Texas Education Agency
TEXAS EDUCATOR CERTIFICATION
TExES/ExCET TExMaT TASC/TASC-ASL

TExES | Texas Examinations of Educator Standards

Preparation Manual

143 Physics/Mathematics 8–12

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Chapter 1

Introduction to the Physics/Mathematics 8–12 Test and Suggestions for Using This Test Preparation Manual

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OVERVIEW

The State Board for Educator Certification (SBEC) has approved Texas educator standards that delineate what the beginning educator should know and be able to do. These standards, which are based on the state-required curriculum for students — the Texas Essential Knowledge and Skills (TEKS) — form the basis for the Texas Examinations of Educator Standards® (TExES®) program. This initiative, administered by Texas Education Agency (TEA), will affect all areas of Texas education — from the more than 170 approved Texas Educator Preparation Programs (EPPs) to the more than 7,000 Texas school campuses. This standards-based system reflects SBEC's commitment to help align Texas education from kindergarten through college. SBEC and TEA's roles in this K–16 initiative will ensure that newly certified Texas educators have the essential knowledge and skills to teach the TEKS to the state's public school students.

This manual is designed to help examinees prepare for the TExES test in this field. Its purpose is to familiarize examinees with the competencies to be tested, test question formats and pertinent study resources. EPP staff may also find this information useful as they help examinees prepare for careers as Texas educators.

KEY FEATURES OF THE MANUAL

- *List of competencies that will be tested*
- *Strategies for answering multiple-choice questions*
- *Sample test questions and answer key*

If you have any questions after reading this preparation manual or you would like additional information about the TExES tests or the educator standards, please visit the TEA website at **www.tea.state.tx.us**.

USING THE TEST FRAMEWORK

The Texas Examinations of Educator Standards (TExES) tests measure the content knowledge required of an entry-level educator in a particular field in Texas public schools. This manual is designed to guide your preparation by helping you become familiar with the material to be covered on the test you are planning to take, identify areas where you feel you may be weak and increase your knowledge in those areas by helping you design a study plan.

When preparing for this test, you should focus on the competencies and descriptive statements, which delineate the content that is eligible for testing. A portion of the content is represented in the sample questions that are included in this manual. These test questions represent only a sampling of questions. Thus, your test preparation should focus on the competencies and descriptive statements and not simply on the sample questions.

ORGANIZATION OF THE TExES TEST FRAMEWORK

The test framework is based on the educator standards for this field.

The content covered by this test 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:

1. 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, and
2. the **descriptive statements**, which describe in greater detail the knowledge and skills eligible for testing.

The educator standards being assessed within each domain are listed for reference at the beginning of the test framework, which begins on page 12. These are followed by a complete set of the framework's competencies and descriptive statements.

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An example of a competency and its accompanying descriptive statements is provided below.

SAMPLE COMPETENCY

Physics/Mathematics 8–12

COMPETENCY 001
THE TEACHER UNDERSTANDS THE REAL NUMBER SYSTEM AND ITS STRUCTURE, OPERATIONS, ALGORITHMS AND REPRESENTATIONS.

SAMPLE DESCRIPTIVE STATEMENTS

The beginning teacher:

A. Understands the concepts of place value, number base and decimal representations of real numbers.

B. Understands the algebraic structure and properties of the real number system and its subsets (e.g., real numbers as a field, integers as an additive group).

C. Describes and analyzes properties of subsets of the real numbers (e.g., closure, identities).

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

E. Uses a variety of models (e.g., geometric, symbolic) to represent operations, algorithms and real numbers.

F. Uses real numbers to model and solve a variety of problems.

G. Uses deductive reasoning to simplify and justify algebraic processes.

H. Demonstrates how some problems that have no solution in the integer or rational number systems have solutions in the real number system.

STUDYING FOR THE TExES TEST

The following steps may be helpful in preparing for the TExES test.

