



Subject Matter Knowledge (SMK) Guidelines

(Draft for Public Comment)

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Purpose [placeholder]

Context [placeholder]

Subject Matter Knowledge (SMK) Guidelines

[Please Note: The final draft of these Guidelines will include the subject matter knowledge requirements for all licenses included in the Regulations, 603 CMR 7.00, however, for the purposes of this draft document we are only including licenses with proposed revisions]

Teacher Licenses and Levels, 603 CMR 7.06:

1. Biology, 8-12

The following topics will be addressed on a subject matter knowledge test:

- a. Understanding of Molecules to Organisms: Structures and Processes:
 1. Use of a model/representation to explain the process for building proteins within a cell including the roles of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in communication and creation of proteins that regulate cell functions.
 2. The principle structures and functions of animal body systems including the digestive, respiratory, circulatory, excretory, and nervous systems.
 3. Use of evidence that the human body uses both positive and negative feedback mechanisms to maintain homeostasis; understand the transport of molecules across a cellular membrane and the function of specialized structures within a cell.
 4. Use of evidence to explain the life cycle of a cell in multicellular organisms, the significance of cell reproduction as the ability to grow, repair, and replace cells. The cycle should include cell growth, DNA replication, the division of the nucleus and division of the cytoplasm.
 5. Use of a model to explain how plants and other photosynthesizing organisms convert light energy into chemical energy.
 6. Carbon, hydrogen, oxygen, nitrogen, sulfur, and phosphorus atoms may chemically combine to form large molecules which are necessary for life.
 7. Use of a model to illustrate the ability of live organisms to convert food into energy.
- b. Understanding of Ecosystems: Interactions, Energy, and Dynamics:
 1. Use of data to support explanations of how living and nonliving factors affect an area's ability to support life.
 2. Living and non-living factors effect different kinds of plants and animals of a population and or a species within a particular environment.
 3. Use of a mathematical model to predict and explain the constant flow of energy in an ecosystem affects the number of individuals living in an environment.
 4. Cycling of the carbon molecule throughout the land, ocean, and atmosphere with the constant input of energy from sunlight, energy created by cells, decomposition of organisms, and combustion.
 5. Use of data to construct an argument with evidence that an area which includes living and non-living components, will tend to resist change and remain more consistent with numbers and types of organisms.
 6. There are direct and indirect effects of human activities on the numbers and types of organisms living in an area.
 7. Human impact on a living organism's health and the condition of the non-living components.
- c. Understanding of Heredity: Inheritance and Variation of Traits:
 1. Use of a model to show how DNA passes genetic information from parents to offspring during sexual reproduction.

2. Use of evidence to explain genetic variations in an organism may come from new combinations of genes during egg and sperm development, mutations during the process of copying cellular DNA, or mutations caused by an organism's environment.
 3. Application of scientific reasoning to illustrate how genetic and environmental factors (living and non-living) can influence the traits of individuals within a population.
- d. Understanding of Biological Evolution: Unity and Diversity:
1. The fossil record, genetic information, anatomical, and developmental homologies provide evidence for common ancestry among organisms to support biological evolution.
 2. Darwin's theory that evolution within a population occurs through a process where organisms with favorable traits are more likely to reproduce and pass on their traits.
 3. The differences between viruses and bacteria and the ability of viruses and bacteria to adapt and reproduce in diverse types of environments.
 4. Evaluation of models that show how changes in an environment may result in the modification of similar organisms living in the same location.

2. Business, 5-12 (no proposed changes)

3. Chemistry, 8-12

The following topics will be addressed on a subject matter knowledge test:

- a. Understanding of Matter and Its Interactions:
 1. Use of the Periodic table to predict properties of ionization energy, atomic size, configuration of outer shell electrons and reactivity.
 2. Use of models to predict the products of a chemical reaction, when basic ionic and molecular compounds are produced, and the relative strength of ionic and covalent bonds using observable data and the concept of electronegativity.
 3. Observable properties of substances relate to their structure in terms of how molecules are arranged, the motion of molecules and the attractive forces between them.
 4. How energy is transferred during endothermic and exothermic chemical reactions by bonds being broken and formed into new substances.
 5. Variables impact how fast a chemical reaction occurs and the motion and collision of the particles impact that rate.
 6. The products of an equilibrium reaction and the motion and collision of particles impacts the forward and reverse rates of a reaction until equilibrium is reached.
 7. Use of balanced chemical equations and stoichiometry to calculate a specific amount of product for a reaction and how atoms and mass are conserved during a reaction.
 8. The relative strengths of acids or bases based on the potential of hydrogen (pH) of a solution.
 9. The oxidation-reduction (Redox) theory of how electrons are transferred within a reaction, the products of a reaction using Redox. Use the oxidation numbers to show how the electrons move through devices that produce electricity or prevent corrosion.
 10. The components of a mixture can be separated and physical and chemical properties can be identified.
- b. Understanding of Motion and Stability: Forces and Interactions:
 1. The structure of polymers, ionic compounds, acids and bases, and metals impact on the functional uses of different materials.
 2. Solubility and conductivity data determines how much an ionic substance dissolves.
 3. The strength and relative amount of attractive forces in solids, liquids and gases based on the motion and collisions of these particles, and how changes in pressure, volume and temperature impact gases.
- c. Understanding of Energy:
 1. Use of data and communication to illustrate that the overall energy in a chemical reaction is conserved despite transfer of enthalpy and entropy that occurs.

