properties

a. Solve problems using the ideal gas law and use the ideal gas law to predict pressure-volume, pressure-temperature, and volume-temperature relationships
b. Relate pressure, volume, and temperature to the kinetic theory of atoms and molecules in gases
c. Know and use STP to solve gas law problems
d. Convert between Kelvin and Celsius temperature scales
e. Recognize the significance of absolute zero
f. Solve problems using Dalton's law of partial pressures and Graham's Laws of diffusion

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 4a-i)

Domain 4. Solution Chemistry

Candidates demonstrate an understanding of the foundations of the solution chemistry contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of solution chemistry and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates predict and explain the properties and behaviors of acids, bases, and salts in solution. They explain the properties of various solutions.

4.1 Solutions

a. Recognize and identify solutes and solvents
b. Calculate concentration in terms of molarity, parts per million, and percent composition
c. Describe the dissolving process at the molecular level
d. Explain how factors such as temperature, pressure, and surface area affect the dissolving process
e. Describe various methods for separation of solutions (e.g., chromatography, distillation)

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 6a-d, 6f)

4.2 Acids and Bases

a. Distinguish between strong and weak acids and bases based on degree of dissociation and their chemical properties
b. Calculate pH and hydrogen ion concentration in solutions including buffer solutions
c. Use Arrhenius, Brønsted-Lowry, and Lewis acid-base definitions appropriately to characterize acids and bases and in acid-base reactions

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 5a-g)

Domain 5. Chemical Thermodynamics

Candidates demonstrate an understanding of the foundations of the chemical thermodynamics contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of chemical thermodynamics and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate by solving problems an understanding that energy is exchanged or transformed in all chemical reactions and physical changes of matter. They apply the concepts of thermodynamic properties of materials such as specific heat, heats of fusion, heats of vaporization, and heat of reaction (enthalpy).

5.1 Chemical Thermodynamics

a. Perform calculations using specific heat, heats of fusion, heats of vaporization, and heat of reaction (enthalpy)
b. Interpret phase diagrams

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 7b, 7e)

Domain 6. Organic Chemistry and Biochemistry

Candidates demonstrate an understanding of the foundations of the organic chemistry and biochemistry contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of organic chemistry and biochemistry and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate understanding that 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.

6.1 Organic Chemistry and Biochemistry

a. Explain the bonding characteristics of carbon
b. Recognize the chemical structure of various organic functional groups (i.e., alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids) and provide examples of reactions involving these groups
c. Inventory the ten simplest hydrocarbons that contain single bonds, multiple bonds, and benzene rings
d. Understand the differences in structures and properties between amino acids and their polymers and between sugars and their polymers

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 10b-f)

Domain 7. Nuclear Processes

Candidates demonstrate an understanding of the foundations of the nuclear processes contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of nuclear processes and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates explain nuclear processes including the radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion (e.g., stellar nucleosynthesis and synthesis of transuranium elements). They apply understanding of these processes to discuss the benefits and hazards of the use of radiation and radioactivity.

7.1 Nuclear Processes

a. Understand how mass-energy relationships in nuclear reactions and radioactive decay requires the relationship $E=mc^2$
b. Compare and contrast alpha, beta, and gamma decay, and the relative kinds of damage to matter caused by α-, β-, and γ- rays
c. Perform calculations involving half-life
d. Contrast the benefits and hazards of the use of radiation and radioactivity

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 11b, 11d-f; Investigation and Experimentation: 1m)

Earth and Planetary Science Subject Matter Requirements

Part I: Content Domains for Subject Matter Understanding and Skill in Earth and Planetary Science

Domain 1. Earth's Place in the Universe

Candidates demonstrate an understanding of Earth's place in the universe as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of the solar system and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand how Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time, and how astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. They base this understanding on their knowledge of the characteristics and properties of phenomena such as galaxies, stars, and bodies of the solar system.

1.1 Galaxies and Stars

a. Identify and describe characteristics of galaxies
b. Explain the evidence for the "big bang" model
c. Know that the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium
d. Describe the process of the nuclear synthesis of chemical elements and how accelerators simulate the conditions for nuclear synthesis (i.e., in stars and in the early universe)
e. Compare the use of visual, radio, and X-ray telescopes to collect data that reveal that stars differ in their life cycles
f. Describe, in terms of color and brightness, how the evolution of a star is determined by a balance between gravitational collapse and nuclear fusion

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 1e, 2b-g)

1.2 Solar Systems

a. Explain how the solar system was formed, including differences and similarities among the sun, terrestrial planets, and the gas planets, and cite the evidence from Earth and moon rocks that indicate that the solar system was formed approximately 4.6 billion years ago
b. Know the current evidence for the existence of planets orbiting other stars
c. Describe changes in the solar system over time

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 1a, 1b, 1g)

1.3 Planets and Satellites

a. Cite various forms of evidence that indicate the proximity of the planets in the solar system in relation to Earth and the stars
b. Cite various forms of evidence that Earth and other planets change over time
c. Describe the influence of collisional processes on early Earth and other planetary bodies in terms of shaping planetary surfaces and affecting life on Earth

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 1c, 1d, 1f)

Domain 2. Planet Earth

Candidates demonstrate an understanding of the foundations of Earth contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of Earth and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate an understanding of the dynamic processes of the solid Earth, oceans, and the atmosphere. Candidates understand how plate tectonics operating over geologic time have changed the patterns of land, sea, and mountains on Earth's surface. Candidates also understand the dynamic processes that operate in and among the atmosphere, oceans and other water bodies, and the biosphere. They understand how life has changed Earth's atmosphere, and how changes in the atmosphere affect conditions for life. Candidates apply their knowledge of dynamic Earth processes to make predictions and form conclusions about surface phenomena such as earthquakes.