1. Identify the information the test will cover by reading through the test competencies (see Chapter 3). Within each domain of this TExES test, each competency will receive approximately equal coverage.
2. Read each competency with its descriptive statements in order to get a more specific idea of the knowledge you will be required to demonstrate on the test. You may wish to use this review of the competencies to set priorities for your study time.
3. Review the "Preparation Resources" section of this manual (Appendix B) for possible resources to consult. Also, compile key materials from your preparation course work that are aligned with the competencies.
4. Study this manual for approaches to taking the TExES test.
5. When using resources, concentrate on the key skills and important abilities that are discussed in the competencies and descriptive statements.
6. Use the study plan sheet (Appendix A) to help you plan your study.

NOTE: This preparation manual is the only TExES test study material endorsed by Texas Education Agency (TEA) for this field. Other preparation materials may not accurately reflect the content of the test or the policies and procedures of the TExES program.

Chapter 2

Background Information on the TExES Testing Program

THE TExES TESTS FOR TEXAS TEACHERS

As required by the Texas Education Code §21.048, successful performance on educator certification examinations is required for the issuance of a Texas educator certificate. Each TExES test is a criterion-referenced examination designed to measure the knowledge and skills delineated in the corresponding TExES test framework. Each test framework is based on standards that were developed by Texas educators and other education stakeholders.

Each TExES test is designed to measure the requisite knowledge and skills that an entry-level educator in this field in Texas public schools must possess. The tests include both individual (stand-alone) test questions and questions that are arranged in clustered sets based on real-world situations faced by educators.

DEVELOPMENT OF THE NEW TExES TESTS

Committees of Texas educators and members of the community guide the development of the new TExES tests by participating in each stage of the test development process. These working committees are composed of Texas educators from public and charter schools, university and EPP faculty, education service center staff, representatives from professional educator organizations, content experts and members of the business community. The committees are balanced in terms of position, affiliation, years of experience, ethnicity, gender and geographical location. The committee membership is rotated during the development process so that numerous Texas stakeholders may be actively involved. The steps in the process to develop the TExES tests are described below.

1. **Develop Standards.** Committees are established to recommend what the beginning educator should know and be able to do. Using the Texas Essential Knowledge and Skills (TEKS) as the focal point, draft standards are prepared to define the knowledge and skills required of the beginning educator.

2. **Review Standards.** Committees review and revise the draft standards. The revised draft standards are then placed on the TEA website for public review and comment. These comments are used to prepare a final draft of the standards that will be presented to the SBEC Board for discussion, the State Board of Education (SBOE) for review and comment and the SBEC Board for approval. Standards not based specifically on the TEKS, such as those for librarians and counselors, are proposed as rule by the SBEC Board; sent to the SBOE for its 90-day review; and, if not rejected by the SBOE, adopted by the SBEC Board.

3. **Develop Test Frameworks.** Committees review and revise draft test frameworks that are based on the standards. These frameworks outline the specific competencies to be measured on the new TExES tests. Draft frameworks are not finalized until after the standards are approved and the job analysis/content validation survey (see #4) is complete.

4. **Conduct Job Analysis/Content Validation Surveys.** A representative sample of Texas educators who practice in or prepare individuals for each of the fields for which an educator certificate has been proposed are surveyed to determine the relative job importance of each competency outlined in the test framework for that content area. Frameworks are revised as needed following an analysis of the survey responses.

5. **Develop and Review New Test Questions.** The test contractor develops draft questions that are designed to measure the competencies described in the test framework. Committees review the newly developed test questions that have been written to reflect the competencies in the new test framework. Committee members scrutinize the draft questions for appropriateness of content and difficulty; clarity; match to the competencies; and potential ethnic, gender and regional bias.

6. **Conduct Pilot Test of New Test Questions.** All of the newly developed test questions that have been deemed acceptable by the question review committees are then administered to an appropriate sample of candidates for certification.