4. Dance, All (no proposed changes)

5. Digital Literacy and Computer Science (DLCS), 5-12 – NEW

The following topics will be addressed on a subject matter knowledge test:

Principles and concepts in the following areas:

- a. Computing and Society
 1. Understand safety and security concepts, security and recovery strategies, and how to deal with cyberbullying and peer pressure.
 2. Understand, analyze impact and intent of, and apply technology laws, license agreements and permissions.
 3. Recognize, analyze, and evaluate the impact of technology, assistive technology, technology proficiencies, and cybercrime in people's lives, commerce, and society.
- b. Digital Tools and Collaboration
 1. Selection and use of digital tools or resources to create an artifact, solve a problem, communicate, or publish online.
 2. Use of advance research skills including advanced searches, digital source evaluation, synthesis of information and appropriate digital citation.
- c. Computing Systems
 1. Selection and use of computing devices to accomplish a real-world task.
 2. Understand how computing device components work. Use of troubleshooting strategies to solve routine hardware and software problems.
 3. Understand how networks communicate, their vulnerabilities and issues that may impact their functionality. Evaluate the benefits of using a service with respect to function and quality.
- d. Computational Thinking
 1. Decompose tasks/problems into sub-problems to plan solutions.
 2. Creation of a new representation through generalization and decomposition. Write and debug algorithms in a structured language (pseudocode).
 3. Understand how different data representation effects storage and quality. Create, modify, and manipulate data structures, data sets, and data visualizations.
 4. Use of iterative design process to create an artifact or solve a problem.
 5. Creation of models and simulations to formulate, test, analyze, and refine a hypothesis.

6. Early Childhood, PreK-2

The following topics will be addressed on the Foundations of Reading test:

- a. Knowledge of the significant theories, approaches, practices, and programs for developing reading skills and reading comprehension:
 1. Current research-based theories and practices for developing proficient and strategic readers; familiarity with programs and approaches for teaching literacy/reading.
 2. Principles and research-based instructional practices for developing proficient readers (phonics and word recognition, vocabulary, reading fluency, comprehension, and the reading-writing connection).
 3. Theories, research, and instructional practices for supporting readers with diverse cultural and linguistic backgrounds, strengths, and challenges.
 4. Knowledge of reading standards as outlined in the *2017 Massachusetts English Language Arts (ELA)/Literacy Curriculum Framework*: reading for key ideas and details, craft and structure, integration of knowledge and ideas, and range of reading and text complexity.
 5. Instructional practices for supporting comprehension in a variety of genres and content areas.
 6. Knowledge of selection criteria for classroom literacy and informational texts.
- b. Principles and research-based instructional practices for developing emergent reader skills (alphabetic principle, concepts of print, phonological and phonemic awareness).
- c. Phonemic awareness and phonics; principles, knowledge, and instructional practices.
- d. Use of assessment for instruction and intervention.
- e. Knowledge of a variety of formal and informal reading assessment tools.
- f. Use of data from screening, diagnostic, and formative assessments to identify individual strengths and weaknesses and differentiate instruction (prepare mini-lessons, select appropriate materials, form flexible groups).
- g. Knowledge of Response to Intervention models/components, including tiered instruction, shared responsibility and decision-making, research-based interventions, and progress monitoring.
 - i. Diagnosis and assessment of reading skills using standardized, criterion-referenced, and informal assessment instruments.

The following topics will be addressed on the Early Childhood test:

- a. English Language Arts
 1. Knowledge and use of literary texts, including variety of genre, literary elements, and literary techniques.
 2. Knowledge and use of types and formats of informational texts, along with practices for instruction of elements of non-fiction.
 3. Practices for developing literacy: speaking, listening, reading, writing including through dramatic play, storytelling, arts integration, opportunities for language play such as through musical and rhyming games, as well as other strategies.
 4. Knowledge and use of emergent writing, such as scribbling, drawing, and invented spelling transitioning to conventional spelling and grade appropriate writing.
 5. Knowledge and use of technology for writing, editing, research, and sharing information.
- b. Mathematics
 1. Knowledge of early numeracy and how children acquire the skills and understandings of numbers.
 2. Fundamental computation and conceptual skills of mathematical principles foundational to increasingly complex mathematical content and methods by understanding the PreK-5 progression continuum.

3. Knowledge and use of research-based practices that result in effective conceptual understanding, procedural skills and fluency, and problem solving applications.
- c. Science
 1. An understanding of how children acquire conceptual understanding of disciplinary core ideas, science and engineering practices, and their application to the natural and designed world through the use of inquiry and authentic contexts.
 2. Knowledge and understanding of the curricular continuum for disciplinary core ideas related to Earth and Space Science, Life Sciences, Physical Sciences and Technology/Engineering.
- d. History/Social Science
 1. An understanding of how children acquire conceptual understanding and knowledge of fundamental ideas of history/social science.
 2. Knowledge and understanding of the curricular continuum disciplinary core ideas related to history and geography, civics and government, and economics.
- e. Knowledge of child development, including language acquisition and development, and the science of early learning and its connection to curriculum, instruction and assessment.
- f. Knowledge and understanding of special education policies and procedures
 1. Knowledge of characteristics of children with disabilities.
 2. Theories of language development and the effects of disabilities on learning.
 3. Knowledge of ways to support students with disabilities in the general education classroom, i.e., use of behavioral management principles.
 4. Knowledge of Individual Family Service Plans (IFSP) and the transition process to an Individualized Education Program (IEP).
 5. Knowledge of the referral processes.
 6. Knowledge of legislation, federal and state laws and regulations pertaining to special education.
 7. Knowledge of services provided by community and state agencies that support children with disabilities and their families.
 8. Instruction on the appropriate use of augmentative and alternative communication and other assistive technologies.
 9. Preparation, implementation, and evaluation of Individualized Education Programs (IEPs).

The following topics shall be included in an approved program, but, will not be addressed on a test of subject matter knowledge:

- a. Application of key theories to learning and development in the domains of:
 1. Social-emotional development
 2. Language and communication development
 3. Approaches to learning and play
 4. Cognitive development
- b. Visual and Performing Arts
 1. Knowledge of the key principles and concepts in the arts (dance, music, theatre, and visual arts).
 2. Knowledge of curriculum, instruction and assessment in arts education informed by child development and the science of early learning.
 3. Knowledge and application of the arts and its integration across all curricular areas.
- c. Health
 1. Knowledge of the key principles and concepts in comprehensive health education (physical health, social and emotional health, safety and prevention, and personal and community health).
 2. Knowledge and application of the comprehensive health framework and its integration across all curricular areas.
- d. Basic principles and concepts for digital literacy and computer science in the following areas.

