Texas
Educator Certification
Examination Program

Preparation Manual
Mathematics/Science 4–8 (114)

Overview and Exam Framework

Reference Materials

Sample Selected-Response Questions

Sample Selected-Response Answers and Rationales

Section 3: Overview and Exam Framework Mathematics/Science 4–8 (114)

Exam Overview

Exam Name	**Mathematics/Science 4–8**
Exam Code	114
Time	5 hours
Number of Questions	120 selected-response questions
Format	Computer-administered test (CAT)

The TExES Mathematics/Science 4–8 (114) exam is designed to assess whether an examinee has the requisite knowledge and skills that an entry-level educator in this field in Texas public schools must possess. The 120 selected-response questions are based on the Mathematics/Science 4–8 exam framework and cover grades 4–8. The exam may contain questions that do not count toward the score. Your final scaled score will be based only on scored questions.

The Standards

Mathematics Standard I	Number Concepts: The mathematics teacher understands and uses numbers, number systems and their structure, operations and algorithms, quantitative reasoning and technology appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) to prepare students to use mathematics.
Mathematics Standard II	Patterns and Algebra: The mathematics teacher understands and uses patterns, relations, functions, algebraic reasoning, analysis and technology appropriate to teach the statewide curriculum (TEKS) to prepare students to use mathematics.
Mathematics Standard III	Geometry and Measurement: The mathematics teacher understands and uses geometry, spatial reasoning, measurement concepts and principles and technology appropriate to teach the statewide curriculum (TEKS) to prepare students to use mathematics.
Mathematics Standard IV	Probability and Statistics: The mathematics teacher understands and uses probability and statistics, their applications and technology appropriate to teach the statewide curriculum (TEKS) to prepare students to use mathematics.
Mathematics Standard V	Mathematical Processes: The mathematics teacher understands and uses mathematical processes to reason mathematically, to solve mathematical problems, to make mathematical connections within and outside of mathematics and to communicate mathematically.

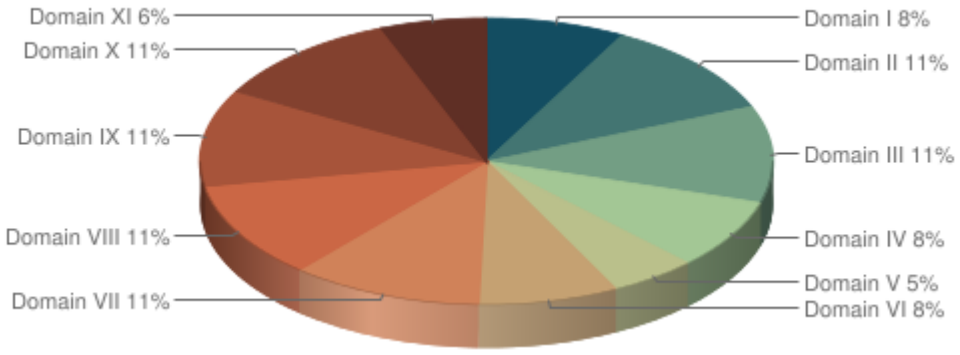
Mathematics Standard VI	Mathematical Perspectives: The mathematics teacher understands the historical development of mathematical ideas, the relationship between society and mathematics, the structure of mathematics and the evolving nature of mathematics and mathematical knowledge.
Mathematics Standard VII	Mathematical Learning and Instruction: The mathematics teacher understands how children learn and develop mathematical skills, procedures and concepts; knows typical errors students make; and uses this knowledge to plan, organize and implement instruction to meet curriculum goals and to teach all students to understand and use mathematics.
Mathematics Standard VIII	Mathematical Assessment: The mathematics teacher understands assessment, and uses a variety of formal and informal assessment techniques appropriate to the learner on an ongoing basis to monitor and guide instruction and to evaluate and report student progress.
Science Standard I	The science teacher manages classroom, field and laboratory activities to ensure the safety of all students and the ethical care and treatment of organisms and specimens.
Science Standard II	The science teacher understands the correct use of tools, materials, equipment and technologies.
Science Standard III	The science teacher understands the process of scientific inquiry and its role in science instruction.
Science Standard IV	The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.
Science Standard V	The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.
Science Standard VI	The science teacher understands the history and nature of science.
Science Standard VII	The science teacher understands how science affects the daily lives of students and how science interacts with and influences personal and societal decisions.
Science Standard VIII	The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.

Science Standard IX	The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in life science.
Science Standard X	The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in Earth and space science.
Science Standard XI	The science teacher knows unifying concepts and processes that are common to all sciences.

Domains and Competencies

Domain	Domain Title	Approx. Percentage of Exam*	Standards Assessed
I	Number Concepts	8%	Mathematics I
II	Patterns and Algebra	11%	Mathematics II
III	Geometry and Measurement	11%	Mathematics III
IV	Probability and Statistics	8%	Mathematics IV
V	Mathematical Processes and Perspectives	5%	Mathematics V—VI
VI	Mathematical Learning, Instruction and Assessment	8%	Mathematics VII—VIII
VII	Scientific Inquiry and Processes	11%	Science I—III, VI—VII, XI
VIII	Physical Science	11%	Science VIII
IX	Life Science	11%	Science IX
X	Earth and Space Science	11%	Science X
XI	Science Learning, Instruction and Assessment	6%	Science III—V

*Percentages do not add up to 100 due to rounding.



The content covered by this exam is organized into broad areas of content called **domains**. Each domain covers one or more of the educator standards for this field. Within each domain, the content is further defined by a set of **competencies**. Each competency is composed of two major parts:

- The **competency statement**, which broadly defines what an entry-level educator in this field in Texas public schools should know and be able to do.
- The **descriptive statements**, which describe in greater detail the knowledge and skills eligible for testing.

Domain I—Number Concepts

Competency 001—The teacher understands the structure of number systems, the development of a sense of quantity and the relationship between quantity and symbolic representations.

The beginning teacher:

A. Analyzes the structure of numeration systems and the roles of place value and zero in the base ten system.

B. Understands the relative magnitude of whole numbers, integers, rational numbers and real numbers.

C. Demonstrates an understanding of a variety of models for representing numbers (e.g., fraction strips, diagrams, patterns, shaded regions, number lines).

D. Demonstrates an understanding of equivalency among different representations of rational numbers.

E. Selects appropriate representations of real numbers (e.g., fractions, decimals, percents, roots, exponents, scientific notation) for particular situations.

F. Understands the characteristics of the set of whole numbers, integers, rational numbers, real numbers and complex numbers (e.g., commutativity, order, closure, identity elements, inverse elements, density).

G. Demonstrates an understanding of how some situations that have no solution in one number system (e.g., whole numbers, integers, rational numbers) have solutions in another number system (e.g., real numbers, complex numbers).

Competency 002—The teacher understands number operations and computational algorithms.

The beginning teacher:

A. Works proficiently with real and complex numbers and their operations.

B. Analyzes and describes relationships between number properties, operations and algorithms for the four basic operations involving integers, rational numbers and real numbers.

C. Uses a variety of concrete and visual representations to demonstrate the connections between operations and algorithms.

D. Justifies procedures used in algorithms for the four basic operations with integers, rational numbers and real numbers and analyzes error patterns that may occur in their application.

E. Relates operations and algorithms involving numbers to algebraic procedures (e.g., adding fractions to adding rational expressions, division of integers to division of polynomials).

F. Extends and generalizes the operations on rationals and integers to include exponents, their properties and their applications to the real numbers.

Competency 003—The teacher understands ideas of number theory and uses numbers to model and solve problems within and outside of mathematics.

The beginning teacher:

A. Demonstrates an understanding of ideas from number theory (e.g., prime factorization, greatest common divisor) as they apply to whole numbers, integers and rational numbers and uses these ideas in problem situations.

B. Uses integers, rational numbers and real numbers to describe and quantify phenomena such as money, length, area, volume and density.

C. Applies knowledge of place value and other number properties to develop techniques of mental Mathematics/Science and computational estimation.

D. Applies knowledge of counting techniques such as permutations and combinations to quantify situations and solve problems.

E. Applies properties of the real numbers to solve a variety of theoretical and applied problems.

Domain II—Patterns and Algebra

Competency 004—The teacher understands and uses mathematical reasoning to identify, extend and analyze patterns and understands the relationships among variables, expressions, equations, inequalities, relations and functions.

The beginning teacher:

A. Uses inductive reasoning to identify, extend and create patterns using concrete models, figures, numbers and algebraic expressions.

B. Formulates implicit and explicit rules to describe and construct sequences verbally, numerically, graphically and symbolically.

C. Makes, tests, validates and uses conjectures about patterns and relationships in data presented in tables, sequences or graphs.

D. Gives appropriate justification of the manipulation of algebraic expressions.

E. Illustrates the concept of a function using concrete models, tables, graphs and symbolic and verbal representations.

F. Uses transformations to illustrate properties of functions and relations and to solve problems.

Competency 005—The teacher understands and uses linear functions to model and solve problems.

The beginning teacher:

A. Demonstrates an understanding of the concept of linear function using concrete models, tables, graphs and symbolic and verbal representations.

B. Demonstrates an understanding of the connections among linear functions, proportions and direct variation.

C. Determines the linear function that best models a set of data.

D. Analyzes the relationship between a linear equation and its graph.

E. Uses linear functions, inequalities and systems to model problems.

F. Uses a variety of representations and methods (e.g., numerical methods, tables, graphs, algebraic techniques) to solve systems of linear equations and inequalities.

G. Demonstrates an understanding of the characteristics of linear models and the advantages and disadvantages of using a linear model in a given situation.

Competency 006—The teacher understands and uses nonlinear functions and relations to model and solve problems.

The beginning teacher:

A. Uses a variety of methods to investigate the roots (real and complex), vertex and symmetry of a quadratic function or relation.

B. Demonstrates an understanding of the connections among geometric, graphic, numeric and symbolic representations of quadratic functions.

C. Analyzes data and represents and solves problems involving exponential growth and decay.

D. Demonstrates an understanding of the connections among proportions, inverse variation and rational functions.

E. Understands the effects of transformations such as $f(x \pm c)$ on the graph of a nonlinear function $f(x)$.

F. Applies properties, graphs and applications of nonlinear functions to analyze, model and solve problems.

G. Uses a variety of representations and methods (e.g., numerical methods, tables, graphs, algebraic techniques) to solve systems of quadratic equations and inequalities.

H. Understands how to use properties, graphs and applications of nonlinear relations including polynomial, rational, radical, absolute value, exponential, logarithmic, trigonometric and piecewise functions and relations to analyze, model and solve problems.

Competency 007—The teacher uses and understands the conceptual foundations of calculus related to topics in middle school mathematics.

The beginning teacher:

A. Relates topics in middle school mathematics to the concept of limit in sequences and series.

B. Relates the concept of average rate of change to the slope of the secant line and instantaneous rate of change to the slope of the tangent line.

C. Relates topics in middle school mathematics to the area under a curve.

D. Demonstrates an understanding of the use of calculus concepts to answer questions about rates of change, areas, volumes and properties of functions and their graphs.

Domain III—Geometry and Measurement

Competency 008—The teacher understands measurement as a process.

The beginning teacher:

A. Selects and uses appropriate units of measurement (e.g., temperature, money, mass, weight, area, capacity, density, percents, speed, acceleration) to quantify, compare and communicate information.

