



California
Subject
Examinations for
Teachers®

TEST GUIDE

MULTIPLE SUBJECTS SUBTEST II

Subtest Description

This document contains the Multiple Subjects subject matter requirements arranged according to the domains covered by Subtest II of CSET: Multiple Subjects. In parentheses after each named domain is the CCTC-assigned domain code from the Multiple Subjects subject matter requirements.

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California Subject Examinations for Teachers® (CSET®)

Multiple Subjects Subtest II: Science; Mathematics

CONTENT SPECIFICATIONS IN SCIENCE

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

0001 Physical Sciences (SMR Domain 1)

- 1.1 Structure and Properties of Matter.** Candidates for Multiple Subject Teaching Credentials understand the physical properties of solids, liquids, and gases, such as color, mass, density, hardness, and electrical and thermal conductivity. They know that matter can undergo physical changes (e.g., changes in state such as the evaporation and freezing of water) and chemical changes (i.e., atoms in reactants rearrange to form products with new physical and chemical properties) and understand conservation laws with respect to matter and energy. They know that matter consists of atoms and molecules in various arrangements, and can give the location and motions of the parts of an atom (protons, neutrons, and electrons). They can describe the constituents of molecules and compounds, naming common elements (e.g., hydrogen, oxygen, iron), and explain how elements are organized on the periodic table on the basis of the characteristics of atoms and their chemical properties. They can describe characteristics of solutions (such as acidic, basic, and neutral solutions) and they know examples with different pH levels, such as soft drinks, liquid detergents, and water. They know that mixtures may often be separated based on physical or chemical properties.
- 1.2 Principles of Motion and Energy.** Candidates for Multiple Subject Teaching Credentials describe an object's motion based on position, displacement, speed, velocity, and acceleration. They know that forces (pushes and pulls), such as gravity, magnetism, and friction, act on objects and may change their motion if these forces are not in balance. They know that "like" electrical charges or magnetic poles produce repulsive forces and "unlike" charges or poles produce attractive forces. They describe simple machines in which small forces are exerted over long distances to accomplish difficult tasks (e.g., using levers or pulleys to move or lift heavy objects). Candidates identify forms of energy, including solar, wind, chemical, electrical, magnetic, nuclear, sound, light, and electromagnetic. They know that total energy in a system is conserved but may be changed from one form to another, as in an electrical motor or generator, and that speed and energy are related. They understand the difference between heat (thermal energy) and temperature, and understand temperature measurement systems. Candidates know how heat may be transferred by conduction, convection, and radiation (e.g., involving a stove, Earth's mantle, or the sun).

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They describe sources of light, including the sun, lightbulbs, or excited atoms (e.g., neon in neon lights), and interactions of light with matter (e.g., vision, photosynthesis). Candidates can describe the properties of waves (e.g., wavelength, amplitude, frequency) and applications and technologies associated with these properties. They know and can apply the optical properties of waves, especially light and sound, including reflection (e.g., by a mirror) or refraction (e.g., bending light through a prism). They explain conservation of energy resources in terms of renewable and nonrenewable natural resources and their use in society.

0002 Life Sciences (SMR Domain 2)

- 2.1 Structure of Living Organisms and Their Function (Cell Biology).** Candidates for Multiple Subject Teaching Credentials describe levels of hierarchical organization and related functions in plants and animals, including organ systems (e.g., the digestive system), organs, tissues (e.g., ovules in plants, heart chambers in humans), cells, and subcellular organelles (e.g., nucleus, chloroplast, mitochondrion). They know structures and related functions of systems in plants and animals, such as the nervous, reproductive, respiratory, circulatory, and digestive systems. They understand the fundamental principles of chemistry underlying the functioning of biological systems (e.g., carbon's central role in living organisms, water and salt, DNA, the energetics of photosynthesis).
- 2.2 Living and Nonliving Components in Environments (Ecology).** Candidates for Multiple Subject Teaching Credentials know that all living things are made up of cells and can describe the characteristics of many living organisms (e.g., growth, reproduction, stimulus response). They understand the basic needs of all living organisms (e.g., food, water, space) and how organisms can alter their environments to meet those needs, and can distinguish between environmental adaptations and accommodations. They describe the relationship between the number and types of organisms an ecosystem can support and relationships among members of a species and across species. They illustrate the transfer of energy and the cycling of matter through an ecosystem from sunlight through individual organisms in food chains and food webs (including primary producers, consumers, and decomposers). They identify the resources available in an ecosystem, and describe the environmental factors that support the ecosystem, such as temperature, water, and soil composition, as well as how the ecosystem responds to changes in these factors. They identify ways in which human activities and natural processes impact the local and global climate and possible solutions to reduce adverse impacts.