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1. Computing and society
2. Digital tools and collaboration
3. Computing systems
4. Computational thinking

7. Earth and Space Science, 8-12

The following topics will be addressed on a subject matter knowledge test:

- a. Understanding of Earth's Place in the Universe:
 1. Nuclear fusion in a star's core affects its lifespan, produces elements from helium to iron, and releases energy in the form of radiation.
 2. The Big Bang Theory including: the motion of galaxies; background microwave radiation; and matter in the universe.
 3. Kepler's laws of planetary motion can predict and describe how interactions and collisions between planets can affect orbits.
 4. The movement of the crust, the theory of plate tectonics, and density of rocks explains why continental rocks are older than rocks on the ocean floor.
- b. Understanding of Earth's Systems:
 1. Use of data to support that one change to Earth's surface water can cause changes to other Earth systems and the properties of water affect Earth materials and surface processes.
 2. Convection currents and the effects of gravity on denser materials causes the cycling of matter inside the earth.
 3. Use of a model to describe how energy variations in Earth's systems over time result in changes in climate. Use of data to illustrate that changes in the Earth's tilt and orbit result in climate change.
 4. Use of a model to describe the carbon cycle through the Earth's systems and how human activity causes increases in carbon dioxide resulting in atmospheric and climate changes.
- c. Earth and Human Activity:
 1. How the availability of natural resources and changes in climate has influenced human activity.
 2. Design solutions for minimizing the impacts of developing/using resources, and conserving/recycling those resources, based on cost-benefit ratios.
 3. Relationships between natural resources, human populations, and biodiversity.
 4. Use of global climate models to describe how forecasts are made of climate change and associated future impacts to Earth systems.

8. Elementary, 1-6

The following topics will be addressed on the Foundations of Reading test:

- a. Knowledge of the significant theories, approaches, practices, and programs for developing reading skills and reading comprehension:
 1. Current research-based theories and practices for developing proficient and strategic readers; familiarity with programs and approaches for teaching literacy/reading.
 2. Principles and research-based instructional practices for developing proficient readers (phonics and word recognition, vocabulary, reading fluency, comprehension, and the reading-writing connection).
 3. Theories, research, and instructional practices for supporting readers with diverse cultural and linguistic backgrounds, strengths, and challenges.
 4. Knowledge of reading standards as outlined in the *2017 Massachusetts English Language Arts (ELA)/Literacy Curriculum Framework*: reading for key ideas and details, craft and structure, integration of knowledge and ideas, and range of reading and text complexity.
 5. Instructional practices for supporting comprehension in a variety of genres and content areas.
 6. Knowledge of selection criteria for classroom literary and informational texts.
- b. Principles and research-based instructional practices for developing emergent reader skills (alphabetic principle, concepts of print, phonological and phonemic awareness).
- c. Phonemic awareness and phonics; principles, knowledge, and instructional practices.
- d. Use of assessment for instruction and intervention.
- e. Knowledge of a variety of formal and informal reading assessment tools.
- f. Use of data from screening, diagnostic, and formative assessments to identify individual strengths and weaknesses and differentiate instruction (prepare mini-lessons, select appropriate materials, form flexible groups).
- g. Knowledge of Response to Intervention models/components, including tiered instruction, shared responsibility and decision-making, research-based interventions, and progress monitoring.
 1. Diagnosis and assessment of reading skills using standardized, criterion-referenced, and informal assessment instruments.

The following topics will be addressed on the General Curriculum test:

- a. Science and Technology/Engineering.
 1. Life Science: Understanding of molecules to organisms: structures and processes, ecosystems: interactions energy, and dynamics, heredity: inheritance and variation of traits, and biological evolution: unity and diversity.
 2. Earth and Space Science: Understanding of Earth's place in the universe, Earth's systems and human activity.
 3. Physical Science: Understanding of matter and its interactions, motion and stability: forces and interactions, energy, and waves and their applications in technologies for information transfer.
 4. Technology/Engineering: Understanding of engineering design, materials, tools, and manufacturing, and technological systems.
 5. Science and Engineering practices: Understanding of the dynamic holistic process of science and engineering practices that emphasizes how scientific knowledge develops and how scientists and engineers apply these practices in their work.
- b. Mathematics.

Comprehensive conceptual understanding, procedural knowledge, and problem solving application skills of the following grade PreK-8 content domains:

 1. Counting and Cardinality: Understand concepts of number including numbers as quantities and the concept of one to one correspondence.

2. Operations and Algebraic Thinking: Understand properties of operations for computing using the operations of addition, subtraction, multiplication, and division with whole numbers, integers, and fractions and understand mathematical relationships and ways of representing relationships.
 3. Numbers— Base Ten and fractions: Understand the concept of place value including decimals and understand fractions and their representations on a number line.
 4. The Number System: Understand rational numbers and operations with rational numbers and know number classifications such as natural, whole, rational (including integers), and/or irrational.
 5. Ratios and Proportional Relationships: Understand ratios and rates and connections to fractions and understand and apply proportional reasoning to solve problems in a variety of ways.
 6. Geometry: Understand properties of two and three-dimensional shapes and understand the structure of the coordinate plane and its use to solve problems including applying the Pythagorean Theorem to solve problems.
 7. Measurement: Understand length, area, and volume and their units of measure for both regular and irregular two and three-dimensional shapes.
 8. Functions: Understand the concept of a function and their capacity to model relationships between quantities.
 9. Expressions and Equations: Understand how expressions and equations are used to solve real-life and mathematical problems and understand correspondences between equations, verbal descriptions, tables, and graphs
 10. Probability and Statistics: Understand statistical variability and statistical measures used to summarize and describe distributions of data and understand random sampling and its purposes and the probability of chance events.
- c. English Language Arts.
1. Children’s and young adult literature and informational texts.
 2. Genres, literary elements, and literary techniques.
 3. Research-based instructional practices for developing skill in using technology (including alternative communications technology).
 4. History and structure of the English language, conventions of Standard English, and vocabulary development using knowledge of Greek/Latin roots.
 5. Research-based instructional practices for writing opinions, arguments, explanations, and narratives.
 6. The writing process and formal elements of writing and composition.
- d. History and Social Science.
1. Major developments and figures in Massachusetts and U.S. history from colonial times to the present.
 2. Major developments and figures in world history, with stress on Western civilization.
 3. Basic economic principles and concepts.
 4. Basic geographical principles and concepts.
 5. U.S. political principles, ideals, founding documents, institutions, processes, and their history and development.