B. Develops, justifies and uses conversions within measurement systems.

C. Applies dimensional analysis to derive units and formulas in a variety of situations (e.g., rates of change of one variable with respect to another) and to find and evaluate solutions to problems.

D. Describes the precision of measurement and the effects of error on measurement.

E. Applies the Pythagorean theorem, proportional reasoning and right triangle trigonometry to solve measurement problems.

Competency 009—The teacher understands the geometric relationships and axiomatic structure of Euclidean geometry.

The beginning teacher:

A. Understands concepts and properties of points, lines, planes, angles, lengths and distances.

B. Analyzes and applies the properties of parallel and perpendicular lines.

C. Uses the properties of congruent triangles to explore geometric relationships and prove theorems.

D. Describes and justifies geometric constructions made using a compass and straight edge and other appropriate technologies.

E. Applies knowledge of the axiomatic structure of Euclidean geometry to justify and prove theorems.

Competency 010—The teacher analyzes the properties of two- and three-dimensional figures.

The beginning teacher:

A. Uses and understands the development of formulas to find lengths, perimeters, areas and volumes of basic geometric figures.

B. Applies relationships among similar figures, scale and proportion and analyzes how changes in scale affect area and volume measurements.

C. Uses a variety of representations (e.g., numeric, verbal, graphic, symbolic) to analyze and solve problems involving two- and three-dimensional figures such as circles, triangles, polygons, cylinders, prisms and spheres.

D. Analyzes the relationship among three-dimensional figures and related two-dimensional representations (e.g., projections, cross-sections, nets) and uses these representations to solve problems.

Competency 011—The teacher understands transformational geometry and relates algebra to geometry and trigonometry using the Cartesian coordinate system.

The beginning teacher:

A. Describes and justifies geometric constructions made using a reflection device and other appropriate technologies.

B. Uses translations, reflections, glide-reflections and rotations to demonstrate congruence and to explore the symmetries of figures.

C. Uses dilations (expansions and contractions) to illustrate similar figures and proportionality.

D. Uses symmetry to describe tessellations and shows how they can be used to illustrate geometric concepts, properties and relationships.

E. Applies concepts and properties of slope, midpoint, parallelism and distance in the coordinate plane to explore properties of geometric figures and solve problems.

F. Applies transformations in the coordinate plane.

G. Uses the unit circle in the coordinate plane to explore properties of trigonometric functions.

Domain IV—Probability and Statistics

Competency 012—The teacher understands how to use graphical and numerical techniques to explore data, characterize patterns and describe departures from patterns.

The beginning teacher:

A. Organizes and displays data in a variety of formats (e.g., tables, frequency distributions, stem-and-leaf plots, box-and-whisker plots, histograms, pie charts).

B. Applies concepts of center, spread, shape and skewness to describe a data distribution.

C. Supports arguments, makes predictions and draws conclusions using summary statistics and graphs to analyze and interpret one-variable data.

D. Demonstrates an understanding of measures of central tendency (e.g., mean, median, mode) and dispersion (e.g., range, interquartile range, variance, standard deviation).

E. Analyzes connections among concepts of center and spread, data clusters and gaps, data outliers and measures of central tendency and dispersion.

F. Calculates and interprets percentiles and quartiles.

Competency 013—The teacher understands the theory of probability.

The beginning teacher:

A. Explores concepts of probability through data collection, experiments and simulations.

B. Uses the concepts and principles of probability to describe the outcome of simple and compound events.

C. Generates, simulates and uses probability models to represent a situation.

D. Determines probabilities by constructing sample spaces to model situations.

E. Solves a variety of probability problems using combinations, permutations and geometric probability (i.e., probability as the ratio of two areas).

F. Uses the binomial, geometric and normal distributions to solve problems.

Competency 014—The teacher understands the relationship among probability theory, sampling and statistical inference and how statistical inference is used in making and evaluating predictions.

The beginning teacher:

A. Applies knowledge of designing, conducting, analyzing and interpreting statistical experiments to investigate real-world problems.

B. Demonstrates an understanding of random samples, sample statistics and the relationship between sample size and confidence intervals.

C. Applies knowledge of the use of probability to make observations and draw conclusions from single variable data and to describe the level of confidence in the conclusion.

D. Makes inferences about a population using binomial, normal and geometric distributions.

E. Demonstrates an understanding of the use of techniques such as scatter plots, regression lines, correlation coefficients and residual analysis to explore bivariate data and to make and evaluate predictions.

Domain V—Mathematical Processes and Perspectives

Competency 015—The teacher understands mathematical reasoning and problem solving.

The beginning teacher:

A. Demonstrates an understanding of proof, including indirect proof, in Mathematics/Science.

B. Applies correct mathematical reasoning to derive valid conclusions from a set of premises.

C. Demonstrates an understanding of the use of inductive reasoning to make conjectures and deductive methods to evaluate the validity of conjectures.

D. Applies knowledge of the use of formal and informal reasoning to explore, investigate and justify mathematical ideas.

E. Recognizes that a mathematical problem can be solved in a variety of ways and selects an appropriate strategy for a given problem.

F. Evaluates the reasonableness of a solution to a given problem.

G. Applies content knowledge to develop a mathematical model of a real-world situation and analyzes and evaluates how well the model represents the situation.

H. Demonstrates an understanding of estimation and evaluates its appropriate uses.

Competency 016—The teacher understands mathematical connections within and outside of mathematics and how to communicate mathematical ideas and concepts.

The beginning teacher:

A. Recognizes and uses multiple representations of a mathematical concept (e.g., a point and its coordinates, the area of circle as a quadratic function in *r*, probability as the ratio of two areas).

B. Uses mathematics to model and solve problems in other disciplines, such as art, music, science, social science and business.

C. Expresses mathematical statements using developmentally appropriate language, standard English, mathematical language and symbolic Mathematics/Science.

D. Communicates mathematical ideas using a variety of representations (e.g., numeric, verbal, graphic, pictorial, symbolic, concrete).

E. Demonstrates an understanding of the use of visual media such as graphs, tables, diagrams and animations to communicate mathematical information.

F. Uses the language of mathematics as a precise means of expressing mathematical ideas.

G. Understands the structural properties common to the mathematical disciplines.

H. Explores and applies concepts of financial literacy as it relates to teaching students (e.g., describe the basic purpose of financial institutions, distinguish the difference between gross income and net income, identify various savings options, define different types of taxes, identify the advantages and disadvantages of different methods of payments).

I. Applies mathematics to model and solve problems to manage financial resources effectively for lifetime financial security as it relates to teaching students (e.g., distinguish between fixed and variable expenses, calculate profit in a given situation develop a system for keeping and using financial records, describe actions that might be taken to balance a budget when expenses exceed income and balance a simple budget).

Domain VI—Mathematical Learning, Instruction and Assessment

Competency 017—The teacher understands how children learn and develop mathematical skills, procedures and concepts.

The beginning teacher:

A. Applies theories and principles of learning mathematics to plan appropriate instructional activities for all students.

B. Understands how students differ in their approaches to learning mathematics with regard to diversity.

C. Uses students' prior mathematical knowledge to build conceptual links to new knowledge and plans instruction that builds on students' strengths and addresses students' needs.

D. Understands how learning may be assisted through the use of mathematics manipulatives and technological tools.

E. Understands how to motivate students and actively engage them in the learning process by using a variety of interesting, challenging and worthwhile mathematical tasks in individual, small-group and large-group settings.

F. Understands how to provide instruction along a continuum from concrete to abstract.

G. Recognizes the implications of current trends and research in mathematics and mathematics education.

Competency 018—The teacher understands how to plan, organize and implement instruction using knowledge of students, subject matter and statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) to teach all students to use mathematics.

The beginning teacher:

A. Demonstrates an understanding of a variety of instructional methods, tools and tasks that promote students' ability to do Mathematics/Science described in the TEKS.

B. Understands planning strategies for developing mathematical instruction as a discipline of interconnected concepts and procedures.

C. Develops clear learning goals to plan, deliver, assess and reevaluate instruction based on the TEKS.

D. Understands procedures for developing instruction that establishes transitions between concrete, symbolic and abstract representations of mathematical knowledge.

E. Applies knowledge of a variety of instructional delivery methods, such as individual, structured small-group and large-group formats.

F. Understands how to create a learning environment that provides all students, including English-language learners, with opportunities to develop and improve mathematical skills and procedures.

G. Demonstrates an understanding of a variety of questioning strategies to encourage mathematical discourse and to help students analyze and evaluate their mathematical thinking.

H. Understands how technological tools and manipulatives can be used appropriately to assist students in developing, comprehending and applying mathematical concepts.

I. Understands how to relate mathematics to students' lives and a variety of careers and professions.

Competency 019—The teacher understands assessment and uses a variety of formal and informal assessment techniques to monitor and guide mathematics instruction and to evaluate student progress.

The beginning teacher:

A. Demonstrates an understanding of the purpose, characteristics and uses of various assessments in mathematics, including formative and summative assessments.

B. Understands how to select and develop assessments that are consistent with what is taught and how it is taught.

C. Demonstrates an understanding of how to develop a variety of assessments and scoring procedures consisting of worthwhile tasks that assess mathematical understanding, common misconceptions and error patterns.

D. Understands how to evaluate a variety of assessment methods and materials for reliability, validity, absence of bias, clarity of language and appropriateness of mathematical level.

E. Understands the relationship between assessment and instruction and knows how to evaluate assessment results to design, monitor and modify instruction to improve mathematical learning for all students, including English-language learners.

Domain VII—Scientific Inquiry and Processes

Competency 020—The teacher understands how to manage learning activities to ensure the safety of all students.

The beginning teacher:

A. Understands safety regulations and guidelines for science facilities and science instruction.

B. Knows procedures for and sources of information regarding the appropriate handling, use, conservation, disposal, recycling, care and maintenance of chemicals, materials, specimens and equipment.

C. Knows procedures for the safe handling and ethical care and treatment of organisms and specimens.

Competency 021—The teacher understands the correct use of tools, materials, equipment and technologies.

The beginning teacher:

A. Selects and safely uses appropriate tools, technologies, materials and equipment needed for instructional activities.

B. Understands concepts of precision, accuracy and error with regard to reading and recording numerical data from a scientific instrument.

C. Understands how to gather, organize, display and communicate data in a variety of ways (e.g., construct charts, tables, graphs, maps, satellite images, diagrams, written reports, oral presentations).

D. Understands the international system of measurement (i.e., metric system) and performs unit conversions within measurement systems.

Competency 022—The teacher understands the process of scientific inquiry and the history and nature of science.

The beginning teacher:

A. Understands the characteristics of various types of scientific investigations (e.g., descriptive studies, controlled experiments, comparative data analysis).

B. Understands how to design, conduct and communicate the results of a variety of scientific investigations.

C. Understands the historical development of science and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge.

D. Understands the roles that logical reasoning, verifiable empirical evidence, prediction and peer review play in the process of generating and evaluating scientific knowledge.

E. Understands principles of scientific ethics.

F. Develops, analyzes and evaluates different explanations for a given scientific result.

G. Demonstrates an understanding of potential sources of error in inquiry-based investigation and the use of multiple trials to increase reliability.