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2.3 Life Cycle, Reproduction, and Evolution (Genetics and Evolution). Candidates for Multiple Subject Teaching Credentials diagram life cycles of familiar organisms (e.g., butterfly, frog, mouse). They explain the factors that affect the growth and development of plants, such as light, gravity, and stress. They distinguish between sexual and asexual reproduction, and understand the process of cell division (mitosis), the types of cells and their functions, and the replication of plants and animals. They distinguish between environmental and genetic sources of variation, and understand the principles of natural and artificial selection. They know how evidence from the fossil record, comparative anatomy, and DNA sequences can be used to support the theory that life gradually evolved on Earth over billions of years. They understand the basis of Darwin's theory, that species evolved by a process of natural selection.

0003 Earth and Space Sciences (SMR Domain 3)

3.1 The Solar System and the Universe (Astronomy). Candidates for Multiple Subject Teaching Credentials identify and describe the components of the solar system (e.g., planets, comets, asteroids) and their predictable patterns of motion around the sun. They explain time zones in terms of longitude and the rotation of Earth, and understand the reasons for changes in the observed position of the sun, moon, and stars in the sky during the course of the day and from season to season. They name and describe bodies in the universe (e.g., sun, stars, galaxies) in terms of apparent brightness and/or relative size.

3.2 The Structure and Composition of the Earth (Geology). Candidates for Multiple Subject Teaching Credentials describe the formation and observable physical characteristics of minerals (e.g., quartz, calcite, hornblende, mica, common ore minerals) and different types of rocks (i.e., sedimentary, igneous, and metamorphic). They identify characteristics of landforms, such as mountains, rivers, deserts, and oceans. They explain chemical and physical weathering, erosion, deposition, and other rock-forming and soil-changing processes and the formation and properties of different types of soils and rocks. They describe layers of the earth (crust, lithosphere, mantle, and core) and plate tectonics, including its convective source. They explain how mountains are created, identify the factors that cause volcanoes and earthquakes to occur, and describe the effect of these phenomena on the earth's surface, ecosystems, and human society. They know the commonly cited evidence supporting the theory of plate tectonics. They identify factors influencing the location and intensity of earthquakes. They describe the effects of plate tectonic motion over time on climate, geography, and distribution of organisms, as well as more general changes on the earth over geologic time as evidenced in landforms and the rock and fossil records, including plant and animal extinction. They identify potential technological solutions to reduce the impact of these natural Earth processes on humans and society and to reduce human impact on Earth's processes.

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- 3.3 The Earth's Atmosphere (Meteorology).** Candidates for Multiple Subject Teaching Credentials explain the influence and role of the sun and oceans in weather and climate and the role of the water cycle. They describe causes and effects of air movements and ocean currents (based on convection of air and water) on daily and seasonal weather and on climate. They describe the importance of technology with regard to predicting and mitigating the impact of severe weather and other natural hazards.
- 3.4 The Earth's Water (Oceanography).** Candidates for Multiple Subject Teaching Credentials compare the characteristics of bodies of water, such as rivers, lakes, oceans, and estuaries. They describe tides and explain the mechanisms causing and modifying them, such as the gravitational attraction of the moon, sun, and coastal topography. Candidates understand the water cycle, including the properties of water and how changes in the form of water are driven by energy from the sun and gravity. They know that Earth's hydrosphere interacts with Earth's other major systems to affect Earth's surface materials and processes.

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

Candidates for Multiple Subject Teaching Credentials know how to plan and conduct a scientific investigation to answer a question, and how to apply the engineering design process to solve problems, including:

- using print and electronic resources for preparation and research;
- applying the principles of experimental design, including formulation of testable questions and hypotheses, and evaluation of the accuracy and reproducibility of data;
- distinguishing between dependent and independent variables and controlled parameters, and between linear and nonlinear relationships on a graph of data;
- conducting scientific discussions in order to clarify, analyze, and interpret data and to explain phenomena;
- using academic language appropriately (e.g., observation, organization, experimentation, inference, prediction, evidence, opinion, hypothesis, theory, law);
- following precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks;
- analyzing experimental results according to explanations in a text;
- communicating and explaining accurately the steps and results of a scientific investigation in both verbal and written formats; and
- applying engineering principles to finding solutions to real-world problems (including defining a problem and identifying its constraints, generating and comparing multiple solutions, and optimizing the design solution).