The following topics shall be included in an approved program, but, will not be addressed on a subject matter knowledge test:

- a. Child development.
1. Basic theories of cognitive, social, emotional, language, and physical development from childhood through adolescence.
 2. Characteristics and instructional implications of moderately and severely disabling conditions.

3. Knowledge of developing literacy and language through intentional play and cooperative group work.
- b. Basic principles and concepts in each of the visual and performing arts (visual art, music, drama/theater, dance).
- c. Basic principles and practices in physical education.
- d. Basic principles and practices related to personal and family health.
- e. Basic principles and concepts for digital literacy and computer science in the following areas:
 1. Computing and society
 2. Digital tools and collaboration
 3. Computing systems
 4. Computational thinking

9. English, 5-12

The following topics will be addressed on a subject matter knowledge test:

- a. Literature – Major written works, movements, genres, and applicable skills
 1. Knowledge of how to analyze key ideas, themes, literary concepts, author’s craft and purpose.
 2. Techniques used to analyze text structure including how specific sentences, paragraphs, and larger portions of the text relate to each other and as a whole.
 3. Knowledge of literary movements and seminal documents that have impacted world cultures and events.
 4. American Literature from the 17th– 21st centuries that represents a diverse range of American perspectives.
 5. American cultural, historical, and political documents of the 17th– 21st centuries
 6. British Literature from the following periods: Anglo-Saxon and Middle Ages, English Renaissance, Elizabethan, Restoration/Enlightenment, Romanticism, Victorian, Modernism, and Contemporary.
 7. World Literature from European countries, Latin America, Africa, and Asia.
 8. Texts from world religions, Ancient Greek and Roman literature and world myths and folktales.
 9. Significant young adult literary and informational text.
- b. Language
 1. Historical and current influences on the development of the English language.
 2. Rules and conventions of standard written and spoken English.
 3. Figurative language, word relationships, and nuances in word meanings.
 4. The distinction between general academic and domain-specific vocabulary and techniques for vocabulary acquisition through context and word study.
 - i. History and structure of the English language.
 - ii. Knowledge of the rules and conventions of standard written and spoke English.
- c. Rhetoric and composition
 1. Principles of classical, modern, and contemporary rhetoric, as well as rhetorical strategies including the impact of structure on other elements of author’s craft.
 2. Characteristics and traits of effective narrative, explanatory, and opinion/argument writing
 3. The writing process: planning, drafting, revising, editing, rewriting, citing sources, and publishing; application of the writing process for on-demand and extended time writing.
 4. Characteristics of research skills, including proper gathering of credible sources and adherence to standard citation formats.
 5. Knowledge of how to apply a broad range of technological tools to enhance writing and content learning.
 6. Speaking and listening techniques to be used in a variety of contexts.
 - i. Principles of classical rhetoric.
 - ii. Modern and contemporary theories of rhetoric.
 - iii. Similarities and differences between oral and written communication.
- d. Reading theory, research, and practice
 1. Knowledge of research-based theories, practices and programs for adolescent language and literacy development (reading, writing, speaking, and listening).
 2. Knowledge of techniques for giving written and oral feedback which lead to student growth in writing.
 3. Knowledge of techniques for facilitating effective text-based questions.
 4. Knowledge of the characteristics of reading language-based learning disabilities and of the research-based strategies for addressing these disabilities in the general education classroom.

10. English as a Second Language (ESL), PreK-6; 5-12 (no proposed changes)

11. Foreign Language, PreK-6; 5-12 (no proposed changes)

12. General Science, 1-6; 5-8

The following topics will be addressed on a subject matter knowledge test for the 1-6 level:

- a. The eight essential science and engineering practices:
 1. Asking questions and defining problems
 2. Developing and using models
 3. Constructing explanations and designing solutions
 4. Obtaining, evaluating and communicating information
 5. Planning and carrying out investigations
 6. Analyzing and interpreting data
 7. Using mathematical and computational thinking
 8. Constructing arguments from evidence
- b. Basic Principles of Understanding Life Science:
 1. Molecules to Organisms: Structure and Processes
 2. Ecosystems: Interactions, Energy, and Dynamics
 3. Heredity: Inheritance and Variation of Traits
 4. Biological Evolution: Unity and Diversity
- c. Basic Principles of Understanding Earth and Space Science:
 1. Earth's Place in the Universe
 2. Earth's Systems
 3. Impact of Human Activity on Earth
- d. Basic Principles of Understanding Physical Science:
 1. Matter and Its Interactions: Structure of Matter
 2. Motion and Stability: Forces and Interaction
 3. Energy
 4. Waves and Their Applications in Technologies for Information Transfer
- e. Basic Principles of Understanding Technology/Engineering:
 1. Engineering and Design
 2. Materials, Tools and Manufacturing
 3. Technological Systems

The following topics will be addressed on a subject matter knowledge test for the 5-8 level:

- a. The eight essential science and engineering practices:
 1. Asking questions and defining problems
 2. Developing and using models
 3. Constructing explanations and designing solutions
 4. Obtaining, evaluating and communicating information
 5. Planning and carrying out investigations
 6. Analyzing and interpreting data
 7. Using mathematical and computational thinking
- b. Intermediate Knowledge and Understanding of Earth and Space Science:
 1. Earth's Place in the Universe
 2. Earth's Systems
 3. Impact of human activity on the Earth
- c. Intermediate Knowledge and Understanding of Life Science:
 1. Structures and Processes of Molecules and Organisms
 2. Ecosystems: Interactions, Energy, and Dynamics
 3. Heredity: Inheritance and Variation of Traits

- 4. Biological Evolution: Unity and Diversity
- d. Intermediate Knowledge and Understanding of Physical Science:
 - 1. Matter and Its Interactions: Structure of matter
 - 2. Motion and Stability: Forces and Interactions
 - 3. Energy
 - 4. Waves and Their Applications in Technologies for Information Transfer
- e. Intermediate Knowledge and Understanding of Technology/Engineering:
 - 1. Engineering Design
 - 2. Material, Tools and Manufacturing
 - 3. Technological Systems