2.1 Tectonic Processes

a. Diagram the major divisions of the geologic time scale as a basis for understanding changes in the Earth's processes
b. Describe how earthquake intensity, magnitude, epicenter, focal mechanism, and distance are determined from a seismogram
c. Compare major types of volcanoes in terms of shape and chemical and rock composition
d. Describe the location and characteristics of volcanoes that are due to hot spots and those due to subduction
e. Relate geologic structures to tectonic settings and forces
f. Describe the evidence for plate tectonics on the sea floor and on land

(Science Content Standards for California Public Schools, Grade 7: 3c, 4b, 4d, 4g; Grades 9-12, Earth Sciences: 1c, 3a-b, 3d-f)

2.2 Oceans

a. Describe the chemical and physical properties of seawater
b. Describe the mechanisms that cause wave action and tides
c. Explain the layered structure of the oceans, including the generation of horizontal and vertical ocean currents and the geographic distribution of marine organisms, and how properties of ocean water, such as temperature and salinity, are related to these phenomena

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 5d)

2.3 Atmosphere

a. Compare the layers of the atmosphere in terms of chemical composition and thermal structure
b. Discuss the evolution of Earth's atmosphere over geologic time, including the effects of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen
c. Know the location of the ozone layer in the upper atmosphere, explain its role in absorbing ultraviolet radiation, and explain the way in which this layer varies both naturally and in response to human activities
d. Identify the bands at specific latitudes where rainforests and deserts are distributed and the causes of this pattern

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 5e-f, 8a-c)

Domain 3. Energy in the Earth System

Candidates demonstrate an understanding of energy in the Earth system contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of energy in the Earth system and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand how energy enters, flows through, and leaves the Earth system, and the relationship between energy transfer and the dynamic processes of the Earth system. They base this on knowledge of how energy enters the Earth system primarily as solar radiation and eventually escapes as heat, and how heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. Candidates apply their knowledge of dynamic Earth processes to make predictions and form conclusions about surface phenomena such as climate.

3.1 Earth's Energy Budget: Inflow and Outflow

a. Compare the amount of incoming solar energy, the Earth's internal energy, the energy used by society, and the energy reflected back to space
b. Describe what happens to incoming solar radiation as it relates to reflection, absorption, and photosynthesis
c. Explain the mechanism and evaluate the significance of the greenhouse effect
d. Differentiate among greenhouse conditions on Earth, Mars, and Venus; the origins of those conditions; and the climatic consequences of each

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 4a-d, 6a)

3.2 Circulation in the Oceans and Atmosphere

a. Assess the differential effects of heating on circulation patterns in the atmosphere and oceans
b. Relate the rotation of Earth to the circular motions of ocean currents and air in low- and high-pressure centers

c. Compare the causes and structures of various cloud types, precipitation, air masses, and fronts, and the causes and effects of different types of severe weather
d. Know and explain features of the ENSO cycle (El Niño southern oscillation, including La Niña) in terms of sea-surface and air temperature variations across the Pacific, and climatic results of this cycle

(Science Content Standards for California Public Schools, Grade 5: 3b-c, 4c; Grades 9-12, Earth Sciences: 5a-b, 5g)

3.3 Climate Variations in Time and Space

a. Analyze weather (short-term) and climate (over time) in relation to the transfer of energy into and out of the atmosphere
b. Discuss and assess factors that affect climate including latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 5e, 6a, 6b)

Domain 4. Biogeochemical Cycles

Candidates demonstrate an understanding of the foundations of the biogeochemical cycles contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of biogeochemical cycles and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate an understanding of how each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. Candidates understand how the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.

4.1 Rock Cycle

a. Compare and contrast the properties of rocks based on physical and chemical conditions in which rocks are formed, including plate tectonic processes
b. Identify common rock-forming minerals (e.g., feldspars, quartz, biotite, calcite) using a table of diagnostic properties
c. Identify common ore minerals as sources of copper, iron, lead, zinc, cement, halite, gypsum, and uranium

(Science Content Standards for California Public Schools, Grade 4: 4b, 6c; Grades 9-12, Earth Sciences: 3c)

4.2 Water, Carbon, and Nitrogen Cycles

a. Illustrate the mechanism that drives the water cycle
b. Compare the processes of photosynthesis and respiration in terms of reservoirs of carbon and oxygen
c. Identify the carbon reservoirs (i.e., physical and chemical forms of carbon in the atmosphere, oceans, biomass, soils, fossil fuels, and solid earth) and describe the movement of carbon among these reservoirs in the global carbon cycle
d. Describe the nitrogen cycle as it relates to the atmosphere, soils as reservoirs, life processes, and pollution

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 7a-d)

Domain 5. California Geology

Candidates demonstrate an understanding of the foundations of the California geology contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of California geology and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that the geology of California underlies the state's scenic diversity and wealth of natural resources as well as its natural hazards. Candidates are familiar with the geology of California, and are aware of the unique opportunities for field experiences in the state. Candidates describe activities using geologic maps that illustrate processes, location, and scale of phenomena. Candidates also describe field experiences that include the basic elements of geologic mapping to record and interpret the history of geological processes portrayed in California.

5.1 Tectonic Evolution

a. Interpret geologic maps as a basis for understanding the tectonic evolution of California in terms of plate margins (i.e., Atlantic-type passive margin, Japanese volcanic arc, Andean arc, and faulted margin)

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 9d, Investigation and Experimentation: 1h)

5.2 Major Economic Earth Resources

a. Understand the importance of water to society, the origins of California's fresh water, statewide water distribution, and the environmental and economic impact of water re-distribution
b. Describe resources of major economic importance in California and their relation to California's geology (e.g., oil, gas, gold, sand, gravel, salts, open space, soil, arable land, clean air)

(Science Content Standards for California Public Schools, Grade 6: 6b; Grades 9-12, Earth Sciences: 9a, 9c)

5.3 Surface Processes

a. Assess mechanisms by which tectonics, geologic structures (i.e., folds and faults), and rock properties influence surface properties (e.g., flow of water, differential erosion, uplift, subsidence)
b. Discuss the factors controlling the influence of water in modifying the landscape
c. Interpret the factors controlling erosion, deposition, and transport in surficial processes
d. Appraise desert environments in terms of water resource needs for habitation

(Science Content Standards for California Public Schools, Grade 4: 5b-c; Grade 6: 2a-c)

5.4 Natural Hazards

a. Analyze published geologic hazard maps of California and know how to use maps to identify evidence of geologic events of the past and to predict the likelihood of geologic changes in the future

(Science Content Standards for California Public Schools, Grades 9-12, Earth Sciences: 9b, 9d, Investigation and Experimentation: 1h)

5.5 Geologic Mapping

a. Know how to find position using a topographic map
b. Know how to make a geologic map showing faults, structural data, and contacts between formations
c. Know how to interpret geologic history and processes from a geologic map

(Science Content Standards for California Public Schools, Grade 6: 7f; Grades 9-12: Earth Sciences, 9d;Investigation and Experimentation; 1h)

Physics Subject Matter Requirements

Part I: Content Domains for Subject Matter Understanding and Skill in Physics

Domain 1. Motion and Forces

Candidates demonstrate an understanding of the foundations of motion and forces as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of motion and forces and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate an understanding of motion and the relationship of force to motion. Candidates use analytical, numerical, and graphical methods in problem-solving.