7. **Review Pilot Test Data.** Pilot test results are reviewed to ensure that the test questions are valid, reliable and free from bias.

8. **Administer TExES Tests.** New TExES tests are constructed to reflect the competencies, and the tests are administered to candidates for certification.

9. **Set Passing Standard.** A Standard Setting Committee convenes to review performance data from the initial administration of each new TExES test and to recommend a final passing standard for that test. The SBEC Board considers this recommendation as it establishes a passing score on the test.

TAKING THE TExES TEST AND RECEIVING SCORES

Please refer to the current TExES *Registration Bulletin* or the ETS TExES website at **www.texes.ets.org** for information on test dates, test centers, fees, registration procedures and program policies.

Your score report will be available to you in your testing account on the ETS TExES online registration system by 5 p.m. Central time on the score reporting date indicated in the *Registration Bulletin*. The report will indicate whether you have passed the test and will include:

- A total test scaled score. Scaled scores are reported to allow for the comparison of scores on the same content-area test taken on different test administration dates. The total scaled score is not the percentage of questions answered correctly and is not determined by averaging the number of questions answered correctly in each domain.
  - For all TExES tests, the score scale is 100–300 with a scaled score of 240 as the minimum passing score. This score represents the minimum level of competency required to be an entry-level educator in this field in Texas public schools.
- Your performance in the major content domains of the test and in the specific content competencies of the test.
  - This information may be useful in identifying strengths and weaknesses in your content preparation and can be used for further study or for preparing to retake the test. However, it is important to use caution when interpreting scores reported by domain and competency as these scores are typically based on a smaller number of items than the total score and therefore may not be as reliable as the total score.
- A link to information to help you understand the score scale and interpret your results.

A score report will not be available to you if you are absent or choose to cancel your score.

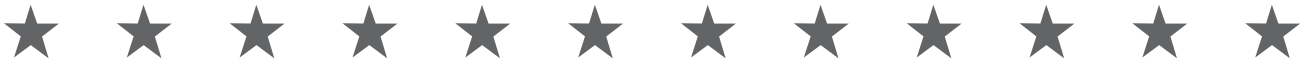
For more information about scores or to access scores online, go to **www.texes.ets.org**.

EDUCATOR STANDARDS

Complete, approved educator standards are posted on the TEA website at **www.tea.state.tx.us**.

Chapter 3

Study Topics



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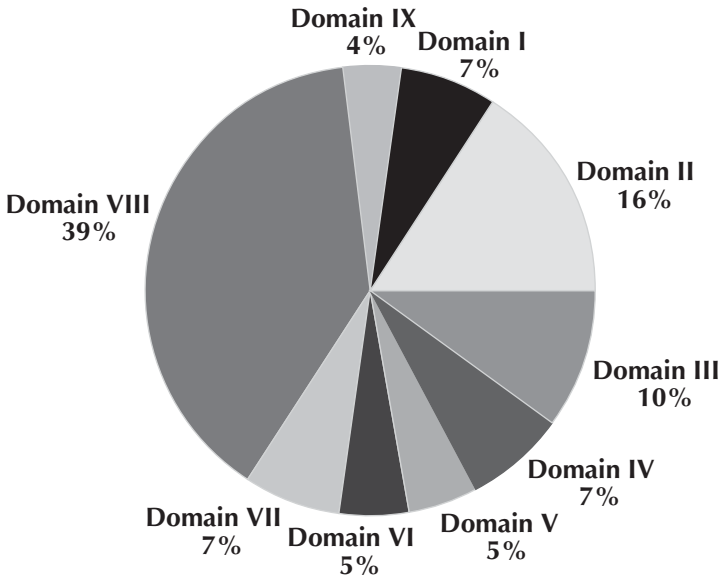
TEST FRAMEWORK FOR FIELD 143: PHYSICS/MATHEMATICS 8–12