13. Health/Family and Consumer Sciences, All (no proposed changes)

14. History, 1-6; 5-12 (no proposed changes)

15. Latin and Classical Humanities, 5-12 (no proposed changes)

16. Library, All (no proposed changes)

17. Mathematics, 1-6; 5-8; 8-12

The following topics will be addressed on a subject matter knowledge test for the 1-6 level:

- a. Comprehensive conceptual understanding, procedural knowledge, and problem-solving application skills of the following grade PreK-8 content domains:
 1. Counting and Cardinality: Understand concepts of number including numbers as quantities and the concept of one to one correspondence
 2. Operations and Algebraic Thinking: Understand properties of operations for computing using the operations of addition, subtraction, multiplication, and division with whole numbers, integers, and fractions and understand mathematical relationships and ways of representing relationships.
 3. Numbers–Base Ten and fractions: Understand the concept of place value including decimals and understand fractions and their representations on a number line.
 4. The Number System: Understand rational numbers and operations with rational numbers and know number classifications such as natural, whole, rational (including integers), and/or irrational.
 5. Ratios and Proportional Relationships: Understand ratios and rates and connections to fractions and understand and apply proportional reasoning to solve problems in a variety of ways.
 6. Geometry: Understand properties of two and three-dimensional shapes and understand the structure of the coordinate plane and its use to solve problems including applying the Pythagorean Theorem to solve problems.
 7. Measurement: Understand length, area, and volume and their units of measure for both regular and irregular two and three-dimensional shapes.
 8. Functions: Understand the concept of a function and their capacity to model relationships between quantities.
 9. Expressions and Equations: Understand how expressions and equations are used to solve real-life and mathematical problems and understand correspondences between equations, verbal descriptions, tables, and graphs
 10. Probability and Statistics: Understand statistical variability and statistical measures used to summarize and describe distributions of data and understand random sampling and its purposes and the probability of chance events.

The following topics will be addressed on a subject matter knowledge test for the 5-8 level:

- a. Comprehensive conceptual understanding, procedural knowledge, and problem solving application skills of the following grade PreK-8 content domains:
 1. Operations and Algebraic Thinking: Understand properties of operations for computing using the operations of addition, subtraction, multiplication, and division with rational numbers and for representing numerical relationships in equivalent ways.
 2. The Number System: Understand the system of rational numbers and their placement, ordering and absolute value on a number line.
 3. Ratios and Proportional Relationships: Understand ratio and rate concepts and understand proportional reasoning and its usefulness for solving real world problems. Understand the connections between proportional relationships, lines, and linear equations.
 4. Expressions and Equations: Understand properties of operations for computing with rational numbers in algebraic expressions and equations and for representing algebraic relationships in equivalent ways.
 5. Functions: Understand the concept of function, and the correspondences between geometric transformations of graphs of functions and algebraic transformations of associated equations (including linear, quadratic, exponential, absolute value, and piecewise functions).
 6. Measurement and Data: Understand concepts of length, area, and volume and relationships

- between different units of measurement. Understand representations for data measurements such as line plots.
7. Geometry: Understand properties and measurements of geometric figures and concepts of congruency and similarity and transformations in the plane.
 8. Statistics and Probability: Understand data concepts, distributions, and statistical variability in data and samples and probabilities of chance events.
- b. Knowledge in these specific topics, drawn from the grades 9-12 conceptual categories and advanced mathematics subject matter:
1. Number Systems: Understand the properties of the rational and irrational number systems and complex numbers. Understand the properties of exponents extended to rational exponents.
 2. Vector and Matrix Quantities: Understand vectors can represent quantities that change over time. Understand matrices and operations on matrices.
 3. Algebraic operations, expressions, equations: Understand the reasoning behind the various methods for operating with expressions and for solving equations and systems of equations.
 4. Polynomial, exponential, trigonometric, logarithmic, rational Functions: Understand functions in terms of their rate of growth, periodicity, zeros, asymptotes, maximum/minimum values.
 5. Geometric proofs, arc length, and triangle trigonometry: Understand proofs in terms of transformations of congruent figures and rigid motion. Understand proofs based on similarity and trigonometric ratios in terms of similar right triangles as well as radian measure of an angle defined as the ratio of arc length to radius.
 6. Random samples, Independence and conditional probability: Understand random processes underlying statistical experiments.
 7. Limits and derivatives: Understand how limits and derivatives approximate the slope of a curve at a point on the curve.

The following topics will be addressed on a subject matter knowledge test for the 8-12 level.

- a. Comprehensive conceptual understanding, procedural knowledge, and problem solving application skills of the following concepts.
1. Number and Quantity: Understand the difference between quantities and numbers. Understand similarities and difference in systems of numbers including real and complex numbers.
 2. Algebra: Understand computations with and operations on algebraic expressions, equations and inequalities and the nature of solutions to equations and inequalities and systems of equations and equalities.
 3. Functions: Understand that functions describe situations where one quantity determines another and their connections to expressions, equations, modeling, and coordinates.
 4. Geometry: Understanding of the attributes and relationships of geometric objects and congruence, similarity, and symmetry from the perspective of geometric transformation.
 5. Statistics and Probability: Understand statistics provides tools for describing variability in data and for making informed decisions that take it into account. Understand randomization concepts for sampling including the concept of statistically significant outcome
- b. Knowledge in these specific topics, drawn from advanced mathematics subject matter:
1. Linear Algebra: Matrices, matrix operations, and linear transformations.
 2. Non-Euclidean Geometry: Spherical and Hyperbolic Geometries
 3. Calculus including Series, Multi-Variable Calculus and introductory topics of Differential Equations, especially modeling
 4. Discrete Mathematics, including combinatorics, set theory, recursion, and graph theory
 5. Applications of mathematics and analytical modeling involving coordinates, algebra, and functions
 6. Introduction to proofs, deductive reasoning: Understand axiomatic systems and their purpose in

- proofs and deductive reasoning.
- 7. Statistical Methods including experimental design, hypothesis testing, and confidence intervals.
- c. Concepts from grades K-7:
 - 1. Conceptual understanding of fractions and decimals and their operations.
 - 2. Conceptual understanding of place value and its relationship to algorithms.
 - 3. Understanding of algebraic thinking.
 - 4. Conceptual understanding of ratios, proportions, and proportional reasoning.