1.1 Motion and Forces

a. Solve problems using Newton's Second Law (e.g., problems involving time, velocity, and space-dependent forces)
b. Construct appropriate free-body diagrams of many-body problems (e.g., two or more coupled masses)
c. Solve periodic motion problems
d. Solve 2-dimensional problems involving vector analysis of motion and forces, including projectile motion, uniform circular motion, and statics
e. Generate and understand functional relationships of graphs showing distance, velocity, and acceleration versus time
f. Recognize relationships among variables for linear motion and rotational motion
g. Solve problems involving linear and rotational motion in term of forces and torques

(Science Content Standards for California Public Schools, Grades 9-12, Physics: 1a-m)

Domain 2. Conservation of Energy and Momentum

Candidates demonstrate an understanding of the conservation of energy and momentum contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of conservation of energy and momentum and of their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate an understanding of the principles of conservation of energy and momentum. They apply this understanding to predict and describe the movement of objects.

2.1 Conservation of Energy and Momentum

a. Use conservation of energy to characterize kinetic-potential energy systems such as oscillating systems (pendula and springs), projectile motion, and roller coasters
b. Analyze elastic and inelastic collisions and solve for unknown values
c. Solve problems involving linear and rotational motion in terms of conservation of momentum and energy

d. Recognize relationships between energy/momentum conservation principles and Newton's Laws
e. Examine the impact of friction on conservation principles
f. Interpret force-versus-time and force-versus-distance graphs to find, for example, work done or impulse on a system

(Science Content Standards for California Public Schools, Grades 9-12, Physics: 2a-h)

Domain 3. Heat and Thermodynamics

Candidates demonstrate an understanding of the foundations of heat and thermodynamics as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of heat and thermodynamics and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates demonstrate understanding of the laws of thermodynamics and the thermodynamic properties of materials.

3.1 Heat and Thermodynamics

a. Solve problems involving the laws of thermodynamics using the relationships among work, heat flow, energy, and entropy
b. Define and correctly apply thermodynamic properties of materials such as specific heat (heat capacity), heats of fusion, heat of vaporization, thermal conductivity, and thermal expansion to solve problems
c. Solve problems for ideal gas systems
d. Solve problems involving cyclic processes, including calculations of work done, heat gain/loss, , and entropy change
e. Interpret graphs showing phase changes and graphs of cyclic processes
f. Describe a plasma, state its characteristic properties, and contrast it with an ideal gas

(Science Content Standards for California Public Schools, Grades 9-12, Physics: 3a-g)

Domain 4. Waves

Candidates demonstrate an understanding of the foundations of waves as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of waves and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates can describe waves and their characteristic properties and understand that these properties do not depend on the type of wave. They use their knowledge of waves and wave properties to predict wave behavior under various conditions. Candidates are familiar with the electromagnetic spectrum.

4.1 Waves and Their Characteristic Properties

a. Relate wave propagation to properties of materials (e.g., predict wave speed from density and tension)
b. Describe, distinguish, and solve both conceptual and numerical problems involving interference, diffraction, refraction, reflection, Doppler effect, polarization, dispersion, and scattering

(Science Content Standards for California Public Schools, Grades 9-12, Physics: 4a-f)

Domain 5. Electromagnetism

Candidates demonstrate an understanding of the foundations of electromagnetism contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of electromagnetism and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand the relationship between electric and magnetic phenomena and can apply their knowledge to real-life examples. They can solve calculus-based problems using the quantitative and vector relationships among charges, currents, forces, and fields.

5.1 Electric and Magnetic Phenomena

a. Analyze electric and magnetic forces, charges, and fields using Coulomb's law, the Lorentz force, and the right-hand rule
b. Apply energy principles to analyze problems in electricity, magnetism, and circuit theory involving capacitors, resistors, and inductors
c. Calculate power, voltage changes, current, and resistance in multiloop circuits involving capacitors, resistors, and inductors
d. Interpret and design mixed series and parallel circuits involving capacitors, resistors, and inductors
e. Solve problems involving the relationships between electric and magnetic phenomena
f. Explain properties of transistors, diodes, and semiconductors

(Science Content Standards for California Public Schools, Grades 9-12, Physics: 5a-o)

Domain 6. Quantum Mechanics and the Standard Model of Particles

Candidates demonstrate an understanding of the foundations of quantum mechanics and the standard model of particles contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of quantum mechanics and the standard model of particles and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates are familiar with the standard model of particles and the four fundamental forces of nature. They recognize the assumptions and principles of early quantum mechanics.

6.1 Quantum Mechanics and the Standard Model

a. Distinguish the four fundamental forces of nature, describe their ranges, and identify their force carriers
b. Evaluate the assumptions and relevance of the Bohr model of the atom

(Science Content Standards for California Public Schools, Grades 9-12, Chemistry: 1i)

Part II: Subject Matter Skills and Abilities Applicable to the Content Domains in Science

Domain 1. Investigation and Experimentation

Candidates for Single Subject Teaching Credentials in Science formulate and conduct scientific investigations. They select appropriate scientific tools, make relevant measurements of changes in natural phenomena, and present unbiased findings in logical and meaningful formats using charts, maps, tables, models, graphs, and labeled diagrams. Candidates apply mathematics to scientific investigations and experimentation(s) for the purpose of quantifying results and drawing conclusions. Candidates interpret experimental results and determine whether further information is necessary to formulate accurate conclusions. They communicate results through various methods, and use technology where appropriate.