H. Demonstrates an understanding of how to communicate and defend the results of an inquiry-based investigation.

Competency 023—The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

The beginning teacher:

A. Understands that decisions about the use of science are based on factors such as ethical standards, economics and personal and societal needs.

B. Applies scientific principles and the theory of probability to analyze the advantages of, disadvantages of or alternatives to a given decision or course of action.

C. Applies scientific principles and processes to analyze factors that influence personal choices concerning fitness and health, including physiological and psychological effects and risks associated with the use of substances and substance abuse.

D. Understands concepts, characteristics and issues related to changes in populations and human population growth.

E. Understands the types and uses of natural resources (renewable, non-renewable) and the effects of human consumption on the renewal and depletion of resources.

F. Understands the role science can play in helping resolve personal, societal and global challenges (e.g., recycling, evaluating product claims, alternative energy sources).

Competency 024—The teacher knows and understands the unifying concepts and processes that are common to all sciences.

The beginning teacher:

A. Understands how the following concepts and processes provide a unifying explanatory framework across the science disciplines: systems, order and organization; evidence, models and explanation; change, constancy and measurements; evolution and equilibrium; and form and function.

B. Demonstrates an understanding of how patterns in observations and data can be used to make explanations and predictions.

C. Analyzes interactions and interrelationships between systems and subsystems.

D. Applies unifying concepts to explore similarities in a variety of natural phenomena.

E. Understands how properties and patterns of systems can be described in terms of space, time, energy and matter.

F. Understands how change and constancy occur in systems.

G. Understands the complementary nature of form and function in a given system.

H. Understands how models are used to represent the natural world and how to evaluate the strengths and limitations of a variety of scientific models (e.g., physical, conceptual, mathematical).

Domain VIII—Physical Science

Competency 025—The teacher understands forces and motion and their relationships.

The beginning teacher:

A. Demonstrates an understanding of properties of universal forces (e.g., gravitational, electrical, magnetic).

B. Understands how to measure, graph and describe changes in motion using concepts of displacement, speed, velocity and acceleration.

C. Understands the vector nature of force.

D. Identifies the forces acting on an object and applies Newton’s laws to describe the motion of an object.

E. Analyzes the relationship between force and motion in a variety of situations (e.g., simple machines, blood flow, geologic processes).

Competency 026—The teacher understands physical properties of and changes in matter.

The beginning teacher:

A. Describes the physical properties of substances (e.g., density, boiling point, melting point, solubility, thermal and electrical conductivity, luster, malleability).

B. Describes the physical properties and molecular structure of solids, liquids and gases.

C. Describes the relationship between the molecular structure of materials (e.g., metals, crystals, polymers) and their physical properties.

D. Relates the physical properties of an element to its placement in the periodic table, including metals, non-metals and metalloids.

E. Distinguishes between physical and chemical changes in matter.

F. Applies knowledge of physical properties of and changes in matter to processes and situations that occur in life and Earth/space science.

Competency 027—The teacher understands chemical properties of and changes in matter.

The beginning teacher:

A. Describes the structure and components of the atom.

B. Distinguishes among elements, compounds, mixtures and solutions and describes their properties.

C. Relates the chemical properties of an element to its placement in the periodic table.

D. Describes chemical bonds and chemical formulas.

E. Analyzes chemical reactions and their associated chemical equations.

F. Explains the importance of a variety of chemical reactions that occur in daily life (e.g., rusting, burning of fossil fuels, photosynthesis, cell respiration, chemical batteries, digestion of food).

G. Understands applications of chemical properties of matter in physical, life and Earth/space science and technology (e.g., materials science, biochemistry, transportation, medicine, telecommunications).

Competency 028—The teacher understands energy and interactions between matter and energy.

The beginning teacher:

A. Describes concepts of work, power and potential and kinetic energy.

B. Understands the concept of heat energy and the difference between heat and temperature.

C. Understands the principles of electricity and magnetism and their applications (e.g., electric circuits, motors, audio speakers, nerve impulses, lightning).

D. Applies knowledge of properties of light (e.g., reflection, refraction, dispersion) to describe the function of optical systems and phenomena (e.g., camera, microscope, rainbow, eye).

E. Demonstrates an understanding of the properties, production and transmission of sound.

F. Applies knowledge of properties and characteristics of waves (e.g., wavelength, frequency, interference) to describe a variety of waves (e.g., water, electromagnetic, sound).

Competency 029—The teacher understands energy transformations and the conservation of matter and energy.

The beginning teacher:

A. Describes the processes that generate energy in the sun and other stars.

B. Applies the law of conservation of matter to analyze a variety of situations (e.g., the water cycle, food chains, decomposition, balancing chemical equations).

C. Describes sources of electrical energy and processes of energy transformation for human uses (e.g., fossil fuels, solar panels, hydroelectric plants).

D. Understands exothermic and endothermic chemical reactions and their applications (e.g., hot and cold packs, energy content of food).

E. Applies knowledge of the transfer of energy in a variety of situations (e.g., the production of heat, light, sound and magnetic effects by electrical energy; the process of photosynthesis; weather processes; food webs; food/energy pyramids).

F. Applies the law of conservation of energy to analyze a variety of physical phenomena (e.g., specific heat, nuclear reactions, efficiency of simple machines, collisions).

G. Understands applications of energy transformations and the conservation of matter and energy in life and Earth/space science.

Domain IX—Life Science

Competency 030—The teacher understands the structure and function of living things.

The beginning teacher:

A. Describes characteristics of organisms from the major taxonomic groups, including domains and kingdoms and uses these characteristics to construct a dichotomous key.

B. Analyzes how structure complements function in cells.

C. Analyzes how structure complements function in tissues, organs, organ systems and organisms including both plants and animals.

D. Identifies human body systems and describes their functions (e.g., digestive, circulatory).

E. Describes how organisms, including producers, consumers and decomposers obtain and use energy and matter.

F. Applies chemical principles to describe the structure and function of the basic chemical components (e.g., proteins, carbohydrates, lipids, nucleic acids) of living things and distinguishes between organic and inorganic compounds.

Competency 031—The teacher understands reproduction and the mechanisms of heredity.

The beginning teacher:

A. Compares and contrasts sexual and asexual reproduction.

B. Understands the organization of hereditary material (e.g., DNA, genes, chromosomes).

C. Describes how an inherited trait can be determined by one or many genes and how more than one trait can be influenced by a single gene.

D. Distinguishes between dominant and recessive traits and predicts the probable outcomes of genetic combinations.

E. Evaluates the influence of environmental and genetic factors on the traits of an organism.

F. Describes current applications of genetic research (e.g., related to cloning, reproduction, health, industry, agriculture).

Competency 032—The teacher understands adaptations of organisms and the theory of evolution.

The beginning teacher:

A. Describes similarities and differences among various types of organisms and methods of classifying organisms (e.g., presence of a nucleus determines if a cell is prokaryotic and eukaryotic).

B. Describes traits in a population or species that enhance its survival and reproductive success.

C. Describes how populations and species change through time.

D. Applies knowledge of the mechanisms and processes of biological evolution (e.g., variation, mutation, environmental factors, natural selection).

E. Describes evidence that supports the theory of evolution of life on Earth.

Competency 033—The teacher understands regulatory mechanisms and behavior.

The beginning teacher:

A. Describes how organisms respond to internal and external stimuli.

B. Applies knowledge of structures and physiological processes that maintain stable internal conditions.

C. Demonstrates an understanding of feedback mechanisms that allow organisms to maintain stable internal conditions.

D. Understands how evolutionary history affects behavior.

Competency 034—The teacher understands the relationships between organisms and the environment.

The beginning teacher:

A. Understands the levels of organization within an ecosystem (organism, population, community) and identifies the abiotic and biotic components of an ecosystem.

B. Analyzes the interrelationships (food chains, food webs) among producers, consumers and decomposers in an ecosystem.

C. Identifies factors that influence the size and growth of populations in an ecosystem.

D. Analyzes adaptive characteristics that result in a population’s or species’ unique niche in an ecosystem.

E. Describes and analyzes energy flow through various types of ecosystems.

F. Knows how populations and species modify and affect ecosystems (e.g., succession), and how biodiversity affects the sustainability of ecosystems.

Domain X—Earth and Space Science

Competency 035—The teacher understands the structure and function of earth systems.

The beginning teacher:

A. Understands the layers and surface features (landforms) of Earth and uses topographic maps and satellite imaging to analyze constructive and destructive processes that produce geologic change.

B. Understands the form and function of surface and subsurface water (e.g., watershed, aquifer).

C. Applies knowledge of the composition and structure of the atmosphere and its properties, including characteristics that allow life to exist.

D. Demonstrates an understanding of the interactions that occur among the biosphere, geosphere, hydrosphere and atmosphere.

E. Applies knowledge of how human activity and natural processes, both gradual and catastrophic, can alter earth and ocean systems.

F. Identifies the sources of energy (e.g., solar, geothermal, wind, hydroelectric, biofuels) in earth systems and describes mechanisms of energy transfer (e.g., conduction, convection, radiation).

Competency 036—The teacher understands cycles in earth systems.

The beginning teacher:

A. Understands the rock cycle and how rocks, minerals, fossil fuels and soils are formed.

B. Understands the water cycle and its relationship to weather processes; how the sun and the ocean interact in the water cycle.

C. Understands the nutrient (e.g., carbon, nitrogen) cycle and its relationship to earth systems.

D. Applies knowledge of how human and natural processes affect Earth systems.

E. Understands the dynamic interactions that occur among the various cycles in the biosphere, geosphere, hydrosphere and atmosphere.

Competency 037—The teacher understands the role of energy in weather and climate.

The beginning teacher:

A. Understands the elements of weather (e.g., humidity, wind speed, pressure, temperature) and how they are measured.

B. Compares and contrasts weather and climate.

C. Analyzes weather charts and data to make weather predictions based on local and global patterns.

D. Applies knowledge of how transfers of energy among earth systems affect weather and climate.

E. Analyzes how Earth’s position, orientation and surface features affect weather and climate.

Competency 038—The teacher understands the characteristics of the solar system and the universe.

The beginning teacher:

A. Understands the properties and characteristics of celestial objects.

B. Applies knowledge of the Earth-moon-sun system and the interactions among them (e.g., seasons, lunar phases, eclipses).

C. Identifies properties of the components of the solar system, including systems that allow life to exist.

D. Recognizes characteristics of stars, nebulae and galaxies and their distribution in the universe.

E. Demonstrates an understanding of scientific theories of the origin of the universe.

Competency 039—The teacher understands the history of the Earth system.

The beginning teacher:

A. Understands the scope of the geologic time scale and its relationship to geologic processes.

B. Demonstrates an understanding of theories about the earth's origin and geologic history.

C. Demonstrates an understanding of how tectonic forces have shaped landforms over time.

D. Understands the formation of fossils and the importance of the fossil record in explaining the Earth's history.

Domain XI—Science Learning, Instruction and Assessment

Competency 040—The teacher has theoretical and practical knowledge about teaching science and about how students learn science.

The beginning teacher:

A. Understands how the developmental characteristics, prior knowledge and experience and attitudes of students influence science learning.

B. Selects and adapts science curricula, content, instructional materials and activities to meet the interests, knowledge, understanding, abilities, experiences and needs of all students, including English-language learners.

C. Understands how to use situations from students' daily lives to develop instructional materials that investigate how science can be used to make informed decisions.