Candidates select and use a variety of scientific tools. They know how to record length, mass, and volume measurements using the metric system. They interpret results of experiments and interpret events by sequence and time (e.g., relative age of rocks, phases of the moon) from evidence of natural phenomena. They communicate the steps in an investigation, record data, and interpret and analyze numerical and non-numerical results using charts, maps, tables, models, graphs, and labeled diagrams. Candidates understand how to define and delimit engineering problems, develop possible solutions to solve problems, and optimize design solutions.

Candidates integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem. They analyze a scientific or technical text to determine the central ideas or conclusions and accurately summarize complex information, concepts, and processes in a text by paraphrasing them in simpler terms. Candidates cite specific textual evidence to support analysis of scientific and technical texts, recognizing gaps or inconsistencies that may exist in the text.

Candidates analyze how informational texts structure the subject matter into categories and hierarchies. They determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in grade-level scientific and technical contexts. They analyze the author's purpose in presenting specific information in a text or passage.

Candidates evaluate hypotheses, data, analysis, and conclusions in a scientific or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

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They synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept.

Candidates display knowledge of the interdependence of science, technology, and engineering and understand the connection between scientific concepts and engineering advances. They explain the relationship between the changing wants and needs of society and the development and improvement of technologies to meet these demands, as well as the impact of technology on the natural world.

Candidates recognize and integrate the following crosscutting concepts in science and engineering in lesson design and classroom activities:

- **Patterns:** Patterns can be observed and used to describe phenomena.
- **Cause and effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- **Scale, proportion, and quantity:** Observation of natural objects and phenomena is dependent upon scale, proportion, and physical quantities (i.e., quantities that may be described or measured using standard units).
- **Systems and system models:** Systems are composed of components that work together and models may be used to represent systems and system interactions.
- **Energy and matter:** Energy is transferred in various ways but can be neither created nor destroyed; within a system, this transfer of energy drives the cycling and motion of matter.
- **Structure and function:** Functions and properties of objects and systems are determined by the way their components are shaped and used, and can be inferred from their overall structure.
- **Stability and change:** Objects and systems may change slowly or rapidly.

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CONTENT SPECIFICATIONS IN MATHEMATICS

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

0004 Number Sense (SMR Domain 1)

- 1.1 Numbers, Relationships Among Numbers, and Number Systems.** Candidates for Multiple Subject Teaching Credentials understand base ten place value, number theory concepts (e.g., greatest common factor), and the structure of the whole, integer, rational, and real number systems. They order real numbers, including integers, mixed numbers, rational numbers (e.g., fractions, decimals, percents) and irrational numbers on a number line. They represent and perform operations on numbers in exponential and scientific notation. They describe the relationships between the algorithms for addition, subtraction, multiplication, and division. They understand properties of number systems and their relationship to the algorithms, [e.g., 1 is the multiplicative identity; $27 + 34 = 2 \times 10 + 7 + 3 \times 10 + 4 = (2 + 3) \times 10 + (7 + 4)$]. Candidates perform operations with positive, negative, and fractional exponents, as they apply to whole numbers and fractions.
- 1.2 Computational Tools, Procedures, and Strategies.** Candidates demonstrate fluency in standard algorithms for computation and evaluate the correctness of nonstandard algorithms. They demonstrate an understanding of the order of operations. They round numbers, estimate the results of calculations, and place numbers accurately on a number line. They demonstrate the ability to use technology, such as calculators or software, for complex calculations.

0005 Algebra and Functions (SMR Domain 2)

- 2.1 Patterns and Functional Relationships.** Candidates represent patterns, including relations and functions, through tables, graphs, verbal rules, or symbolic rules. They use proportional reasoning such as ratios, equivalent fractions, and similar triangles, to solve numerical, algebraic, and geometric problems. They use mathematics to represent and analyze quantitative relationships between dependent and independent variables in real-world problems.
- 2.2 Linear and Quadratic Equations and Inequalities.** Candidates are able to find equivalent expressions for equalities and inequalities, explain the meaning of symbolic expressions (e.g., relating an expression to a situation and vice versa), find the solutions, and represent them on graphs. They recognize and create equivalent algebraic expressions (e.g., $2(a+3) = 2a + 6$), and represent geometric problems algebraically (e.g., the area of a triangle). They use mathematics to solve real-world problems using numerical and algebraic expressions and equations. Candidates have a basic understanding of linear equations and their properties (e.g., slope, perpendicularity); the multiplication, division,

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and factoring of polynomials; and graphing and solving quadratic equations through factoring and completing the square. They interpret graphs of linear and quadratic equations and inequalities, including solutions to systems of equations.