18. Middle School: Humanities, 5-8

19. Middle School: Mathematics/Science, 5-8

The following topics will be addressed on a subject matter knowledge test for the 5-8 level:

Science

- a. The eight essential science and engineering practices:
 1. Asking questions and defining problems
 2. Developing and using models
 3. Constructing explanations and designing solutions
 4. Obtaining, evaluating and communicating information
 5. Planning and carrying out investigations
 6. Analyzing and interpreting data
 7. Using mathematical and computational thinking
 8. Constructing arguments from evidence
- b. Intermediate knowledge of Earth and Space Science
 1. Understanding of Earth's Place in the Universe
 2. Understanding of Earth's Systems
 3. Understanding of the impact of human activity on the Earth
- c. Intermediate knowledge of Life Science
 1. Understanding of Structures and Processes of Molecules and Organisms
 2. Understanding of Ecosystems: Interactions, Energy, and Dynamics
 3. Understanding of Heredity: Inheritance and Variation of Traits
 4. Understanding of Biological Evolution: Unity and Diversity
- d. Intermediate Knowledge of Physical Science
 1. Understanding of Matter and Its Interactions: Structure of matter
 2. Understanding of Motion and Stability: Forces and Interactions
 3. Understanding of Energy
 4. Understanding of Waves and Their Applications in Technologies for Information Transfer
- e. Intermediate knowledge of Technology/Engineering
 1. Understanding of Engineering Design
 2. Understanding of Material, Tools and Manufacturing
 3. Understanding of Technological Systems

Math

- a. Comprehensive conceptual understanding, procedural knowledge, and problem solving application skills of the following grade PreK-8 content domains:
 1. Operations and Algebraic Thinking: Understand properties of operations for computing using the operations of addition, subtraction, multiplication, and division with rational numbers and for representing numerical relationships in equivalent ways.
 2. The Number System: Understand the system of rational numbers and their placement, ordering and absolute value on a number line.
 3. Ratios and Proportional Relationships: Understand ratio and rate concepts and understand proportional reasoning and its usefulness for solving real world problems. Understand the connections between proportional relationships, lines, and linear equations.
 4. Expressions and Equations: Understand properties of operations for computing with rational numbers in algebraic expressions and equations and for representing algebraic relationships in equivalent ways.
 5. Functions: Understand the concept of function, and the correspondences between geometric transformations of graphs of functions and algebraic transformations of associated equations

- (including linear, quadratic, exponential, absolute value, and piecewise functions).
6. Measurement and Data: Understand concepts of length, area, and volume and relationships between different units of measurement. Understand representations for data measurements such as line plots.
 7. Geometry: Understand properties and measurements of geometric figures and concepts of congruency and similarity and transformations in the plane.
 8. Statistics and Probability: Understand data concepts, distributions, and statistical variability in data and samples and probabilities of chance events.
- b. Knowledge in these specific topics, drawn from the grades 9-12 conceptual categories and advanced mathematics subject matter:
1. Number Systems: Understand the properties of the rational and irrational number systems and complex numbers. Understand the properties of exponents extended to rational exponents.
 2. Vector and Matrix Quantities: Understand vectors can represent quantities that change over time. Understand matrices and operations on matrices.
 3. Algebraic operations, expressions, equations: Understand the reasoning behind the various methods for operating with expressions and for solving equations and systems of equations.
 4. Polynomial, exponential, trigonometric, logarithmic, rational Functions: Understand functions in terms of their rate of growth, periodicity, zeros, asymptotes, maximum/minimum values.
 5. Geometric proofs, arc length, and triangle trigonometry: Understand proofs in terms of transformations of congruent figures and rigid motion. Understand proofs based on similarity and trigonometric ratios in terms of similar right triangles as well as radian measure of an angle defined as the ratio of arc length to radius.
 6. Random samples, Independence and conditional probability: Understand random processes underlying statistical experiments.
 7. Limits and derivatives: Understand how limits and derivatives approximate the slope of a curve at a point on the curve.

20. Music: Vocal/Instrumental/General, All (no proposed changes)

21. Physical Education, PreK-8; 5-12 (no proposed changes)

22. Physics, 8-12

The following topics will be addressed on a subject matter knowledge test:

- a. Understanding of Matter and its Interactions: The processes of fission, fusion and radioactive decay as energy is released and absorbed.
- b. Understanding of Motion and Stability: Forces and Interactions
 1. Showing mathematically the total momentum of a system is conserved when there is no net force on the system.
 2. Prediction of the effects of gravitational and electrostatic forces between objects.
 3. Use of evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
- c. Understanding of Energy
 1. Identify energy transformations from one form to another and calculate the change of energy in the system.
 2. That moving particles and energy stored in fields can be accounted for on the macroscopic scale.
 3. Use of evidence that thermal energy will transfer between touching objects from high to low temperature to reach thermal equilibrium.
 4. Use of illustration to show the forces and changes in energy between two magnetically or electrically charged objects changing position in a magnetic or electric field.
- d. Understanding of Waves and their Applications in Technologies for Information Transfer
 1. Showing mathematically the relationships among the frequency, wavelength, and speed of waves.
 2. The idea that electromagnetic radiation can be understood by either a wave model or a particle model.
 3. How devices use waves to transmit and capture information and energy.

23. Social Science, 5-12 (no proposed changes)

24. Speech, all (no proposed changes)

25. Teacher of Students with Moderate Disabilities, PreK-8; 5-12

(Please see proposed changes to the Foundations of Reading Requirements in 8.a. and General Curriculum Requirements in 8.b.)

(No proposed changes to other SMKs)

26. Teacher of Students with Severe Disabilities, All

(Please see proposed changes to the General Curriculum Requirements in 8.b.)