1.1 Question Formulation

a. Formulate and evaluate a viable hypothesis
b. Recognize the value and role of observation prior to question formulation
c. Recognize the iterative nature of questioning
d. Given an experimental design, identify possible hypotheses that it may test

(Science Content Standards for California Public Schools, Grade 6: 7a)

1.2 Planning a Scientific Investigation (including Experimental Design)

a. Given a hypothesis, formulate an investigation or experimental design to test that hypothesis
b. Evaluate an experimental design for its suitability to test a given hypothesis
c. Distinguish between variable and controlled parameters

(Science Content Standards for California Public Schools, Grade 5: 6c-d; Grade 8: 9a, 9c)

1.3 Observation and Data Collection

a. Identify changes in natural phenomena over time without manipulating the phenomena (e.g., a tree limb, a grove of trees, a stream, a hill slope)
b. Analyze the locations, sequences, and time intervals that are characteristic of natural phenomena (e.g., locations of planets over time, succession of species in an ecosystem)
c. Select and use appropriate tools and technology (e.g., computer-linked probes, spreadsheets, graphing calculators) to perform tests, collect data, analyze relationships, and display data
d. Evaluate the precision, accuracy, and reproducibility of data
e. Identify and analyze possible reasons for inconsistent results, such as sources of error or uncontrolled conditions
f. Identify and communicate sources of unavoidable experimental error
g. Recognize the issues of statistical variability and explain the need for controlled tests
h. Know and evaluate the safety issues when designing an experiment and implement appropriate solutions to safety problems

i. Appropriately employ a variety of print and electronic resources (e.g., the World Wide Web) to collect information and evidence as part of a research project
j. Assess the accuracy validity and reliability of information gathered from a variety of sources

(Science Content Standards for California Public Schools, Grade 3: 5a; Grade 6: 7a-b, 7g-h; Grade 7: 7a-b; Grade 8: 9b; Grades 9-12, Investigation and Experimentation: 1a-c, 1i-j, 1m)

1.4 Data Analysis/Graphing

a. Construct appropriate graphs from data and develop qualitative and quantitative statements about relationships between variables
b. Recognize the slope of the linear graph as the constant in the relationship y=kx and apply this principle in interpreting graphs constructed from data
c. Apply simple mathematical relationships to determine a missing quantity in an algebraic expression, given the two remaining terms (e.g., speed = distance/time, density = mass/volume, force = pressure x area, volume = area x height)
d. Determine whether a relationship on a given graph is linear or non-linear and determine the appropriateness of extrapolating the data
e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions

(Science Content Standards for California Public Schools, Grade 6: 7c; Grade 8: 9d-g; Grades 9-12, Investigation and Experimentation: 1e)

1.5 Drawing Conclusions and Communicating Explanations

a. Draw appropriate and logical conclusions from data
b. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence
c. Communicate the steps and results of an investigation in written reports and oral presentations
d. Recognize whether evidence is consistent with a proposed explanation
e. Construct appropriate visual representations of scientific phenomenon and processes (e.g., motion of Earth's plates, cell structure)
f. Read topographic and geologic maps for evidence provided on the maps and construct and interpret a simple scale map

(Science Content Standards for California Public Schools, Grade 5: 6g; Grade 6: 7e-f; Grade 7: 7c-e; Grade 8: 9a; Grades 9-12, Investigation and Experimentation: 1d, 1h)

Domain 2. Nature of Science

Candidates recognize that science is an active endeavor in which acquisition of knowledge is based upon the collection and examination of data. Candidates understand that scientists have a responsibility to report fully and openly the methods and results of their observations and experiments, even if those results disagree with their favored hypotheses or are controversial in public opinion. They understand that to hide data, arbitrarily eliminate data, or conceal how an experiment was conducted is to invite errors, make those errors difficult to discover, and risk harm

to colleagues and communities. They understand that scientists carefully consider questions and challenges raised by fellow scientists about the assumptions, procedures, and accuracy of their experiments. They understand that a fundamental aspect of scientific inquiry is that it is dynamic and self-correcting by design. Conclusions, hypotheses, and theories are tested in every experiment and revised or rejected when they no longer correctly or accurately predict experimental results. Candidates understand that scientists must consider the safety, ethical concerns, risks, and costs and benefits of experiments to society.

2.1 Scientific Inquiry

a. Distinguish among the terms hypothesis, theory, and prediction as used in scientific investigations
b. Evaluate the usefulness, limitations, and interdisciplinary and cumulative nature of scientific evidence as it relates to the development of models and theories as representations of reality
c. Recognize that when observations do not agree with an accepted scientific theory, either the observations are mistaken or fraudulent, or the accepted theory is erroneous or incorrect
d. Understand that reproducibility of data is critical to the scientific endeavor
e. Recognize that science is a self-correcting process that eventually identifies misconceptions and experimental biases
h. Recognize that an inquiring mind is at the heart of the scientific method and that doing science involves thinking critically about the evidence presented, the usefulness of models, and the limitations of theories
i. Recognize that theories are judged by how well they explain observations and predict results and that when they represent new ideas that are counter to mainstream ideas they often encounter vigorous criticism
j. Recognize that when observations, data, or experimental results do not agree, the unexpected results are not necessarily mistakes; to discard the unusual in order to reach the expected is to guarantee that nothing but what is expected will ever be seen
k. Know why curiosity, honesty, openness, and skepticism are so highly regarded in science and how they are incorporated into the way science is carried out

(Science Content Standards for California Public Schools, Grade 6: 7e; Grades 9-12, Investigation and Experimentation: 1f-g, 1n)

2.2 Scientific Ethics

a. Understand that honesty is at the core of scientific ethics; first and foremost is the honest and accurate reporting of procedures used and data collected
b. Know that all scientists are obligated to evaluate the safety of an investigation and ensure the safety of those performing the experiment
c. Know the procedures for respectful treatment of all living organisms in experimentation and other investigations

2.3 Historical Perspectives

a. Discuss the cumulative nature of scientific evidence as it relates to the development of models and theories
b. Recognize that as knowledge in science evolves, when observations do not support an accepted scientific theory, the observations are reconsidered to determine if they are mistaken or fraudulent, or if the accepted theory is erroneous or incomplete (e.g., an erroneous theory is the Piltdown Man fossil; an incomplete theory is Newton's laws of gravity)
c. Recognize and provide specific examples that scientific advances sometimes result in profound paradigm shifts in scientific theories
d. Discuss the need for clear and understandable communication of scientific endeavors so that they may be reproduced and why reproduction of these endeavors is important

(Science Content Standards for California Public Schools, Grade 6: 7d; Grade 7: 7c, 7e; Grades 9-12, Investigation and Experimentation: 1k, 1n)

Domain 3. Science and Society

Candidates understand that science relies on basic human qualities such as reasoning, insight, curiosity, skill, and creativity – as well as on scientific habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. Candidates recognize their responsibility to increase scientific literacy so that the general population can understand current issues and appreciate their personal roles and responsibilities. Candidates know about possible hazards and take precautions that are the basis for creating a safe learning environment that benefits all students. They are familiar with established rules and guidelines that intend to ensure the safety of students and to protect the subjects and environments studied. Candidates understand that technology is the application of proven scientific knowledge for practical purposes serving human needs; however, science and technology are interrelated—one often propels the other.