0006 Measurement and Geometry (SMR Domain 3)

- 3.1 Two- and Three-dimensional Geometric Objects.** Candidates for Multiple Subject Teaching Credentials understand characteristics of common two- and three-dimensional figures, such as triangles (e.g., isosceles and right triangles), quadrilaterals, and spheres. They are able to draw conclusions based on the congruence, similarity, or lack thereof, of two figures. They identify different forms of symmetry, translations, rotations, and reflections. They understand the Pythagorean theorem and its converse. They are able to work with properties of parallel lines.
- 3.2 Representational Systems, Including Concrete Models, Drawings, and Coordinate Geometry.** Candidates use concrete representations, such as manipulatives, drawings, and coordinate geometry to represent geometric objects. They construct basic geometric figures using a compass and straightedge, and represent three-dimensional objects through two-dimensional drawings. They combine and dissect two- and three-dimensional figures into familiar shapes, such as dissecting a parallelogram and rearranging the pieces to form a rectangle of equal area.
- 3.3 Techniques, Tools, and Formulas for Determining Measurements.** Candidates estimate and measure time, length, angles, perimeter, area, surface area, volume, weight/mass, and temperature through appropriate units and scales. They identify relationships between different measures within the metric or customary systems of measurements and estimate an equivalent measurement across the two systems. They calculate perimeters and areas of two-dimensional objects and surface areas and volumes of three-dimensional objects, and use mathematics to solve real-world problems involving the volume of cones, cylinders, and spheres. They relate proportional reasoning to the construction of scale drawings or models. They use measures such as miles per hour to analyze and solve problems.

0007 Statistics, Data Analysis, and Probability (SMR Domain 4)

- 4.1 Collection, Organization, and Representation of Data.** Candidates represent a collection of data through graphs, tables, or charts, incorporating technology as appropriate. They understand the mean, median, mode, and range of a collection of data. They have a basic understanding of the design of surveys, such as the role of a random sample.

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- 4.2 Inferences, Predictions, and Arguments Based on Data.** Candidates interpret a graph, table, or chart representing a data set. They investigate patterns of association in bivariate data (e.g., linear associations, goodness of fit) in scatter plots and frequency tables. They draw conclusions about a population from a random sample, and identify potential sources and effects of bias.
- 4.3 Basic Notions of Chance and Probability.** Candidates can define the concept of probability in terms of a sample space of equally likely outcomes. They use their understanding of complementary, mutually exclusive, dependent, and independent events to calculate probabilities of simple events. They can express probabilities in a variety of ways, including ratios, proportions, decimals, and percents. They find probabilities of compound events using various representations (e.g., organized lists, tables, tree diagrams, simulations).

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

Candidates for Multiple Subject Teaching Credentials identify and prioritize relevant and missing information in mathematical problems. They make sense of problems and persevere in solving them. They look for and make use of structure, analyzing complex problems to identify similar simple problems that might suggest solution strategies. They model with mathematics, representing a problem in alternate ways, such as with words, symbols, concrete models, diagrams, and technology in order to gain greater insight. They consider examples and patterns as means to formulating a conjecture.

Candidates reason abstractly and quantitatively, and apply logical reasoning and techniques from arithmetic, algebra, geometry, and probability/statistics to solve mathematical problems. They look for and express regularity in repeated reasoning, use appropriate tools strategically, and analyze problems to identify alternative solution strategies. They evaluate the truth of mathematical statements (i.e., whether a given statement is always, sometimes, or never true). They apply different solution strategies (e.g., estimation) to check the reasonableness of a solution. They demonstrate whether or not a solution is correct.

Candidates explain their mathematical reasoning through a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and concrete models. They use academic language to construct viable arguments and critique the reasoning of others. They use appropriate mathematical notation with clear and accurate language, and they attend to precision. They explain how to derive a result based on previously developed ideas, and explain how a result is related to other ideas.