D. Understands common misconceptions in science and effective ways to address these misconceptions.

E. Understands the rationale for the use of active learning and inquiry processes for students.

F. Understands questioning strategies designed to elicit higher-level thinking and how to use them to move students from concrete to more abstract understanding.

G. Understands the importance of planning activities that are inclusive and accommodate the needs of all students.

H. Understands how to sequence learning activities in a way that allows students to build upon their prior knowledge and challenges them to expand their understanding of science.

Competency 041—The teacher understands the process of scientific inquiry and its role in science instruction.

The beginning teacher:

A. Plans and implements instruction that provides opportunities for all students to engage in nonexperimental and experimental inquiry investigations.

B. Focuses inquiry-based instruction on questions and issues relevant to students and uses strategies to assist students with generating, refining and focusing scientific questions and hypotheses.

C. Instructs students in the safe and proper use of a variety of grade-appropriate tools, equipment, resources, technology and techniques to access, gather, store, retrieve, organize and analyze data.

D. Knows how to guide and manage students in making systematic observations and measurements.

E. Knows how to promote the use of critical-thinking skills, logical reasoning and scientific problem solving to reach conclusions based on evidence.

F. Knows how to teach students to develop, analyze and evaluate different explanations for a given scientific result.

G. Knows how to teach students to demonstrate an understanding of potential sources of error in inquiry-based investigation.

H. Knows how to teach students to demonstrate an understanding of how to communicate and defend the results of an inquiry-based investigation.

Competency 042—The teacher knows the varied and appropriate assessments and assessment practices to monitor science learning in laboratory, field and classroom settings.

The beginning teacher:

A. Understands the relationships among science curriculum, assessment and instruction and bases instruction on information gathered through assessment of students' strengths and needs.

B. Understands the importance of monitoring and assessing students' understanding of science concepts and skills on an ongoing basis.

C. Understands the importance of carefully selecting or designing formative and summative assessments for the specific decisions they are intended to inform.

D. Selects or designs and administers a variety of appropriate assessment methods (e.g., performance assessment, self-assessment, formal/informal, formative/summative) to monitor student understanding and progress.

E. Uses formal and informal assessments of student performance and products (e.g., projects, lab journals, rubrics, portfolios, student profiles, checklists) to evaluate student participation in and understanding of the inquiry process.

F. Understands the importance of sharing evaluation criteria and assessment results with students.

This reference material will also be available to you during the exam. To access it, click on the Reference Materials icon located in the lower-left corner of the screen.

Definitions and Formulas

CALCULUS

First Derivative: $f'(x) = \dfrac{dy}{dx}$

Second Derivative: $f''(x) = \dfrac{d^2y}{dx^2}$

PROBABILITY

$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

$P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$

ALGEBRA

i $\quad i^2 = -1$

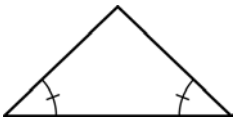
A^{-1} inverse of matrix A

$A = P\left(1 + \dfrac{r}{n}\right)^{nt}$ Compound interest,
where A is the final value
P is the principal
r is the interest rate
t is the term
n is the number of divisions within the term

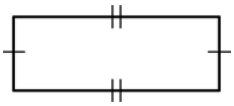
$[x] = n$ Greatest integer function,
where n is the integer such that $n \le x < n + 1$

GEOMETRY

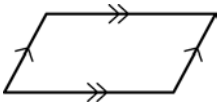
Congruent Angles



Congruent Sides



Parallel Sides



Circumference of a Circle

$C = 2\pi r$

VOLUME

Cylinder: (area of base) × height

Cone: $\dfrac{1}{3}$(area of base) × height

Sphere: $\dfrac{4}{3}\pi r^3$

Prism: (area of base) × height

AREA

Triangle: $\dfrac{1}{2}(\text{base} \times \text{height})$

Rhombus: $\dfrac{1}{2}(\text{diagonal}_1 \times \text{diagonal}_2)$

Trapezoid: $\dfrac{1}{2}\,\text{height}\,(\text{base}_1 + \text{base}_2)$

Sphere: $4\pi r^2$

Circle: πr^2

Lateral surface area of cylinder: $2\pi rh$

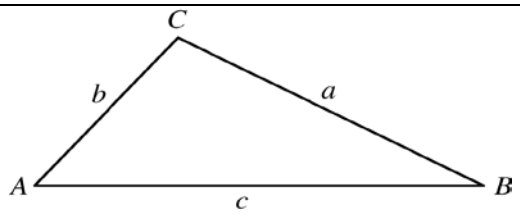
TRIGONOMETRY

Law of Sines: $\dfrac{\sin A}{a} = \dfrac{\sin B}{b} = \dfrac{\sin C}{c}$

Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos C$

$b^2 = a^2 + c^2 - 2ac\cos B$

$a^2 = b^2 + c^2 - 2bc\cos A$



End of Definitions and Formulas

This reference material will also be available to you during the exam. To access it, click on the Reference Materials icon located in the lower-left corner of the screen.

PERIODIC TABLE OF THE ELEMENTS

1 1A																	18 8A
1 H 1.01	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 23.0	12 Mg 24.3	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98.9)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57–71	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89–103	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

Lanthanide Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinide Series	89 Ac (227)	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Section 4: Sample Selected-Response Questions Mathematics/Science 4–8 (114)

This section presents some sample exam questions for you to review as part of your preparation for the exam. To demonstrate how each competency may be assessed, sample questions are accompanied by the competency that they measure. While studying, you may wish to read the competency before and after you consider each sample question. Please note that the competency statements do not appear on the actual exam.

For each sample exam question, there is a correct answer and a rationale for each answer option. The sample questions are included to illustrate the formats and types of questions you will see on the exam; however, your performance on the sample questions should not be viewed as a predictor of your performance on the actual exam.

The following reference materials will be available to you during the exam:

- Definitions and Formulas (see page 22)
- Periodic Table (see page 23)

Practice Questions

Domain I—Number Concepts

Competency 001—The teacher understands the structure of number systems, the development of a sense of quantity and the relationship between quantity and symbolic representations.

1. Which of the following numbers are greater than π?

Select all that apply.

A. 3

B. 3.14

C. $\frac{22}{7}$

D. 3.142

Answer _____

Competency 002—The teacher understands number operations and computational algorithms.

Use the equation below to answer the question that follows.

> $x^2 + x + 2 = 0$

2. Which of the following statements is true about the equation above?

A. The equation has no solutions.

B. The equation has two real solutions.

C. The equation has two complex solutions.

D. The equation has one real solution and one complex solution.

Answer _____

Competency 003—The teacher understands ideas of number theory and uses numbers to model and solve problems within and outside of mathematics.

3. Which of the following is the prime factorization of 900?

A. (4)(9)(25)

B. (16)(5)(11)

C. $(2^3)(3^3)(5^3)$

D. $(2^2)(3^2)(5^2)$

Answer _____

Domain II—Patterns and Algebra

Competency 004—The teacher understands and uses mathematical reasoning to identify, extend and analyze patterns and understands the relationships among variables, expressions, equations, inequalities, relations and functions.

> **Use the student work below to answer the question that follows**.
>
> Solve for x: $x^2 - 8x = -15$
>
> Step 1. $x^2 - 8x + 15 = -15 + 15$
>
> Step 2. $x^2 - 8x + 15 = 0$
>
> Step 3. $(x - 3)(x - 5) = 0$
>
> Step 4. $x - 3 = 0$ or $x - 5 = 0$
>
> Step 5. $x = 3$ or $x = 5$

4. Which of the following is the justification for step 4 in the student work above?

A. 0 is the identity element for addition.

B. $(a)(0) = 0$ for all real numbers a.

C. Division by 0 is undefined.

D. The zero product property was used.

Answer _____

Competency 005—The teacher understands and uses linear functions to model and solve problems.

5. The value of a car that Nakeshia purchased was $11,300. Assuming that the value of the car decreases by $900 every year, which of the following functions correctly models the value of the car, *f*, after *x* years?

A. $f(x) = 11{,}300x + 900$

B. $f(x) = 11{,}300x - 900$

C. $f(x) = 11{,}300 + 900x$

D. $f(x) = 11{,}300 - 900x$

Answer _____

Competency 006—The teacher understands and uses nonlinear functions and relations to model and solve problems.

6. The initial population of a bacteria culture is 300. After 2 hours, the population doubles to 600, and after 4 hours, the population doubles again to 1200. Which of the following functions best models the population, *P*, of the bacteria as a function of time, *t*, in hours?

A. $P(t) = 300(2t)$

B. $P(t) = 300(2 + t)$

C. $P(t) = 300t^2$

D. $P(t) = 300(2)^{\frac{t}{2}}$

Answer _____

Competency 007—The teacher uses and understands the conceptual foundations of calculus related to topics in middle school mathematics.

7. Ship A and ship B start sailing from the same harbor at the same time. Ship A is moving due north at a constant rate and has sailed a distance of $x(t)$ where t is the number of hours since the ships began moving. Ship B is moving due east at a constant rate and has sailed a distance of $y(t)$. The distance between the ships at time t is given by the function $f(t) = \sqrt{x(t)^2 + y(t)^2}$. Which of the following can be used to find the instantaneous rate of change of the distance between the two ships at time t?

A. $f'(t)$

B. $f''(t)$

C. $\frac{f(t) - f(0)}{t}$

D. $\int f(t)dt$

Answer _____

Domain III—Geometry and Measurement

Competency 008—The teacher understands measurement as a process.

Use the formula below to answer the question that follows.

$$C = \frac{5}{9}(F - 32)$$

8. The formula above shows the relationship between *C* degrees Celsius and *F* degrees Fahrenheit. In an experiment, a certain chemical is to be kept in a temperature interval between 10°C and 45°C. What is this temperature interval in degrees Fahrenheit?

A. Between 8.4°F and 15.4°F

B. Between 10°F and 45°F

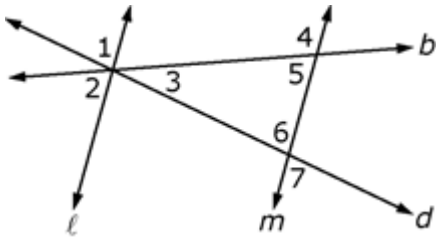
C. Between 50°F and 113°F

D. Between 75.6°F and 138.6°F

Answer _____

Competency 009—The teacher understands the geometric relationships and axiomatic structure of Euclidean geometry.

Use the figure below to answer the question that follows.



9. In the figure above lines *l* and *m* are parallel, and the triangle containing ∠3, ∠5, and ∠6 is **not** isosceles. Which of the following angles are congruent to ∠6?

Select all that apply.

A. ∠1

B. ∠2

C. ∠3

D. ∠4

E. ∠5

F. ∠7

Answer _____

Competency 010—The teacher analyzes the properties of two- and three-dimensional figures.

10. Equilateral triangle *ABC* has sides of length 2. Equilateral triangle *XYZ* has sides of length 8. The area of triangle *XYZ* is how many times the area of triangle *ABC*?

A. 4

B. 8

C. 16

D. 64

Answer _____

Competency 011—The teacher understands transformational geometry and relates algebra to geometry and trigonometry using the Cartesian coordinate system.

11. An equilateral triangle has a perimeter of 24 centimeters. If the triangle is dilated by a factor of 1.5, what is the perimeter of the new triangle?