(No proposed changes to other SMKs)

27. Teacher of the Deaf and Hard-of-Hearing, All

(Please see proposed changes to the General Curriculum Requirements in 8.b.)

The following topics shall be included in an approved program for the **Teacher of the Deaf and Hard of Hearing: Oral/Aural**; but, will not be addressed on a written test of subject matter knowledge:

- a. Hearing and Hearing Technology including:
 1. The anatomy and physiology of ear and neural pathways, physics of sound and psychoacoustics including auditory perception, speech acoustics and impact of environmental acoustics on speech understanding and listening.
 2. Hearing measurement and etiology (both objective and subjective screening and test methods), test interpretation, hearing levels and the impact on listening and speech perception.
 3. Function and uses of available sensory devices and hearing assistive technology.
- b. Auditory Functioning including:
 1. Typical auditory development, auditory development of children with hearing loss, auditory development using hearing technology, the auditory hierarchy, acoustic phonetics (sounds of speech and transmission/reception), appropriate electroacoustic and functional assessments, and factors that impact auditory development.
- c. Spoken Language Communication including:
 1. Speech production: sequence of development (typical and atypical), anatomy and physiology of the speech/voice mechanism; and formal and informal speech production assessment measures.

The following topics shall be included in an approved program for the **Teacher of the Deaf and Hard of Hearing: American Sign Language (ASL)**; but, will not be addressed on a written test of subject matter knowledge:

- a. Knowledge of the perception, acquisition and processing of language (including both spoken and sign language).
- b. Knowledge of strategies for supporting language acquisition in sign language.
- c. Knowledge of theories in typical and atypical child development as it relates to children who are deaf or hard of hearing, including emotional, social and intellectual development.
- d. Knowledge of the design and modifications of curricular and instructional materials to ensure accessibility of the curriculum for deaf or hard of hearing students with and without special needs.
- e. Knowledge of strategies for promoting literacy among students who are deaf or hard of hearing.
- f. Knowledge of the clinical foundations of hearing.
- g. Knowledge of the relationship between ASL and English and strategies for translating between ASL and English.
- h. Knowledge of Deaf culture, Deaf history and the Deaf community.
- i. Knowledge of medical, social, and ethical issues related to educating students who are deaf or hard of hearing.
- j. Knowledge of Federal and State Special Education laws, IEP and Section 504 of the Rehabilitation Act of 1973 (29 USC 794) plan development and implementation for students who are deaf or hard of hearing.
- k. Critical analysis and application of research relevant to educating students who are deaf or hard of hearing.

28. Teacher of the Visually Impaired, All

(Please see proposed changes to the Foundations of Reading Requirements in 8.a. and General Curriculum Requirements in 8.b.)

The following topics shall be included in an approved program; but, will not be addressed on a written test of subject matter knowledge:

- a. Similarities and differences between visually impaired and non-visually impaired children in emotional, social, physical, and intellectual development.
- b. Anatomy and physiology of the eye and visual abnormalities.
- c. Historical and current developments in education of the visually impaired in the United States and other countries.
- d. How to use state-of-the-art diagnostic information.
- e. Medical and educational research related to the visually impaired.
- f. Use of English Braille (UEB) for non-technical materials and UEB and Nemeth Braille Code for Mathematics for technical materials.
- g. Use of assistive technology, such as low-vision devices.
- h. Design or modification of the curriculum and instructional materials for the visually impaired.
- i. Ways to prepare visually impaired students for classrooms ranging from general education classrooms to schools for the visually impaired.
- j. Features of family support and services.
- k. Preparation, implementation, and evaluation of Individualized Education Programs (IEPs).
- l. Knowledge of Federal and State Special Education laws, IEP, and 504 plan development and implementation for students who are visually impaired.
- m. Science laboratory work.
- n. Child development.
 1. Basic theories of cognitive, social, emotional, language, and physical development from childhood through adolescence.
 2. Characteristics and instructional implications of moderately and severely disabling conditions.

29. Technology/Engineering, 5-12

The following topics will be addressed on a subject matter knowledge test:

- a. Understanding of Engineering Design
 1. Global challenges and/or design problems that can be improved.
 2. Qualitative and quantitative criteria for designing a solution.
 3. Use of scientific and engineering principles to break a complex real world problem into smaller, more manageable problems.
 4. Solutions to complex and real world problems based on prioritized criteria and trade-offs that account for a range of constraints, as well as social, cultural, and environmental impacts.
 5. Prototypes or design solutions that use drawings with proper scale and proportions.
- b. Understanding of Materials, Tools, and Manufacturing
 1. Manufacturing processes and applications to create products with desired shape, size, and finish based on available resources and safety.
 2. How computers and robots can be utilized in a manufacturing system to differentiate the tasks that are best suited for humans and/or robots.
 3. Comparison of the costs and benefits of custom versus mass production of products.
 4. How manufacturing processes transform material properties to meet specified purpose or function.
- c. Understanding of Technological Systems
 1. The function of a communication system and the role of its components, including a source, encoder, transmitter, receiver, decoder, and storage.
 2. Transportation systems designed to move people and goods using a variety of vehicles and devices and subsystems of a transportation vehicle, including structural, propulsion, guidance, suspension, and control subsystems.
 3. Use of the concept of systems engineering to model inputs, processes, outputs, and feedback among components of a transportation, structural, or communication system.
 4. Use of a model to explain how information transmitted via digital and analog signals travels through the following media: electrical wire, optical fiber, air, and space.
- d. Understanding of Energy and Power Technologies
 1. Use of a model to explain differences between open and closed fluid systems.
 2. Differences and similarities between hydraulic and pneumatic systems.
 3. Ways that energy and power systems harness resources to accomplish tasks effectively and efficiently.
 4. How a machine converts energy, through mechanical means, to do work.

