



# California Subject Examinations for Teachers®

## TEST GUIDE

### SCIENCE SUBTEST IV: EARTH AND PLANETARY SCIENCE (SPECIALIZED)

#### Subtest Description

This document contains the General Science subject matter requirements arranged according to the domains covered by Subtest IV: Earth and Planetary Science (Specialized) of CSET: Science. In parentheses after each named domain is the CCTC-assigned domain code from the General Science subject matter requirements.

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**California Subject Examinations for Teachers (CSET®)**

**Earth and Planetary Science (Specialized)  
Subtest IV: Astronomy; Dynamic Processes of the Earth;  
Earth Resources**

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

**ASTRONOMY (SMR Domain 1)**

Candidates demonstrate an understanding of the foundations of the astronomy contained in the Science Content Standards for California Public Schools (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.

**0001 Astronomy (SMR 1.1, General Science 118/0001)**

- 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)

**EARTH AND PLANETARY SCIENCE (SPECIALIZED)**  
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**DYNAMIC PROCESSES OF THE EARTH (GEODYNAMICS) (SMR Domain 2)**

Candidates demonstrate an understanding of the foundations of the geodynamics contained in the Science Content Standards for California Public Schools (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.

**0002 Tectonic Processes and Features (SMR 2.1, General Science 118/0002)**

- 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)

**0003 Rock Formation (SMR 2.2, General Science 118/0003)**

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

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

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**0004 Shaping Earth’s Surface: Surficial Processes and Features (SMR 2.3, General Science 118/0004)**

- 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)

**0005 Energy in the Earth System (SMR 2.4, General Science 118/0005)**

- 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)

**EARTH RESOURCES (SMR Domain 3)**

Candidates demonstrate an understanding of the Earth resources contained in the Science Content Standards for California Public Schools (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.

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**0006 Earth Resources (SMR 3.1, General Science 118/0006)**

- 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)

## 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

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- 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)

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**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)

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**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.

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**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)