A. 12 centimeters

B. 16 centimeters

C. 36 centimeters

D. 108 centimeters

Answer _____

12. Which of the following represents the equation of a line in the *xy*-plane that is the reflection of the line $y = 4x - 1$ about the *y*-axis?

A. $y = 4x - 1$

B. $y = \frac{1}{4}x - 1$

C. $y = -4x - 1$

D. $y = -\frac{1}{4}x - 1$

Answer _____

Domain IV—Probability and Statistics

Competency 012—The teacher understands how to use graphical and numerical techniques to explore data, characterize patterns and describe departures from patterns.

Use the list below to answer the question that follows.

> List *L*: 64, 81, 96, 77, 93, 81, 71, 69

13. Which of the following statements is true about the numbers in list *L*?

A. The mean of the numbers in list *L* is equal to the mode.

B. The mean of the numbers in list *L* is greater than the mode.

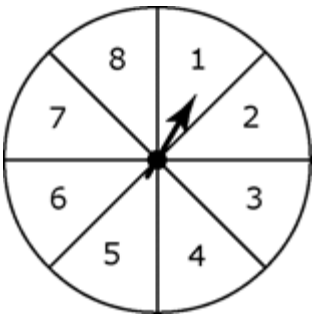
C. The mean of the numbers in list *L* is equal to the median.

D. The mean of the numbers in list *L* is greater than the median.

Answer _____

Competency 013—The teacher understands the theory of probability.

Use the figure below to answer the question that follows.



14. The spinner shown is in the shape of a circle divided into equal sections numbered 1, 2, 3, 4, 5, 6, 7, and 8. When the arrow on the spinner is spun, it is equally likely that the arrow will land in any of the 8 sections. If the arrow is spun three times, what is the probability that the arrow will land on 8 all three times?

A. $(\frac{1}{8})(\frac{1}{8})(\frac{1}{8})$

B. $(\frac{1}{8})(\frac{1}{7})(\frac{1}{6})$

C. $(\frac{7}{8})(\frac{7}{8})(\frac{7}{8})$

D. $(\frac{7}{8})(\frac{6}{7})(\frac{5}{6})$

Answer _____

Competency 014—The teacher understands the relationship among probability theory, sampling and statistical inference and how statistical inference is used in making and evaluating predictions.

15. A high school has a total of 1100 students. A student in a statistics class takes a random sample of 100 students and finds that 9 of the students sampled are taller than 6 feet. Based on this sample, which of the following is the best estimate of the number of students at the high school who are taller than 6 feet?

A. 1

B. 10

C. 100

D. 1000

Answer _____

Domain V—Mathematical Processes and Perspectives

Competency 015—The teacher understands mathematical reasoning and problem solving.

16. A mathematics teacher is conducting a lesson on mathematical modeling. The teacher asks the students to determine how long it would take to walk from Nome, Alaska, to Houston, Texas. By assigning this task, the teacher has asked the students to demonstrate

A. an understanding of proofs in mathematics.

B. an understanding of estimation and its appropriate uses.

C. an understanding of symbolic mathematics.

D. the use of manipulatives.

Answer _____

Competency 016—The teacher understands mathematical connections within and outside of mathematics and how to communicate mathematical ideas and concepts.

17. A teacher engages students in a discussion of prime and composite integers. The students are asked to discuss whether 1 is a prime number, whether negative integers can be called primes, and whether fractions can be called prime or composite numbers. The teacher most likely designed this activity to address which of the following objectives?

A. Demonstrating the use of multiple representations of mathematical concepts

B. Demonstrating the use of formative and summative assessments

C. Demonstrating how abstract mathematical concepts relate to a variety of careers and professions

D. Demonstrating the use of mathematical terminology as a precise means of expressing mathematical ideas

Answer _____

Domain VI—Mathematical Learning, Instruction and Assessment

Competency 017—The teacher understands how children learn and develop mathematical skills, procedures and concepts.

18. Students are using computer software that allows them to create compass and straightedge constructions on the computer. Which of the following is the best activity for the teacher to ask students to do using the software?

A. Finding the zeros of a polynomial

B. Finding the maximum and minimum values of differentiable functions

C. Finding the circle in the plane that passes through three noncollinear points

D. Finding the list of prime numbers greater than 1000 but less than 2000

Answer _____

Competency 018—The teacher understands how to plan, organize and implement instruction using knowledge of students, subject matter and statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) to teach all students to use mathematics.

19. An eighth-grade mathematics teacher notices that students are having difficulty understanding the difference between the mean and the median of a set of data. The teacher asks the students to find 10 different data sets from newspapers and Web sites. For each data set the students should calculate the mean and the median and write a paragraph explaining the data set and the significance of the mean and the median. With this activity the teacher demonstrates an understanding of the

A. procedures for developing instruction that establishes transitions between concrete, symbolic and abstract representations of mathematical knowledge.

B. use of visual media, such as graphs, tables, diagrams and animations, to communicate mathematical information.

C. structural properties common to the mathematical disciplines.

D. implications of current trends and research in mathematics and mathematics education.

Answer _____

Competency 019—The teacher understands assessment and uses a variety of formal and informal assessment techniques to monitor and guide mathematics instruction and to evaluate student progress.

20. Ms. Hernandez gives her mathematics class a 15-minute multiple-choice quiz each Friday covering the material that had been discussed in class that week. The options in the multiple-choice questions include the correct answer as well as incorrect answers that are common misconceptions and common arithmetic mistakes.

Ms. Hernandez counts the number of correct answers and determines the number of students making the same mistakes or making the same misconceptions. By using this testing strategy, Ms. Hernandez is demonstrating how to

A. use mathematics to model and solve problems in other disciplines.

B. develop a variety of assessments and scoring procedures that assess mathematical understanding and inform instruction strategies.

C. use manipulatives and technological tools.

D. provide instruction along a continuum from concrete to abstract.

Answer _____

Domain VII—Scientific Inquiry and Processes

Competency 021—The teacher understands the correct use of tools, materials, equipment and technologies.

21. Which of the following units is used to represent density?

A. g

B. mL

C. g/mL

D. cm^3

Answer _____

Competency 022—The teacher understands the process of scientific inquiry and the history and nature of science.

22. Which of the following is the next step after students develop a hypothesis?

A. Design an experiment

B. Develop a theory

C. Analyze experimental data

D. Draw conclusions

Answer _____

Competency 023—The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

23. Some power plants burn natural gas to produce electricity. Which THREE of the following are alternative sources of power that can be used to reduce the amount of carbon dioxide produced and emitted into the atmosphere during electrical power production?

A. Coal power plant

B. Hydropower plant

C. Wind turbines

D. Nuclear power plant

Answer _____

Competency 024—The teacher knows and understands the unifying concepts and processes that are common to all sciences.

24. Which of the following illustrates the concept of equilibrium?

A. Leaves burning

B. A ball rolling down a hill

C. Heat entering into an open refrigerator

D. A saturated sugar solution with some solid sugar present

Answer _____

Domain VIII—Physical Science

Competency 025—The teacher understands forces and motion and their relationships.

25. Of the following, which is a statement of Newton's first law of motion?

A. Kinetic energy is conserved during the elastic collision of two objects.

B. An object at rest will remain at rest unless acted on by an external net force.

C. An object's linear momentum is proportional to its mass and speed.

D. The acceleration of an object depends on the mass of the object and the net force acting on the object.

Answer _____

Competency 026—The teacher understands physical properties of and changes in matter.

26. Which of the following processes involves a pure solid changing directly into a gas?

A. Oxidation

B. Vaporization

C. Condensation

D. Sublimation

Answer _____

Competency 027—The teacher understands chemical properties of and changes in matter.

27. Which of the following is an ionic compound?

A. KCl

B. CO_2

C. CH_4

D. NH_3

Answer _____

Competency 028—The teacher understands energy and interactions between matter and energy.

28. Loudness is a characteristic of sound that is related to which of the following properties of a sound wave?

A. Frequency

B. Speed

C. Intensity

D. Wavelength

Answer _____

Domain IX—Life Science

Competency 030—The teacher understands the structure and function of living things.

29. Which of the following organisms have an exoskeleton and jointed appendages?

A. Frogs

B. Spiders

C. Alligators

D. Earthworms

Answer _____

Competency 031—The teacher understands reproduction and the mechanisms of heredity.

30. In a particular variety of plant, the allele for red flowers (*W*) is dominant and the allele for white flowers (*w*) is recessive. Which of the following is the genotype of plants with white flowers?

A. *WW*

B. *Ww*

C. *ww*

D. *w*

Answer _____

Competency 032—The teacher understands adaptations of organisms and the theory of evolution.

31. The wing of a bat and the arm of a gorilla are best described as examples of which of the following?

A. Primary structures

B. Vestigial structures

C. Homologous structures

D. Analogous structures

Answer _____

Competency 033—The teacher understands regulatory mechanisms and behavior.

32. Of the following, which is the best example of homeostasis?

A. In humans, the enzyme salivary amylase catalyzes the digestion of some starches in the mouth.

B. Marine birds use salt glands to remove excess salt from the seawater they drink to maintain a balance between salt and water.

C. Spores are produced internally in mushrooms and then are dispersed externally.

D. When a blood vessel is damaged, blood that leaks out undergoes processes that result in a blood clot that stops blood loss.

Answer _____

Competency 034—The teacher understands the relationships between organisms and the environment.

33. Which of the following is typically a secondary consumer in a food chain?

A. Tree

B. Deer

C. Squirrel

D. Fox

Answer _____

Domain X—Earth and Space Science

Competency 035—The teacher understands the structure and function of earth systems.

34. Of the following, which describes an atoll?

A. A sandy landform that extends out from a mainland coast

B. A sandy landform that is parallel to a mainland coast

C. A long narrow inlet with steep sides created by glacial erosion

D. A ring-shaped coral reef that partially or completely encircles a lagoon

Answer _____

Competency 036—The teacher understands cycles in earth systems.

35. Which of the following is a metamorphic rock?

A. Slate

B. Granite

C. Basalt

D. Sandstone

Answer _____

Competency 037—The teacher understands the role of energy in weather and climate.

36. If the relative humidity is 95% on a day when the air temperature is 85.0°F, which of the following is most likely closest to the dew point?

A. 95.0°F

B. 85.0°F

C. 84.0°F

D. 45.0°F

Answer _____

Competency 038—The teacher understands the characteristics of the solar system and the universe.

37. Which of the following is a late stage in the life cycle of most low-mass stars?

A. Black hole

B. White dwarf

C. Red supergiant

D. Supernova

Answer _____

Competency 039—The teacher understands the history of the Earth system.

38. The half-life of carbon-14 is 5,730 years. How much of the original quantity of carbon-14 in a sample remains after 22,920 years?

A. One-half

B. One-quarter

C. One-eighth

D. One-sixteenth

Answer _____

Domain XI—Science Learning, Instruction and Assessment

Competency 040—The teacher has theoretical and practical knowledge about teaching science and about how students learn science.

39. Which of the following student statements is an example of a student misconception about science?

A. Positively charged ions have lost electrons and have an imbalance between positive and negative charges.

B. The boiling point is the highest possible temperature of a substance.

C. Even though an object is not moving, it has energy.

D. The Moon orbits Earth in approximately 27.32 days.

Answer _____

Competency 042—The teacher knows the varied and appropriate assessments and assessment practices to monitor science learning in laboratory, field and classroom settings.

