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Subject
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TEST GUIDE

MATHEMATICS
SUBTEST I

Subtest Description

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

CS-TG-SD211-01

Mathematics
Subtest I: Number and Quantity; Algebra

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

NUMBER AND QUANTITY (SMR Domain 1)

Candidates demonstrate an understanding of number theory and a command of number sense as outlined in the California Common Core Content Standards for Mathematics (Grade 6, Grade 7, Grade 8, and High School). Candidates demonstrate a depth and breadth of conceptual knowledge to ensure a rigorous view of number systems and their underlying structures. They prove and use properties of natural numbers. They formulate conjectures about the natural numbers using inductive reasoning and verify conjectures with proofs.

0001 The Real and Complex Number Systems (SMR 1.1)

  a. Demonstrate knowledge of the properties of the real number system and of its subsets
  b. Perform operations and recognize equivalent expressions using various representations of real numbers (e.g., fractions, decimals, exponents)
  c. Solve real-world and mathematical problems using numerical and algebraic expressions and equations
  d. Apply proportional relationships to model and solve real-world and mathematical problems
  e. Reason quantitatively and use units to solve problems (i.e., dimensional analysis)
  f. Perform operations on complex numbers and represent complex numbers and their operations on the complex plane

(California Common Core Content Standards for Mathematics, including Standards for Mathematical Practice 1–8: The Number System, Grade 7 [7.NS]; The Real Number System, Grade 8; Quantities, High School [N-Q]; Expressions and Equations, Grade 7 [7.EE]; Ratios and Proportional Relationships, Grade 7 [7.RP]; The Real Number System, High School [N-RN]; The Complex Number System, High School [N-CN])

0002 Number Theory (SMR 1.2)

  a. Prove and use basic properties of natural numbers (e.g., properties of divisibility)
  b. Use the principle of mathematical induction to prove results in number theory
  c. Apply the Euclidean Algorithm

d. Apply the Fundamental Theorem of Arithmetic (e.g., find the greatest common factor and the least common multiple; show that every fraction is equivalent to a unique fraction where the numerator and denominator are relatively prime; prove that the square root of any number, not a perfect square number, is irrational)

(California Common Core Content Standards for Mathematics, including Standards for Mathematical Practice 1–8: The Number System, Grade 6 [6.NS])

ALGEBRA (SMR Domain 2)

Candidates demonstrate an understanding of the foundations of algebra as outlined in the California Common Core Content Standards for Mathematics (Grade 7, Grade 8, and High School). Candidates demonstrate a depth and breadth of conceptual knowledge to ensure a rigorous view of algebra and its underlying structures. They are skilled at symbolic reasoning and use algebraic skills and concepts to model a variety of problem-solving situations. They understand the power of mathematical abstraction and symbolism.

0003   Algebraic Structures (SMR 2.1)

a. Demonstrate knowledge of why the real and complex numbers are each a field, and that particular rings are not fields (e.g., integers, polynomial rings, matrix rings)
b. Apply basic properties of real and complex numbers in constructing mathematical arguments (e.g., if $a < b$ and $c < 0$, then $ac > bc$)
c. Demonstrate knowledge that the rational numbers and real numbers can be ordered and that the complex numbers cannot be ordered, but that any polynomial equation with real coefficients can be solved in the complex field
d. Identify and translate between equivalent forms of algebraic expressions and equations using a variety of techniques (e.g., factoring, applying properties of operations)
e. Justify the steps in manipulating algebraic expressions and solving algebraic equations and inequalities
f. Represent situations and solve problems using algebraic equations and inequalities

(California Common Core Content Standards for Mathematics, including Standards for Mathematical Practice 1–8: The Real Number System, High School [N-RN]; The Complex Number System, High School [N-CN]; Seeing Structure in Expressions, High School [A-SSE]; Reasoning with Equations and Inequalities, High School [A-REI]; Creating Equations, High School [A-CED])