3.1 Science Literacy

a. Recognize that science attempts to make sense of how the natural and the designed world function
b. Demonstrate the ability to apply critical and independent thinking to weigh alternative explanations of events
c. Apply evidence, numbers, patterns, and logical arguments to solve problems
d. Understand that, although much has been learned about the objects, events and phenomena in nature, there are many unanswered questions, i.e., science is a work in progress
e. Know that the ability of science and technology to resolve societal problems depends on the scientific literacy of a society

3.2 Diversity

a. Identify examples of women and men of various social and ethnic backgrounds with diverse interests, talents, qualities and motivations who are, or who have been, engaged in activities of science and related fields

3.3 Science, Technology, and Society

a. Identify and evaluate the impact of scientific advances on society
b. Recognize that scientific advances may challenge individuals to reevaluate their personal beliefs

(Science Content Standards for California Public Schools, Grades 9-12, Investigation and Experimentation: 1m, 1n)

3.4 Safety

a. Choose appropriate safety equipment for a given activity (e.g., goggles, apron, vented hood)
b. Discuss the safe use, storage, and disposal of commonly used chemicals and biological specimens
c. Assess the safety conditions needed to maintain a science laboratory (e.g., eye wash, shower, fire extinguisher)
d. Read and decode MSDS/OSHA (Material Safety Data Sheet/Occupational Safety and Health Administration) labels on laboratory supplies and equipment
e. Discuss key issues in the disposal of hazardous materials in either the laboratory or the local community
f. Be familiar with standard safety procedures such as those outlined in the Science Safety Handbook for California Schools (1999)

Part 3: Implementation of Program Quality Standards for the Subject Matter Preparation of Science Teachers

The 2003 Program Quality Standards for Subject Matter Preparation in Science are part of a broad shift in the policies of the Commission on Teacher Credentialing related to the preparation of professional teachers and other educators in California colleges and universities resulting from the mandate of Senate Bill 2042. The Commission initiated this policy change to insure high quality in educator preparation and to combine flexibility with accountability for institutions that offer programs for prospective teachers. The success of this reform effort depends on the effective *implementation* of program quality standards for each credential.

Program Equivalency

The Ryan Act established two alternative ways for prospective teachers to meet the subject matter requirement. An individual who completes an approved subject matter program is not required to pass the subject matter examination, and an individual who achieves a passing score on an adopted exam is not required to complete a subject matter program. Subject matter programs are completed by more than half of the candidates for Single Subject Credentials.

Senate Bill 2042 required that subject matter programs and examinations be aligned with the K-12 Student Content Standards and made equivalent to each other. This has been achieved in the new standards, and references are included. A candidate who completes an approved subject matter program is issued an "equivalency" to the subject matter examination.

Review and Improvement of Subject Matter Standards

The Commission will adhere to its cycle of review and reconsideration of the *Standards of Quality and Effectiveness for Subject Matter Programs in Science* and in other subjects. The standards will be reviewed and reconsidered in relation to changes in academic disciplines, school curricula, and the backgrounds and needs of California students (K-12). Reviews of program standards will be based on the advice of subject matter teachers, professors and curriculum specialists. Prior to each review, the Commission will invite interested individuals and organizations to participate in the review process.

Adoption and Implementation of Standards by the Commission

Program sponsors have approximately two years to transition from current to new standards of quality and effectiveness for Single Subject Matter Programs. Each sponsor is being asked to select from among seven submission deadlines during the period October 2003 through March 2005. The form for requesting a submission date is included in this section. In the absence of a timely request for a submission date, the review may take longer. All program documents will be reviewed by statewide teams of peer reviewers selected from among qualified K–12 and IHE professional educators. It should be noted that each program of Single Subject Matter Preparation for the Single

Subject Credentials must be submitted for review by the statewide panel. No new programs written to the old standards will be reviewed after the adoption of the new standards in January 2003.

Information about transition timelines for candidates, sunset dates for currently approved programs, and preconditions will be provided by the Commission through Coded Correspondence and additional program transition documents as it becomes available. Program sponsors should check the Commission website (www.ctc.ca.gov) frequently for updates.

Technical Assistance Meetings for Colleges and Universities

During April and May 2003, the Commission sponsored eight meetings to provide assistance to institutions related to their subject matter programs in Science. The agenda for each workshop included:

- Explanation of the implementation plan adopted by the Commission.
- Description of the steps in program review and approval.
- Review of program standards, preconditions and examples presented by Subject Matter Advisory Panel members and others with experience in implementing Standards of Program Quality.
- Opportunities to discuss subject-specific questions in small groups.

Information disseminated at those meetings is available upon request to those who were unable to attend.

Implementation Timeline: Impact on Candidates for Science Credentials

Based on the Commission's implementation plan, candidates for Single Subject Credentials in Science who do not plan to pass the subject matter examinations adopted by the Commission should enroll in subject matter programs that fulfill the "new" standards either (1) once a new program commences at their institution, or (2) before July 1, 2005, whichever occurs first. After a new program begins at an institution, no students should enroll for the first time in an "old" program (i.e. one approved under "old" standards). Regardless of the date when new programs are implemented, no students should enter old programs after July 1, 2005.

Candidates who enrolled in programs approved on the basis of 1994 standards ("old" programs) may complete those programs provided that (1) they entered the old programs either before new programs were available at their institutions, or before July 1, 2005, and (2) they complete the old programs before July 1, 2009. Candidates who do not comply with these timelines may qualify for Single Subject Teaching Credentials by passing the subject matter examinations that have been adopted for that purpose by the Commission.

Implementation Plan Adopted by the Commission

July 1, 2003

(1) By July 1, 2005, existing ("old") programs based on current guidelines should be superseded by new programs with full approval.

(a) Once a new program receives full approval, all students not previously enrolled in the old program (i.e., all "new" students) should enroll in the new program.

(b) After July 1, 2005, no "new" students should enroll in an "old" program, even if a new program in the subject is not available at that institution.

(c) Students who enrolled in an old program prior to July 1, 2005, may continue to complete the old program until July 1, 2009.

Timeline for Implementing the Science Standards

January 2003 The Commission on Teacher Credentialing adopts the Standards of Program Quality and Effectiveness that are in this handbook. The Commission adopts the implementation plan outlined in this handbook. No new subject matter programs in science will be reviewed in relation to the Commission's "old" standards.

April to May 2003 The Commission conducts statewide technical assistance meetings for developing new subject matter programs to meet the new standards.