40. A short written multiple-choice quiz given after the first section of a unit on chemical and physical properties of matter is an example of

A. a formative assessment.

B. a performance assessment.

C. a summative assessment.

D. a self-assessment.

Answer _____

Section 4: Sample Selected-Response Answers and Rationales Mathematics/Science 4–8 (114)

This section presents some sample exam questions for you to review as part of your preparation for the exam. To demonstrate how each competency may be assessed, sample questions are accompanied by the competency that they measure. While studying, you may wish to read the competency before and after you consider each sample question. Please note that the competency statements do not appear on the actual exam.

For each sample exam question, there is a correct answer and a rationale for each answer option. The sample questions are included to illustrate the formats and types of questions you will see on the exam; however, your performance on the sample questions should not be viewed as a predictor of your performance on the actual exam.

The following reference materials will be available to you during the exam:

- Definitions and Formulas (see page 22)
- Periodic Table (see page 23)

Practice Questions

Domain I—Number Concepts

Competency 001—The teacher understands the structure of number systems, the development of a sense of quantity and the relationship between quantity and symbolic representations.

1. Which of the following numbers are greater than π?

Select all that apply.

A. 3

B. 3.14

C. $\frac{22}{7}$

D. 3.142

Answer

Options C and D are correct because the approximation of π to five decimal places is 3.14159, and therefore $\frac{22}{7} = 3.\overline{142857} > \pi$ and $3.142 > \pi$. **Options A and B are incorrect** because $3 < \pi$ and $3.14 < \pi$.

Competency 002—The teacher understands number operations and computational algorithms.

Use the equation below to answer the question that follows.

> $x^2 + x + 2 = 0$

2. Which of the following statements is true about the equation above?

A. The equation has no solutions.

B. The equation has two real solutions.

C. The equation has two complex solutions.

D. The equation has one real solution and one complex solution.

Answer

Option C is correct because the solutions of the equation can be found using the quadratic formula which gives two complex solutions.

$$x = \frac{-1 \pm \sqrt{1^2 - 4(1)(2)}}{2(1)}$$
$$= \frac{-1 \pm \sqrt{-7}}{2}$$
$$= -\frac{1}{2} \pm \frac{\sqrt{7}}{2}i$$

Option A is incorrect because the equation has two complex solutions. **Options B and D are incorrect** because the equation does not have any real solution.

Competency 003—The teacher understands ideas of number theory and uses numbers to model and solve problems within and outside of mathematics.

3. Which of the following is the prime factorization of 900?

A. (4)(9)(25)

B. (16)(5)(11)

C. $(2^3)(3^3)(5^3)$

D. $(2^2)(3^2)(5^2)$

Answer

Option D is correct because $(2^2)(3^2)(5^2)$ is a factorization of 900 where each of the factors is a prime number.
Option A is incorrect because although (4)(9)(25) is a factorization of 900, the factors are not prime numbers.
Options B and C are incorrect because they are not factorizations of 900.

Domain II—Patterns and Algebra

Competency 004—The teacher understands and uses mathematical reasoning to identify, extend and analyze patterns and understands the relationships among variables, expressions, equations, inequalities, relations and functions.

> **Use the student work below to answer the question that follows**.

Solve for x: $x^2 - 8x = -15$

Step 1.	$x^2 - 8x + 15 = -15 + 15$
Step 2.	$x^2 - 8x + 15 = 0$
Step 3.	$(x - 3)(x - 5) = 0$
Step 4.	$x - 3 = 0$ or $x - 5 = 0$
Step 5.	$x = 3$ or $x = 5$

4. Which of the following is the justification for step 4 in the student work above?

A. 0 is the identity element for addition.

B. $(a)(0) = 0$ for all real numbers a.

C. Division by 0 is undefined.

D. The zero product property was used.

Answer

Option D is correct because the zero product property states that $ab = 0$ implies that $a = 0$ or $b = 0$. **Options A, B and C are incorrect** because although the properties of 0 stated are correct, they are not applied in step 4.

Competency 005—The teacher understands and uses linear functions to model and solve problems.

5. The value of a car that Nakeshia purchased was $11,300. Assuming that the value of the car decreases by $900 every year, which of the following functions correctly models the value of the car, f, after x years?

A. $f(x) = 11{,}300x + 900$

B. $f(x) = 11{,}300x - 900$

C. $f(x) = 11{,}300 + 900x$

D. $f(x) = 11{,}300 - 900x$

Answer

Option D is correct because the value of the car when purchased corresponds to $x = 0$, and the value of the car decreases by $900 for every unit increase of x. **Options A and B are incorrect** because the value of the functions increase by 11,300 for every unit increase of x. **Option C is incorrect** because the value of this function increases by 900 for every unit increase of x.

Competency 006—The teacher understands and uses nonlinear functions and relations to model and solve problems.

6. The initial population of a bacteria culture is 300. After 2 hours, the population doubles to 600, and after 4 hours, the population doubles again to 1200. Which of the following functions best models the population, *P*, of the bacteria as a function of time, *t*, in hours?

A. $P(t) = 300(2t)$

B. $P(t) = 300(2 + t)$

C. $P(t) = 300t^2$

D. $P(t) = 300(2)^{\frac{t}{2}}$

Answer

Option D is correct because the population can be modeled by an exponential growth function $P(t) = (A)\left(2^{\frac{t}{h}}\right)$, where *A* is the initial population, *t* is the number of hours after the initial time, *h* is the time, in hours, it takes the population to double, and *P*(*t*) is the population after *t* hours. Using this general exponential model leads to $P(t) = 300(2)^{\frac{t}{2}}$. **Options A, B and C are incorrect** because they do not model exponential growth.

Competency 007—The teacher uses and understands the conceptual foundations of calculus related to topics in middle school mathematics.

7. Ship A and ship B start sailing from the same harbor at the same time. Ship A is moving due north at a constant rate and has sailed a distance of *x*(*t*) where *t* is the number of hours since the ships began moving. Ship B is moving due east at a constant rate and has sailed a distance of *y*(*t*). The distance between the ships at time *t* is given by the function $f(t) = \sqrt{x(t)^2 + y(t)^2}$. Which of the following can be used to find the instantaneous rate of change of the distance between the two ships at time *t*?

A. $f'(t)$

B. $f''(t)$

C. $\frac{f(t) - f(0)}{t}$

D. $\int f(t)dt$

Answer

Option A is correct because the derivative of a function at a point is the instantaneous rate of change of the function at that point. **Option B is incorrect** because the second derivative gives information about the concavity of the graph of a function. **Option C is incorrect** because $\frac{f(t) - f(0)}{t}$ is the slope of the line between (0,0) and (*t*, *f*(*t*)). **Option D is incorrect** because $\int f(t)dt$ is the indefinite integral of the function *f*.

Domain III—Geometry and Measurement

Competency 008—The teacher understands measurement as a process.

Use the formula below to answer the question that follows.

$$C = \frac{5}{9}(F - 32)$$

8. The formula above shows the relationship between C degrees Celsius and F degrees Fahrenheit. In an experiment, a certain chemical is to be kept in a temperature interval between 10°C and 45°C. What is this temperature interval in degrees Fahrenheit?

A. Between 8.4°F and 15.4°F

B. Between 10°F and 45°F

C. Between 50°F and 113°F

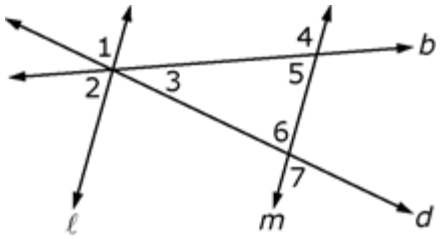
D. Between 75.6°F and 138.6°F

Answer

Option C is correct because the inequality $10 \le C \le 45$ is equivalent to $10 \le \frac{5}{9}(F - 32) \le 45$, which is equivalent to $\frac{9}{5}(10) + 32 \le F \le \frac{9}{5}(45) + 32$, or $50 \le F \le 113$. **Option A is incorrect** because it results from incorrectly solving the inequality $10 \le \frac{5}{9}(F - 32) \le 45$ by first adding 32 to all terms and then multiplying all the terms by $\frac{1}{5}$. **Option B is incorrect** because no calculations were performed; only the units were changed. **Option D is incorrect** because it results from incorrectly solving the inequality $10 \le \frac{5}{9}(F - 32) \le 45$ by first adding 32 to all terms and then multiplying all the terms by $\frac{9}{5}$.

Competency 009—The teacher understands the geometric relationships and axiomatic structure of Euclidean geometry.

Use the figure below to answer the question that follows.



9. In the figure above lines *l* and *m* are parallel, and the triangle containing ∠3, ∠5, and ∠6 is **not** isosceles. Which of the following angles are congruent to ∠6?

Select <u>all</u> that apply.

A. ∠1

B. ∠2

C. ∠3

D. ∠4

E. ∠5

F. ∠7

Answer

Options A and F are correct. Lines *l* and *m* are parallel, so ∠6 ≅ ∠1 because they are corresponding angles. Because they are vertical angles, ∠6 ≅ ∠7. **Options C and E are incorrect** because if either ∠3 or ∠5 was congruent to ∠6, then their opposite sides would be equal, and the triangle would be isosceles, a contradiction. **Option B is incorrect** because ∠2 and ∠5 are corresponding angles and therefore are congruent, and ∠5 has been established as not being congruent to ∠6. **Option D is incorrect** because as an exterior angle of the triangle, ∠4 has a measure equal to the sum of ∠3 and ∠6 and therefore must be greater than either one of them individually.

Competency 010—The teacher analyzes the properties of two- and three-dimensional figures.

10. Equilateral triangle *ABC* has sides of length 2. Equilateral triangle *XYZ* has sides of length 8. The area of triangle *XYZ* is how many times the area of triangle *ABC*?

A. 4

B. 8

C. 16

D. 64

Answer

Option C is correct because all equilateral triangles are similar. For similar triangles, there is a similar ratio of the sides and a similar ratio for the areas that is the square of the similar ratio of the sides. Since the ratio of the sides is 4:1, the ratio of the areas is 16:1, or 16 times greater. **Option A is incorrect** because the ratio of the sides is not equal to the ratio of the areas. **Option B is incorrect** because the similar ratio of the areas is not two times the ratio of the sides. **Option D is incorrect** because the ratio is 16:1, not 64:1.

Competency 011—The teacher understands transformational geometry and relates algebra to geometry and trigonometry using the Cartesian coordinate system.

11. An equilateral triangle has a perimeter of 24 centimeters. If the triangle is dilated by a factor of 1.5, what is the perimeter of the new triangle?

A. 12 centimeters

B. 16 centimeters

C. 36 centimeters

D. 108 centimeters

Answer

Option C is correct because the length of each side of the new triangle is 1.5 times the length of the corresponding side of the original triangle. The perimeter of the original equilateral triangle is 24 centimeters, so the length of each side is 24 ÷ 3 = 8 centimeters. The length of each side of the new triangle is 8 × 1.5 = 12 centimeters, and the perimeter of the new triangle is 12 + 12 + 12 = 36. **Option A is incorrect** because the length of each side of the new triangle is 12. **Option B is incorrect** because 16 = 24 ÷ 1.5 would be the perimeter of the new triangle if the equilateral triangle were dilated by a factor of (1 ÷ 1.5). **Option D is incorrect** because 108 = 1.5(24 + 24 + 24) would be the perimeter of the new triangle if each side of the equilateral triangle were length 24.