0004   Polynomial Equations and Inequalities (SMR 2.2)

a. Analyze and solve polynomial equations with real coefficients using:
  ◆ the Fundamental Theorem of Algebra
  ◆ the Rational Root Theorem for polynomials with integer coefficients
  ◆ the Conjugate Root Theorem for polynomial equations with real coefficients
  ◆ the Binomial Theorem

b. Prove and use the Factor Theorem and the quadratic formula for real and complex quadratic polynomials
c. Solve polynomial inequalities

(California Common Core Content Standards for Mathematics, including Standards for Mathematical Practice 1–8: Reasoning with Equations and Inequalities, High School [A-REI]; Arithmetic with Polynomials and Rational Expressions, High School [A-APR]; Linear, Quadratic, and Exponential Models, High School [F-LE])

0005   Functions (SMR 2.3)

a. Analyze general properties of functions (i.e., domain and range, one-to-one, onto, inverses, composition, and differences between relations and functions) and apply arithmetic operations on functions
b. Analyze properties of linear functions (e.g., slope, intercepts) using a variety of representations
c. Demonstrate knowledge of why graphs of linear inequalities are half planes and be able to apply this fact
d. Analyze properties of polynomial, rational, radical, and absolute value functions in a variety of ways (e.g., graphing, solving problems)
e. Analyze properties of exponential and logarithmic functions in a variety of ways (e.g., graphing, solving problems)
f. Model and solve problems using nonlinear functions

(California Common Core Content Standards for Mathematics, including Standards for Mathematical Practice 1–8: Interpreting Functions, High School [F-IF]; Building Functions, High School [F-BF]; Linear, Quadratic, and Exponential Models, High School [F-LE])

0006   Linear Algebra (SMR 2.4)

a. Understand and apply the geometric interpretation and basic operations of vectors in two and three dimensions, including their scalar multiples
b. Prove the basic properties of vectors (e.g., perpendicular vectors have zero dot product)
c. Understand and apply the basic properties and operations of matrices and determinants (e.g., to determine the solvability of linear systems of equations)
d. Analyze the properties of proportional relationships, lines, linear equations, and their graphs, and the connections between them
e. Model and solve problems using linear equations, pairs of simultaneous linear equations, and their graphs

(California Common Core Content Standards for Mathematics, including Standards for Mathematical Practice 1–8: Vector and Matrix Quantities, High School [N-VM]; Expressions and Equations, Grade 8; Linear, Quadratic, and Exponential Models, High School [F-LE]; Ratios and Proportional Relationships, Grade 7 [7.RP])

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

Candidates for Single Subject Teaching Credentials in mathematics use inductive and deductive reasoning to develop, analyze, draw conclusions, and validate conjectures and arguments. As they reason both abstractly and quantitatively, they use counterexamples, construct proofs using contradictions, construct viable arguments, and critique the reasoning of others. They create multiple representations of the same concept. They know the interconnections among mathematical ideas, use appropriate tools strategically, and apply techniques and concepts from different domains and sub-domains to model the same problem. They explain mathematical interconnections with other disciplines. They are able to communicate their mathematical thinking clearly and coherently to others, orally, graphically, and in writing. They attend to precision, including the use of precise language and symbols.

Candidates make sense of routine and complex problems, solving them by selecting from a variety of strategies. They look for and make use of structure while demonstrating persistence and reflection in their approaches. They analyze problems through pattern recognition, look for and express regularity in repeated reasoning, and use analogies. They formulate and prove conjectures, and test conclusions for reasonableness and accuracy. They use counterexamples to disprove conjectures.

Candidates select and use different representational systems (e.g., coordinates, graphs). They understand the usefulness of transformations and symmetry to help analyze and simplify problems. They model with mathematics to analyze mathematical structures in real contexts. They use spatial reasoning to model and solve problems that cross disciplines.

(California Common Core Content Standards for Mathematics [Grade 7, Grade 8, and High School], including Standards for Mathematical Practice 1–8)