July/October 2003 The Commission disseminates the handbook. The Commission selects, orients and trains a Program Review Panel in Science. Qualified subject matter experts are prepared to review programs in relation to the standards beginning in 2003-04.

October 2003 Review and approval of programs under the new standards begins.

2003-05 Institutions may submit programs for review on or after October 1, 2003, after requesting and being assigned a submission date by Commission staff. Once a "new" program is approved, all students who were not previously enrolled in the "old" program (i.e., all new students) should enroll in the new program. Students may complete an old program if they enrolled in it either (1) prior to the commencement of the new program at their campus, or (2) prior to July 1, 2005, whichever occurs first.

July 1, 2005 "Old" programs that are based on 1994 standards must be superseded by new programs with full approval (see pages 42-43). After July 1, 2005, no new students may enroll in an old program, even if a new program in science is not yet available at the institution.

2005-09 The Commission will continue to review program proposals based on the standards and preconditions in this handbook. Institutions which submit program proposals without an assigned submission date will be reviewed at the earliest date of an opening in the submission schedule.

July 1, 2009 The final date for candidates to complete subject matter preparation programs approved under the 1994 standards. To qualify for a credential based on an "old" program, students must have entered that program prior to either (1) the implementation of a new program with full or interim approval at their institution, or (2) July 1 2005, whichever occurs first.

Implementation Timeline Diagram

January 2003

Adopt the science standards and preconditions in this handbook, including the implementation plan.

January to May, 2003

Disseminate the standards, timeline and implementation plan throughout the state. Hold regional technical assistance meetings to offer information, answer questions, and assist colleges and universities in developing new programs.

October 2003

Colleges and universities may begin to present program documents for review by the Commission's staff and Program Review Panels.

July 1, 2005

"Old" subject matter programs in science must be superseded by new approved programs.

July 1, 2009

Final date for candidates to qualify for Single Subject Credentials in Science on the basis of "old" programs of subject matter preparation.

Review and Approval of Science Subject Matter Programs

A regionally accredited institution of post-secondary education that would like to offer (or continue to offer) a Program of Subject Matter Preparation for the Single Subject Credential in Science may present a program proposal that responds to the standards and preconditions in this handbook. The submission of programs for review and approval is voluntary for colleges and universities.

If an institution would like to offer two or more distinct programs of subject matter preparation in science, a separate proposal may be forwarded to the Commission for each program. For example, one program in science might emphasize studies of biology, while a second program at the same institution could have an emphasis in chemistry or physics. However, the Commission encourages institutions to coordinate its single subject programs that are within the same subject matter discipline.

The Commission is prepared to review subject matter program proposals beginning on October 1, 2003. Prior to that date, the Commission's professional staff is able to consult with institutional representatives on meeting the new standards and preparing program documents.

Selection, Composition and Training of Program Review Panels

Review panel members are selected because of their expertise in science, and their knowledge of science curriculum and instruction in the public schools of California. Reviewers are selected from institutions of higher education, school districts, county offices of education, organizations of subject matter experts, and statewide professional organizations. Members are selected according to the Commission's adopted policies that govern the selection of panels. Members of the Commission's former Single Subject Waiver Panels and Subject Matter Advisory Panels may be selected to serve on Program Review Panels.

The Commission staff conducts a training and calibration session that all reviewers must attend. Training includes:

- The purpose and function of subject matter preparation programs.
- The Commission's legal responsibilities in program review and approval.
- The role of the review panel in making program determinations.
- The role of the Commission's professional staff in assisting the panel.
- A thorough analysis and discussion of each standard and rationale.
- Alternative ways in which the standard could be met.
- An overview of review panel procedures.
- Simulated practice and calibration in reviewing programs.
- Responsive feedback for program revision.

Steps in the Review of Programs

The Commission is committed to conducting a program review process that is objective, authoritative and comprehensive. The agency also seeks to be as helpful as possible to colleges and universities throughout the review process. Commission staff is available to consult with during program document development.

Review of Preconditions. An institution's response to the preconditions is reviewed by the Commission's professional staff because the preconditions are based on Commission policies and do not involve issues of program quality. Preconditions are reviewed upon the institution's formal submission of a document. Once the status of the preconditions is established, the program document is referred to the expert review panel.

Review of Program Quality Standards. Unlike the preconditions, the standards address issues of program quality and effectiveness, so each institution's response to the standards is reviewed by a small Program Review Panel of subject matter experts. If the Program Review Panel determines that a proposed program fulfills the standards, the Commission's staff recommends the program for approval by the Commission during a public meeting no more than eight weeks after the panel's decision.

If the Program Review Panel determines that the program does not meet the standards, the document is returned to the institution with an explanation of the panel's findings. Specific reasons for the panel's decision are communicated to the institution. If the panel has substantive concerns about one or more aspects of program quality, representatives of the institution can obtain information and assistance from the Commission's staff.

The Commission would like the program review process to be as helpful as possible to colleges and universities. Because a large number of institutions prepare teachers in California, representatives of an institution should first consult with the Commission's professional staff regarding programs that are in preparation or under review. The staff responds to all inquiries expeditiously and knowledgeably. Representatives of colleges and universities should contact members of a Program Review Panel only when they are authorized to do so by the Commission's staff. This restriction must be observed to ensure that membership on a panel is manageable for the reviewers. If an institution finds that needed information is not sufficiently available, please inform the designated staff consultant. If the problem is not corrected in a timely way, please contact the executive director of the Commission. After changes have been made in the program, the proposal may be re-submitted to the Commission's staff for reconsideration by the panel.

If the Program Review Panel determines that minor or technical changes should be made in a program, the responsibility for reviewing the resubmitted document rests with the Commission's professional staff, which presents the *revised* program to the Commission for approval without further review by the panel.

Appeal of an Adverse Decision. An institution that would like to appeal a decision of the staff (regarding preconditions) or the Program Review Panel (regarding standards) may do so by submitting the appeal to the Executive Director of the Commission. The institution should include the following information in the appeal:

- The original program document, and the stated reasons of the Commission's staff or the review panel for not recommending approval of the program.
- A specific response by the institution to the initial denial, including a copy of the resubmitted document (if it has been resubmitted).

- A rationale for the appeal by the institution.

The executive director may deny the appeal, or appoint an independent review panel, or present the appeal directly to the Commission for consideration.

Submission Guidelines for Single Subject Matter Program Documents

To facilitate the proposal review and approval process, Commission staff has developed the following instructions for organizations submitting documents for approval of Single Subject Matter Programs. It is essential that these instructions be followed accurately. Failure to comply with these procedures can result in a proposal being returned to the prospective program sponsor for reformatting and/or revision prior to being forwarded to program reviewers.