12. Which of the following represents the equation of a line in the *xy*-plane that is the reflection of the line $y = 4x - 1$ about the *y*-axis?

A. $y = 4x - 1$

B. $y = \frac{1}{4}x - 1$

C. $y = -4x - 1$

D. $y = -\frac{1}{4}x - 1$

Answer

Option C is correct because if $f(x)$ is reflected about the *y*-axis, then the new function $g(x)$ is generated by finding $f(-x)$. Following this condition, $y = 4(-x) - 1 = -4x - 1$. **Option A is incorrect** because it is the same function and is not reflected. **Option B is incorrect** because $\frac{1}{4}$ is the reciprocal of the slope, not the reflection. **Option D is incorrect** because $-\frac{1}{4}$ is the slope of a line perpendicular to *f* and is not necessarily a reflection.

Domain IV—Probability and Statistics

Competency 012—The teacher understands how to use graphical and numerical techniques to explore data, characterize patterns and describe departures from patterns.

Use the list below to answer the question that follows.

> List *L*: 64, 81, 96, 77, 93, 81, 71, 69

13. Which of the following statements is true about the numbers in list *L*?

A. The mean of the numbers in list *L* is equal to the mode.

B. The mean of the numbers in list *L* is greater than the mode.

C. The mean of the numbers in list *L* is equal to the median.

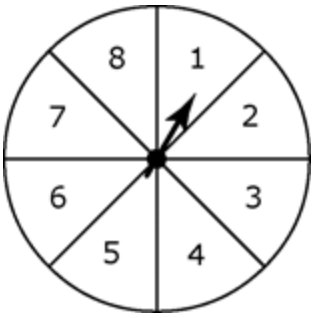
D. The mean of the numbers in list *L* is greater than the median.

Answer

Option C is correct. The median is calculated by ordering the values in list *L* from least to greatest and then selecting the middle value from the list. Since the number of values in the list is even, the two middle numbers are 77 and 81. The median is $\frac{77 + 81}{2}$ = 79. The mode is the number that appears in list *L* most frequently, which is 81. The mean is calculated by adding all the values in the list and then dividing by the total number of values, which is 79. Therefore, in list *L*, the median has the same value as the mean. **Option A is incorrect** because the mean of 79 in list *L* does not equal the mode of 81 in list *L*. **Option B is incorrect** because the mean of 79 in list *L* is not greater than the mode of 81 in list *L*. **Option D is incorrect** because the mean of 79 in list *L* is equal to the median of 79 in list *L*.

Competency 013—The teacher understands the theory of probability.

Use the figure below to answer the question that follows.



14. The spinner shown is in the shape of a circle divided into equal sections numbered 1, 2, 3, 4, 5, 6, 7, and 8. When the arrow on the spinner is spun, it is equally likely that the arrow will land in any of the 8 sections. If the arrow is spun three times, what is the probability that the arrow will land on 8 all three times?

A. $(\frac{1}{8})(\frac{1}{8})(\frac{1}{8})$

B. $(\frac{1}{8})(\frac{1}{7})(\frac{1}{6})$

C. $(\frac{7}{8})(\frac{7}{8})(\frac{7}{8})$

D. $(\frac{7}{8})(\frac{6}{7})(\frac{5}{6})$

Answer

Option A is correct. The probability of landing on 8 on a single spin is $\frac{1}{8}$, and because each spin is an independent event, the probability of landing on 8 on all three spins is the product $(\frac{1}{8})(\frac{1}{8})(\frac{1}{8})$. **Options B, C and D are incorrect** because the events are independent.

Competency 014—The teacher understands the relationship among probability theory, sampling and statistical inference and how statistical inference is used in making and evaluating predictions.

15. A high school has a total of 1100 students. A student in a statistics class takes a random sample of 100 students and finds that 9 of the students sampled are taller than 6 feet. Based on this sample, which of the following is the best estimate of the number of students at the high school who are taller than 6 feet?

A. 1

B. 10

C. 100

D. 1000

Answer

Option C is correct because $\frac{9}{100}$, or 9%, of the sample is taller than 6 feet; 9% of 1100 is 99, and therefore, 100 is the best estimate among the options provided. **Options A, B and D are incorrect** because they are wrong order of magnitude.

Domain V—Mathematical Processes and Perspectives

Competency 015—The teacher understands mathematical reasoning and problem solving.

16. A mathematics teacher is conducting a lesson on mathematical modeling. The teacher asks the students to determine how long it would take to walk from Nome, Alaska, to Houston, Texas. By assigning this task, the teacher has asked the students to demonstrate

A. an understanding of proofs in mathematics.

B. an understanding of estimation and its appropriate uses.

C. an understanding of symbolic mathematics.

D. the use of manipulatives.

Answer

Option B is correct because to determine how long it would take a student to walk from Nome, Alaska, to Houston, Texas, the students should make a variety of estimates and apply the estimates to a mathematical model. **Option A is incorrect** because the activity is not designed to use mathematical proofs. **Option C is**

incorrect because the use of estimation is more important in this activity than symbolic mathematics. **Option D is incorrect** because manipulatives are not needed for the task.

Competency 016—The teacher understands mathematical connections within and outside of mathematics and how to communicate mathematical ideas and concepts.

17. A teacher engages students in a discussion of prime and composite integers. The students are asked to discuss whether 1 is a prime number, whether negative integers can be called primes, and whether fractions can be called prime or composite numbers. The teacher most likely designed this activity to address which of the following objectives?

A. Demonstrating the use of multiple representations of mathematical concepts

B. Demonstrating the use of formative and summative assessments

C. Demonstrating how abstract mathematical concepts relate to a variety of careers and professions

D. Demonstrating the use of mathematical terminology as a precise means of expressing mathematical ideas

Answer

Option D is correct because the precise definition of prime numbers is critical to applications and uses of prime numbers. **Option A is incorrect** because multiple representations of mathematical concepts are not discussed. **Option B is incorrect** because no assessments were discussed or given with this activity. **Option C is incorrect** because careers and professions are not discussed.

Domain VI—Mathematical Learning, Instruction and Assessment

Competency 017—The teacher understands how children learn and develop mathematical skills, procedures and concepts.

18. Students are using computer software that allows them to create compass and straightedge constructions on the computer. Which of the following is the best activity for the teacher to ask students to do using the software?

A. Finding the zeros of a polynomial

B. Finding the maximum and minimum values of differentiable functions

C. Finding the circle in the plane that passes through three noncollinear points

D. Finding the list of prime numbers greater than 1000 but less than 2000

Answer

Option C is correct because the circle in the plane that passes through three noncollinear points can be found with compass and straightedge constructions. **Options A and B are incorrect** because these applications can be done with graphing calculators or graphing software. **Option D is incorrect** because the determination of prime numbers cannot be done with compass and straightedge constructions.

Competency 018—The teacher understands how to plan, organize and implement instruction using knowledge of students, subject matter and statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) to teach all students to use mathematics.

19. An eighth-grade mathematics teacher notices that students are having difficulty understanding the difference between the mean and the median of a set of data. The teacher asks the students to find 10 different data sets from newspapers and Web sites. For each data set the students should calculate the mean and the median and write a paragraph explaining the data set and the significance of the mean and the median. With this activity the teacher demonstrates an understanding of the

A. procedures for developing instruction that establishes transitions between concrete, symbolic and abstract representations of mathematical knowledge.

B. use of visual media, such as graphs, tables, diagrams and animations, to communicate mathematical information.

C. structural properties common to the mathematical disciplines.

D. implications of current trends and research in mathematics and mathematics education.

Answer

Option A is correct because the activity asks the students to relate concrete data with abstract concepts. **Option B is incorrect** because students are not asked to use visual media. **Option C is incorrect** because the activity references statistics and is not about connections to other mathematical disciplines. **Option D is incorrect** because the activity does not reference current trends in mathematics education.

Competency 019—The teacher understands assessment and uses a variety of formal and informal assessment techniques to monitor and guide mathematics instruction and to evaluate student progress.

20. Ms. Hernandez gives her mathematics class a 15-minute multiple-choice quiz each Friday covering the material that had been discussed in class that week. The options in the multiple-choice questions include the correct answer as well as incorrect answers that are common misconceptions and common arithmetic mistakes.

Ms. Hernandez counts the number of correct answers and determines the number of students making the same mistakes or making the same misconceptions. By using this testing strategy, Ms. Hernandez is demonstrating how to

A. use mathematics to model and solve problems in other disciplines.

B. develop a variety of assessments and scoring procedures that assess mathematical understanding and inform instruction strategies.

C. use manipulatives and technological tools.

D. provide instruction along a continuum from concrete to abstract.

Answer

Option B is correct because by tracking common errors and misconceptions, the teacher can assess the level of mathematical understanding and address those errors through instruction. **Option A is incorrect** because the testing strategy may be used for any mathematical content, not just solving problems in other disciplines. **Option C is incorrect** because manipulatives may or may not be used in each weekly assessment. **Option D is incorrect** because the primary goal of the testing strategy is to identify errors and misconceptions.

Domain VII—Scientific Inquiry and Processes

Competency 021—The teacher understands the correct use of tools, materials, equipment and technologies.

21. Which of the following units is used to represent density?

A. g

B. mL

C. g/mL

D. cm^3

Answer

Option C is correct because density is a measure of mass per unit volume and can be represented by g/mL, which is equivalent to g/cm^3. **Options A, B and D are incorrect** because g is a unit of mass, and mL and cm^3 are each a unit of volume.

Competency 022—The teacher understands the process of scientific inquiry and the history and nature of science.

22. Which of the following is the next step after students develop a hypothesis?

A. Design an experiment

B. Develop a theory

C. Analyze experimental data

D. Draw conclusions

Answer

Option A is correct because after a hypothesis is developed, an experiment should be designed to test the hypothesis. **Option B is incorrect** because a theory is not developed until various experiments have been done that result in data that support a hypothesis. **Options C and D are incorrect** because analyzing data and drawing conclusions are done after the experiment is conducted.

Competency 023—The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

23. Some power plants burn natural gas to produce electricity. Which THREE of the following are alternative sources of power that can be used to reduce the amount of carbon dioxide produced and emitted into the atmosphere during electrical power production?

A. Coal power plant

B. Hydropower plant

C. Wind turbines

D. Nuclear power plant

Answer

Options B, C and D are correct because hydropower plants, wind turbines, and nuclear power plants do not directly produce and emit carbon dioxide during their operation and if they are used as an alternative to combustion-powered plants, will result in a reduction in the production and emission of carbon dioxide. **Option A is incorrect** because coal power plants produce carbon dioxide as a by-product of combustion.

Competency 024—The teacher knows and understands the unifying concepts and processes that are common to all sciences.

24. Which of the following illustrates the concept of equilibrium?

A. Leaves burning

B. A ball rolling down a hill

C. Heat entering into an open refrigerator

D. A saturated sugar solution with some solid sugar present

Answer

Option D is correct because in the saturated sugar solution the rate of sugar crystallizing is equal to the rate of sugar dissolving, thus achieving a balance. **Option A is incorrect** because as leaves burn, carbon combines with oxygen to form carbon dioxide that escapes into the atmosphere along with smoke particles. **Option B is incorrect** because a ball rolling down hill is not at equilibrium. **Option C is incorrect** because heat entering an open refrigerator is not an example of equilibrium.