30. Theater, All (no proposed changes)

31. Visual Art (no proposed changes)

Specialist Teacher Licenses and Levels, 603 CM 7.07:**32. Instructional Technology Specialist, All (Initial License)**

The following topics will be addressed on a subject matter knowledge test:

- a. Understand safety and security concepts, security and recovery strategies, and how to deal with cyberbullying and peer pressure.
- b. Understand, analyze impact of, and apply technology laws and license agreements and permissions.
- c. Recognize, analyze, and evaluate the impact of technology, including cybercrime and assistive technology, in people's lives, commerce, and society.
- d. Understand what it means to be a good digital citizen.
- e. Selection and use of appropriate digital tools and varied input techniques, such as keyboards and speech recognition software, to publish multimedia artifacts or to communicate, collaborate, or exchange information.
- f. Use of online research skills to gather relevant information from multiple digital sources, evaluate the credibility and accuracy of sources, and appropriately attribute sources.
- g. Understand that computing devices can take different forms and have different components.
- h. Selection and use of a variety of computing devices and digital tools to troubleshoot and solve simple problems.
- i. Differentiation between tasks that are best done by computing systems and humans.
- j. Understand the components of a network and network authentication.
- k. Basic understanding of the relationship among computing systems, networks, and services.
- l. Understand binary and Boolean logic and how these are implemented in computer hardware and software.
- m. Understand how graphics and text are represented in a computer system.
- n. Basic understanding of abstractions, computer programs (such as block-based programs), algorithms, and databases.
- o. How information can be collected, used, and presented with computing devices or digital tools.
- p. How to create a model and use data from a simulation.
- q. Understand how to decompose tasks/problems into sub-problems to plan solutions.
- r. Understand how to write and analyze algorithms and block-based computer programs using an iterative design process.

The following topics shall be included in an approved program, but, will not be addressed on a subject matter knowledge test:

- a. Collaboration with school and district leaders, content specialists and other stakeholders to identify the appropriate uses of technology resources to support the development, communication, and implementation of plans for improving student performance under M.G.L. c. 69, § 1I.
- b. Coaching, modeling, observation, and feedback for teachers in the integration of in-person learning and technology to improve, facilitate, and extend learning and instruction within and beyond the classroom; continuously monitor student progress to inform tailoring of instruction; individualize learning for each student; and allow students to advance to new content based upon mastery.
- c. Strategies for achieving equitable access to digital resources outside the classroom and connecting educators, students, and parents/guardians.
- d. Coaching of teachers and instruction to students in the safe, healthy, legal, and ethical uses of digital information and technologies in people's lives, commerce, and society.
- e. The impact of technology on instructional practice, student learning, and resource allocation at the school and district level.

- f. The selection, support, and evaluation of the use of assistive and adaptive technology and accessible educational materials for students and adults.

33. Reading, (All Levels)

The following topics will be addressed on a subject matter knowledge test:

- a. Knowledge of the significant theories, practices, and programs for developing reading and writing skills and oral and written communication.
- b. Knowledge of phonemic awareness, phonics, vocabulary, fluency, comprehension, and higher-order thinking skills; principles, knowledge, applications, and research-based practices.
- c. Conventions and composition of argument/opinion, explanatory and narrative writing.
- d. Effective communication for reading, writing, speaking and listening.
- e. History and structure of the English language and vocabulary.
- f. Theories, research, and instructional practices for language and literacy in the academic disciplines for grades PreK-12.
- g. Selection and use of appropriate programs, materials, and technology for language and literacy instruction.
- h. Knowledge of and selection criteria for literature and informational text for children and adolescents based on text complexity and student reading proficiency.
- i. Knowledge of the characteristics of reading, writing and language-based learning disabilities, as well as the research-based strategies to address them in the general education classroom.
- j. Differentiation of literacy instruction
- k. Knowledge of how to identify, administer, interpret, and appropriately use informal, standardized, and norm-referenced reading and writing assessments to drive instruction – determine student strengths, weaknesses (including possible delays and disabilities) and growth.
- l. Knowledge of research-based language/literacy practices.
- m. Knowledge of implementation of tiered instruction.
- n. Selection of supplemental literacy and language materials and formative assessments.
- o. Use of data to inform instruction and intervention grouping.
- p. Theories of first and second language acquisition and development and related research-based instruction and assessment practices.
- q. Knowledge of differentiation among language differences, dialects and disabilities.
- r. Child and adolescent development and the timing of formal reading instruction.
- s. Knowledge of language and literacy development in children birth to age eight and its effect on later academic achievement
- t. Cognitive development and its relationship to language/literacy development.
- u. Social-emotional development and its relationship to language/literacy development.
- v. Culture and its relationship to language/literacy development.
- w. Knowledge of principles and practices for writing instruction, including the relationship to reading.
- x. Knowledge of the theories of evidence-based research for disciplinary literacy instruction and acquisition through the grades PreK-12.
- y. Approaches and practices for writing instruction, including assessment of writing skills and their relationship to reading.
- z. The historical, theoretical and evidence-based components of writing development throughout the grades PreK-12.
- aa. Selection and design of research-based literacy curricula and programs that meet the needs of all learners, including whole class, small group and individualized instruction.
- bb. Child and adolescent development and the timing of formal reading instruction.
- cc. Cognitive development in adolescence and its relationship to reading instruction.
- dd. Methods to support classroom teachers and tutors in the improvement of reading instruction, including consultation techniques and professional development.

34. Speech, Language, and Hearing Disorders, All (no proposed changes)

Administrator Licenses and Levels, 603 CMR 7.09:

1. Superintendent/Assistant Superintendent, All (no license specific SMKs)
2. School Principal/Assistant School Principal, PreK-8; 5-12 (no license specific SMKs)
3. Supervisor/Director, Dependent on Prerequisite License (no license specific SMKs)
4. Special Education Administrator, All (no license specific SMKs)
5. School Business Administrator, All (no proposed changes)

Professional Support Personnel Licenses and Levels, 603 CMR 7.11:

1. School Counselor, PreK-8; 5-12 (no proposed changes)
2. School Nurse, All (no license specific SMKs)
3. School Psychologist, All (no license specific SMKs)
4. School Social Worker/School Adjustment Counselor, All (no proposed changes)

Appendix: Resources for Educator Preparation Programs [placeholder]

[In this section we will unpack the SMK's to provide additional detail in support of program development]