Transmittal Instructions

Sponsoring agencies are required to submit **one printed bound paper copy** of their proposal(s), to the following address:

California Commission on Teacher Credentialing
Professional Services Division: Single Subject Matter Programs
1900 Capitol Avenue
Sacramento, CA 95814

In addition, **one electronic copy of the proposal text** (including supporting evidence where possible) should be submitted in Microsoft Word, or a Microsoft Word compatible format. Some phases of the review process will involve secure web-based editing. To facilitate this process, please leave no spaces in the name of your document, and be sure that the name of the file ends in ".doc" (example: CTCdocument.doc).

Submittal Deadlines

There are seven opportunities during which to submit proposals for review and approval. The submittal deadlines are:

October 1, 2003	**August 2, 2004**
January 5, 2004	**November 2, 2004**
March 2, 2004	**March 1, 2005***
June 1, 2004	

*Any programs submitted after 2005 will be reviewed according to the availability of the review panel.

Organization of Required Documents

Sponsoring agencies should include as the cover page of each copy of the program application the "Sponsoring Organization Transmittal Cover Sheet." A copy of the Transmittal Cover Sheet is located at the end of this section of the handbook for use by program sponsors. The proposal application documents should begin with Transmittal Cover Sheet that includes the original signatures of the program contacts and chief executive officer

The program contact identified on the Transmittal Cover Sheet will be the individual who is informed electronically and by mail as changes occur, and to whom the review feedback will be sent. Program sponsors are strongly urged to consult the CTC web site, www.ctc.ca.gov, for updates relating to the implementation of new single subject matter standards and programs.

Each proposal must be organized in the following order:

- Transmittal Cover Sheet
- Table of Contents
- Responses to Preconditions, including course lists, units and catalog descriptions
- A matrix identifying which courses meet which subject matter requirements
- One to two pages of narrative responses to each Standard

Responses to the standards must:

- include numbered pages,
- include to address the pre-conditions, and
  - provide supporting evidence for each standard response organized into appendices. Evidence should be cross-referenced or electronically linked and cited in the response, and appendices *must* be tabbed and labelled for easy access by reviewers.

Responding to Standards Common to All

The Commission adopted two standards that relate to program design and structure for programs in *all* single subject disciplines:

Standard 1 Program Philosophy and Purpose
Standard 2 Diversity and Equity

These two standards are referred to as "standards common to all" because they are the same in all subject areas. Both of these standards require subject-specific program information.

Responding to Program Standards

Program proposals should provide sufficient information about how the program intends to deliver content consistent with each standard so that a knowledgeable team of professionals can determine whether each standard has been met by the program. The goal in writing the response to any standard should be to describe the proposed program clearly enough for an outside reader to understand what a prospective teacher will experience, as he or she progresses through the program in terms of depth, breadth, and sequencing of instructional and field experiences, and what he or she will know and be able to do and demonstrate at the end of the program. Review teams will then be able to assess the responses for consistency with the standard, completeness of the response, and quality of the supporting evidence.

The written text should be organized in the same order as the standards. Responses should not merely reiterate the standard. They should describe how the standard will be met in the coursework content, requirements, and processes and by providing evidence from course syllabi or other course materials to support the explanation. ***Responses that do not completely address each standard will be returned for revision***.

Lines of suitable evidence will vary with each standard. Some examples of evidence helpful for review teams include:

- Charts and graphic organizers to illustrate program organization and design
- Course or module outlines, or showing the sequence of course topics, classroom activities, materials and texts used, and out-of-class assignments
- Specific descriptions of assignments and other formative assessments that demonstrate how prospective teachers will reinforce and extend key concepts and/or demonstrate an ability or competence
- Documentation of materials to be used, including tables of contents of textbooks and identification of assignments from the texts, and citations for other reading assignments.
- Current catalog descriptions.

Packaging A Submission for Shipment to the Commission

Please do **not**:

- Use foam peanuts as packaging material.
- Overstuff the binders. Use two binders if necessary.
- Overstuff the boxes in which the binders are packed, as these may break open in shipment.

Submission Request Form
For Single Subject Matter Preparation Program Response to Standards

_____

Program Sponsor (Name of Institution and Department)

Please fill out the requested information below to help us plan for providing technical assistance in a timely manner.

Contact Person: _____Title:_____

Department: _____

Address: _____

Phone: _____ Fax: _____

Email: _____

Please indicate the subject area for which you are submitting a program proposal document:
English_____ Mathematics_____ Science_____ Social Science_____

Please indicate when you intend to submit program documents responding to the new Single Subject Matter Preparation Standards: _____

Submit to: Commission on Teacher Credentialing
Professional Services Division:
Single Subject Matter Programs
1900 Capitol Ave.
Sacramento, CA 95814
Fax (916) 324-8927

Single Subject Matter Program Sponsor - Transmittal Cover Sheet

(Page 1 of 2*)*

- **Date**_____
- **Sponsoring Organization:**

  Name_____

- **Submission Type(s) Place a check mark in the appropriate box.**

English Subject Matter Preparation	
Mathematics Subject Matter Preparation	
Science Subject Matter Preparation	
Social Science Subject Matter Preparation	

- **Program Contacts:**

  1. Name _____

  Title_____

  Address_____

  _____

  Phone _____Fax _____

  E-mail _____

Single Subject Program Sponsor - Transmittal Cover Sheet
(Page 2 of 2)

Name _____

Title_____

Address_____

_____

Phone _____Fax _____

E-mail_____

Chief Executive Officer *(President or Provost; Superintendent):*

Name_____

Address_____

_____

Phone _____Fax _____

E-mail_____

I Hereby Signify My Approval to Transmit This Program Document to the California Commission on Teacher Credentialing:

CEO Signature _____

Title _____

Date_____

Appendix A
Assembly Bill No. 537
(Education Code Chapter 587, Statutes of 1999)

CHAPTER 587

An act to amend Sections 200, 220, 66251, and 66270 of, to add Section 241 to, and to amend and renumber Sections 221 and 66271 of, the Education Code, relating to discrimination.

[Approved by Governor October 2, 1999. Filed
with Secretary of State October 10, 1999.]

LEGISLATIVE COUNSEL'S DIGEST

AB 537, Kuehl. Discrimination.

(1) Existing law provides that it is the policy of the State of California to afford all persons in public schools and postsecondary institutions, regardless of their sex, ethnic group identification, race, national origin, religion, or mental or physical disability, equal rights and opportunities in the educational institutions of the state.