Domain VIII—Physical Science

Competency 025—The teacher understands forces and motion and their relationships.

25. Of the following, which is a statement of Newton's first law of motion?

A. Kinetic energy is conserved during the elastic collision of two objects.

B. An object at rest will remain at rest unless acted on by an external net force.

C. An object's linear momentum is proportional to its mass and speed.

D. The acceleration of an object depends on the mass of the object and the net force acting on the object.

Answer

Option B is correct because a statement of Newton's first law of motion is that an object at rest will remain at rest unless acted on by an external net force. **Option A is incorrect** because although there is conservation of kinetic energy in an elastic collision, it is not a statement of Newton's first law of motion. **Option C is incorrect** because while linear momentum is the product of the mass and velocity of an object, it is not a statement of Newton's first law of motion. **Option D is incorrect** because it is a statement of Newton's second law.

Competency 026—The teacher understands physical properties of and changes in matter.

26. Which of the following processes involves a pure solid changing directly into a gas?

A. Oxidation

B. Vaporization

C. Condensation

D. Sublimation

Answer

Option D is correct because in the process of sublimation, a pure solid undergoes a phase transition to a gas. **Option A is incorrect** because oxidation is not a phase transition but is a chemical process. **Option B is incorrect** because vaporization is the phase transition in which a liquid becomes a gas. **Option C is incorrect** because condensation is the phase transition in which gas becomes a liquid.

Competency 027—The teacher understands chemical properties of and changes in matter.

27. Which of the following is an ionic compound?

A. KCl

B. CO_2

C. CH_4

D. NH_3

Answer

Option A is correct because the compound KCl has ionic bonding between metallic K^+ ions and nonmetallic Cl^- ions. **Options B, C and D are incorrect** because CO_2, CH_4, and NH_3 are covalently bonded molecules.

Competency 028—The teacher understands energy and interactions between matter and energy.

28. Loudness is a characteristic of sound that is related to which of the following properties of a sound wave?

A. Frequency

B. Speed

C. Intensity

D. Wavelength

Answer

Option C is correct because loudness is a characteristic of sound that is related to the intensity of the sound wave. **Options A, B and D are incorrect** because loudness is not related to the frequency, speed, or wavelength of the sound wave.

Domain IX—Life Science

Competency 030—The teacher understands the structure and function of living things.

29. Which of the following organisms have an exoskeleton and jointed appendages?

A. Frogs

B. Spiders

C. Alligators

D. Earthworms

Answer

Option B is correct because spiders are arthropods and have an exoskeleton and jointed appendages. **Options A, C and D are incorrect** because frogs and alligators are vertebrates that have an endoskeleton, and earthworms do not have a skeleton.

Competency 031—The teacher understands reproduction and the mechanisms of heredity.

30. In a particular variety of plant, the allele for red flowers (*W*) is dominant and the allele for white flowers (*w*) is recessive. Which of the following is the genotype of plants with white flowers?

A. *WW*

B. *Ww*

C. *ww*

D. *w*

Answer

Option C is correct because in complete dominance, only an individual with the genotype *ww* can have the phenotype of white flowers. **Options A and B are incorrect** because individuals with the genotype of *WW* or *Ww* will each have the phenotype of red flowers since *W* is the dominant allele. **Option D is incorrect** because each plant has two copies of the gene for flower color, so the genotype of white plants is *ww*.

Competency 032—The teacher understands adaptations of organisms and the theory of evolution.

31. The wing of a bat and the arm of a gorilla are best described as examples of which of the following?

A. Primary structures

B. Vestigial structures

C. Homologous structures

D. Analogous structures

Answer

Option C is correct because in evolutionary biology a bat wing is homologous to the arm of a gorilla. Homologous structures are adapted to different purposes as a result of descent with modification from a common ancestor. **Option A is incorrect** because the term "primary structures" is not a term associated with the relationship between a bat wing and the arm of a gorilla. **Option B is incorrect** because a vestigial structure has lost much or all of the functions it had in its ancestors, such as the eyes of a mole, which are covered by a layer of skin and no longer function. **Option D is incorrect** because analogous structures, such as the wings of a bat and the wings of a moth, have similar functions in two different organisms, but were not present in a common ancestor and evolved separately.

Competency 033—The teacher understands regulatory mechanisms and behavior.

32. Of the following, which is the best example of homeostasis?

A. In humans, the enzyme salivary amylase catalyzes the digestion of some starches in the mouth.

B. Marine birds use salt glands to remove excess salt from the seawater they drink to maintain a balance between salt and water.

C. Spores are produced internally in mushrooms and then are dispersed externally.

D. When a blood vessel is damaged, blood that leaks out undergoes processes that result in a blood clot that stops blood loss.

Answer

Option B is correct because homeostasis is a process that maintains the stability of internal conditions such as the maintenance of a balance between salt and water in a marine bird. **Option A is incorrect** because the chemical process involving salivary amylase is an example of a digestive process. **Option C is incorrect** because the production and dispersal of mushroom spores is an aspect of asexual reproduction. **Option D is incorrect** because the processes that result in blood clotting and a cessation of bleeding from a blood vessel is called hemostasis.

Competency 034—The teacher understands the relationships between organisms and the environment.

33. Which of the following is typically a secondary consumer in a food chain?

A. Tree

B. Deer

C. Squirrel

D. Fox

Answer

Option D is correct because a fox is a secondary consumer. Foxes eat animals such as squirrels that are primary consumers. **Option A is incorrect** because a tree is a primary producer. Primary producers are the organisms in an ecosystem that produce biomass from inorganic compounds. **Options B and C are incorrect** because deer and squirrels are primary consumers. Primary consumers eat primary producers.

Domain X—Earth and Space Science

Competency 035—The teacher understands the structure and function of earth systems.

34. Of the following, which describes an atoll?

A. A sandy landform that extends out from a mainland coast

B. A sandy landform that is parallel to a mainland coast

C. A long narrow inlet with steep sides created by glacial erosion

D. A ring-shaped coral reef that partially or completely encircles a lagoon

Answer

Option D is correct because an atoll is a ring-shaped coral reef that partially or completely encircles a lagoon. **Option A is incorrect** because a spit is a sandy landform that extends out from a mainland. **Option B is incorrect** because a barrier island is a sandy landform that is parallel to a coastline. **Option C is incorrect** because a fjord is a long narrow inlet with steep sides that was created by glacial activity.

Competency 036—The teacher understands cycles in earth systems.

35. Which of the following is a metamorphic rock?

A. Slate

B. Granite

C. Basalt

D. Sandstone

Answer

Option A is correct because slate is a metamorphic rock. **Options B and C are incorrect** because granite and basalt are igneous rocks. **Option D is incorrect** because sandstone is a sedimentary rock.

Competency 037—The teacher understands the role of energy in weather and climate.

36. If the relative humidity is 95% on a day when the air temperature is 85.0°F, which of the following is most likely closest to the dew point?

A. 95.0°F

B. 85.0°F

C. 84.0°F

D. 45.0°F

Answer

Option C is correct because the dew point of this particular air sample must be slightly below 85.0°F, so the correct answer is 84.0°F. Relative humidity is the amount of water vapor in the air compared to the amount required for saturation, expressed as a percentage. The maximum amount of water vapor that can be in the air decreases with decreasing temperature. The dew point is the temperature to which an air sample would have to be cooled for saturation to occur (dew is likely to form at this temperature). Therefore, when the relative humidity is very high (such as 95%) the air is almost saturated and the temperature would only have to decrease a small amount to reach saturation (100% relative humidity). **Option A is incorrect** because if the air temperature were 95.0°F, the relative humidity would be lower than 95% and well above the dew point. **Option B is incorrect** because the relative humidity is only 95% at 85.0°F, and relative humidity is 100% at the dew point. **Option D is incorrect** because the air would become saturated (100% relative humidity) and therefore dew would start to form long before the temperature dropped to 45.0°F.

Competency 038—The teacher understands the characteristics of the solar system and the universe.

37. Which of the following is a late stage in the life cycle of most low-mass stars?

A. Black hole

B. White dwarf

C. Red supergiant

D. Supernova

Answer

Option B is correct because for most stars of low mass, white dwarf is a late stage in the life cycle of the star. **Options A, C and D are incorrect** because they are stages in the life cycle of a star with a very large mass.

Competency 039—The teacher understands the history of the Earth system.

38. The half-life of carbon-14 is 5,730 years. How much of the original quantity of carbon-14 in a sample remains after 22,920 years?

A. One-half

B. One-quarter

C. One-eighth

D. One-sixteenth

Answer

Option D is correct because 22,920 years is four half-lives (four times 5,730 years), and after four half-lives elapse, one-sixteenth of the original quantity of carbon-14 remains. During each half-life, half of the remaining carbon-14 radioactively decays. So after four half-lives, the amount of carbon-14 in the sample is equal to (1/2)(1/2)(1/2)(1/2) times the original quantity of carbon-14 (one-sixteenth of the original quantity). **Options A, B, and C are incorrect** because they do not represent the correct quantity of carbon-14 remaining.

Domain XI—Science Learning, Instruction and Assessment

Competency 040—The teacher has theoretical and practical knowledge about teaching science and about how students learn science.

39. Which of the following student statements is an example of a student misconception about science?

A. Positively charged ions have lost electrons and have an imbalance between positive and negative charges.

B. The boiling point is the highest possible temperature of a substance.

C. Even though an object is not moving, it has energy.

D. The Moon orbits Earth in approximately 27.32 days.

Answer

Option B is correct because the student statement that the boiling point is the highest temperature possible of a substance is a misconception. After a substance undergoes a phase transition from liquid to gas at its boiling point, its temperature can increase above the boiling point if additional energy is absorbed by the substance. **Option A is incorrect** because the student statement that positively charged ions have lost electrons and have an imbalance between positive and negative charges is not a misconception, but is true based on current models of the atom. **Option C is incorrect** because the student statement that an object that is not moving still has energy is not a misconception; it is true. For example, an object that is not moving has potential energy based on its position relative to the ground due to gravitational forces, and it has potential energy based on the relative positions of the atoms in the material from which it is made. **Option D is incorrect** because the student statement that the Moon orbits Earth in approximately 27.32 days is not a misconception but is correct based on measurements of the Moon's motion around Earth relative to distant stars.

Competency 042—The teacher knows the varied and appropriate assessments and assessment practices to monitor science learning in laboratory, field and classroom settings.

40. A short written multiple-choice quiz given after the first section of a unit on chemical and physical properties of matter is an example of

A. a formative assessment.

B. a performance assessment.

C. a summative assessment.

D. a self-assessment.

Answer

Option A is correct because a formative assessment is used to monitor student progress and to inform both student and teacher of areas that need additional work. **Option B is incorrect** because a performance assessment involves assessing a student's performance of a task, such as a lab activity, to assess how well the student understands the concepts he or she has learned. **Option C is incorrect** because a summative assessment occurs after completion of learning and assesses what has been learned and how well it has been learned. **Option D is incorrect** because a self-assessment involves the student evaluating his or her own learning.