Existing law makes it a crime for a person, whether or not acting under color of law, to willfully injure, intimidate, interfere with, oppress, or threaten any other person, by force or threat of force, in the free exercise or enjoyment of any right or privilege secured to him or her by the Constitution or laws of this state or by the Constitution or laws of the United States because of the other person's race, color, religion, ancestry, national origin, disability, gender, or sexual orientation, or because he or she perceives that the other
person has one or more of those characteristics.

This bill would also provide that it is the policy of the state to afford all persons in public school and postsecondary institutions equal rights and opportunities in the educational institutions of the state, regardless of any basis referred to in the aforementioned paragraph.

(2) Existing law prohibits a person from being subjected to discrimination on the basis of sex, ethnic group identification, race, national origin, religion, color, or mental or physical disability in any program or activity conducted by any educational institution or
postsecondary educational institution that receives, or benefits from, state financial assistance or enrolls students who receive state student financial aid.

This bill would also prohibit a person from being subjected to discrimination on the basis of any basis referred to in paragraph (1) in any program or activity conducted by any educational institution or postsecondary educational institution that receives, or benefits from, state financial assistance or enrolls students who receive state student financial aid.

(3) This bill would state that it does not require the inclusion of any curriculum, textbook, presentation, or other material in any program or activity conducted by an educational institution or a postsecondary educational institution and would prohibit this bill from being deemed to be violated by the omission of any curriculum, textbook, presentation, or other material in any program or activity conducted by an educational institution or a postsecondary educational institution.

To the extent that this bill would impose new duties on school districts and community college districts, it would impose a state-mandated local program.

(4) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement, including the creation of a State Mandates Claims Fund to pay the costs of mandates that do not exceed $1,000,000 statewide and other procedures for claims whose statewide costs exceed $1,000,000.

This bill would provide that, if the Commission on State Mandates determines that the bill contains costs mandated by the state, reimbursement for those costs shall be made pursuant to these statutory provisions.

The people of the State of California do enact as follows:

SECTION 1. This bill shall be known, and may be cited, as the California Student Safety and Violence Prevention Act of 2000.

SEC. 2. (a) The Legislature finds and declares all of the following:

(1) Under the California Constitution, all students of public schools have the inalienable right to attend campuses that are safe, secure, and peaceful. Violence is the number one cause of death for young people in California and has become a public health problem of epidemic proportion. One of the Legislature's highest priorities must be to prevent our children from the plague of violence.

(2) The fastest growing, violent crime in California is hate crime, and it is incumbent upon us to ensure that all students attending public school in California are protected from potentially violent discrimination. Educators see how violence affects youth every day; they know first hand that youth cannot learn if they are concerned about their safety. This legislation is designed to protect the institution of learning as well as our students.

(3) Not only do we need to address the issue of school violence but also we must strive to reverse the increase in teen suicide. The number of teens who attempt suicide, as well as the number who actually kill themselves, has risen substantially in recent years. Teen suicides in the United States have doubled in number since 1960 and every year over a quarter of a million adolescents in the United States attempt suicide. Sadly, approximately 4,000 of these attempts every year are completed. Suicide is the third leading cause of death for youths 15 through 24 years of age. To combat this problem we must seriously examine these grim statistics and take immediate action to ensure all students are offered equal protection from discrimination under California law.

SEC. 3. Section 200 of the Education Code is amended to read:

200. It is the policy of the State of California to afford all persons in public schools, regardless of their sex, ethnic group identification, race, national origin, religion, mental or physical disability, or regardless of any basis that is contained in the prohibition of hate crimes set forth in subdivision (a) of Section 422.6 of the Penal Code, equal rights and opportunities in the educational institutions of the state. The purpose of this chapter is to prohibit acts which are contrary to that policy and to provide remedies therefor.

SEC. 4. Section 220 of the Education Code is amended to read:

220. No person shall be subjected to discrimination on the basis of sex, ethnic group identification, race, national origin, religion, color, mental or physical disability, or any basis that is contained in the prohibition of hate crimes set forth in subdivision (a) of Section 422.6 of the Penal Code in any program or activity conducted by an educational institution that receives, or benefits from, state financial assistance or enrolls pupils who receive state student financial aid.

SEC. 5. Section 221 of the Education Code is renumbered to read:

220.5. This article shall not apply to an educational institution which is controlled by a religious organization if the application would not be consistent with the religious tenets of that organization.

SEC. 6. Section 241 is added to the Education Code, to read:

241. Nothing in the California Student Safety and Violence Prevention Act of 2000 requires the inclusion of any curriculum, textbook, presentation, or other material in any program or activity conducted by an educational institution or postsecondary educational institution; the California Student Safety and Violence Prevention Act of 2000 shall not be deemed to be violated by the omission of any curriculum, textbook, presentation, or other material in any program or activity conducted by an educational institution or postsecondary educational institution.

SEC. 7. Section 66251 of the Education Code is amended to read:

66251. It is the policy of the State of California to afford all persons, regardless of their sex, ethnic group identification, race, national origin, religion, mental or physical disability, or regardless of any basis that is contained in the prohibition of hate crimes set forth in subdivision (a) of Section 422.6 of the Penal Code, equal rights and opportunities in the postsecondary institutions of the state. The purpose of this chapter is to prohibit acts that are contrary to that policy and to provide remedies therefor.

SEC. 8. Section 66270 of the Education Code is amended to read:

66270. No person shall be subjected to discrimination on the basis of sex, ethnic group identification, race, national origin, religion, color, or mental or physical disability, or any basis that is contained in the prohibition of hate crimes set forth in subdivision (a) of Section 422.6 of the Penal Code in any program or activity conducted by any postsecondary educational institution that receives, or benefits from, state financial assistance or enrolls students who receive state student financial aid.

SEC. 9. Section 66271 of the Education Code is renumbered to read:

66270.5. This chapter shall not apply to an educational institution that is controlled by a religious organization if the application would not be consistent with the religious tenets of that organization.

SEC. 10. Notwithstanding Section 17610 of the Government Code, if the Commission on State Mandates determines that this act contains costs mandated by the state, reimbursement to local agencies and school districts for those costs shall be made pursuant to Part 7 (commencing with Section 17500) of Division 4 of Title 2 of the Government Code. If the statewide cost of the claim for reimbursement does not exceed one million dollars ($1,000,000), reimbursement shall be made from the State Mandates Claims Fund.