THE DOMAINS



- **Domain I: Number Concepts**
  Standard Assessed: Mathematics I
- **Domain II: Patterns and Algebra**
  Standard Assessed: Mathematics II
- **Domain III: Geometry and Measurement**
  Standard Assessed: Mathematics III
- **Domain IV: Probability and Statistics**
  Standard Assessed: Mathematics IV
- **Domain V: Mathematical Processes and Perspectives**
  Standards Assessed: Mathematics V–VI
- **Domain VI: Mathematical Learning, Instruction and Assessment**
  Standards Assessed: Mathematics VII–VIII
- **Domain VII: Scientific Inquiry and Processes**
  Standards Assessed: Physical Science I–III, VI–VII, XI
- **Domain VIII: Physics**
  Standard Assessed: Physical Science VIII
- **Domain IX: Science Learning, Instruction and Assessment**
  Standards Assessed: Physical Science IV–V

TOTAL TEST BREAKDOWN

- Exam is offered as a paper-based test
- 120 Multiple-Choice Questions (100 Scored Questions*)

*The number of scored questions will not vary; however, the number of questions that are not scored may vary in the actual test. Your final scaled score will be based only on scored questions.

THE STANDARDS

DOMAIN I — NUMBER CONCEPTS (approximately 7% of the test)

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]) in order to prepare students to use mathematics.

DOMAIN II — PATTERNS AND ALGEBRA (approximately 16% of the test)

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 (Texas Essential Knowledge and Skills [TEKS]) in order to prepare students to use mathematics.

DOMAIN III — GEOMETRY AND MEASUREMENT (approximately 10% of the test)

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 (Texas Essential Knowledge and Skills [TEKS]) in order to prepare students to use mathematics.

DOMAIN IV — PROBABILITY AND STATISTICS (approximately 7% of the test)

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 (Texas Essential Knowledge and Skills [TEKS]) in order to prepare students to use mathematics.

DOMAIN V — MATHEMATICAL PROCESSES AND PERSPECTIVES (approximately 5% of the test)

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 interrelationship between society and mathematics, the structure of mathematics and the evolving nature of mathematics and mathematical knowledge.

DOMAIN VI — MATHEMATICAL LEARNING, INSTRUCTION AND ASSESSMENT (approximately 5% of the test)

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.

DOMAIN VII — SCIENTIFIC INQUIRY AND PROCESSES (approximately 7% of the test)

PHYSICAL 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.

PHYSICAL SCIENCE STANDARD II:

The science teacher understands the correct use of tools, materials, equipment and technologies.

PHYSICAL SCIENCE STANDARD III:

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

PHYSICAL SCIENCE STANDARD VI:

The science teacher understands the history and nature of science.

PHYSICAL 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.

PHYSICAL SCIENCE STANDARD XI:

The science teacher knows unifying concepts and processes that are common to all sciences.

DOMAIN VIII — PHYSICS (approximately 39% of the test)

PHYSICAL 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.

DOMAIN IX — SCIENCE LEARNING, INSTRUCTION AND ASSESSMENT (approximately 4% of the test)

PHYSICAL SCIENCE STANDARD IV:
The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.

PHYSICAL SCIENCE STANDARD V:
The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.

COMPETENCIES

DOMAIN I — NUMBER CONCEPTS

COMPETENCY 001
THE TEACHER UNDERSTANDS THE REAL NUMBER SYSTEM AND ITS STRUCTURE, OPERATIONS, ALGORITHMS AND REPRESENTATIONS.

The beginning teacher:

A. Understands the concepts of place value, number base and decimal representations of real numbers.

B. Understands the algebraic structure and properties of the real number system and its subsets (e.g., real numbers as a field, integers as an additive group).

C. Describes and analyzes properties of subsets of the real numbers (e.g., closure, identities).

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

E. Uses a variety of models (e.g., geometric, symbolic) to represent operations, algorithms and real numbers.

F. Uses real numbers to model and solve a variety of problems.

G. Uses deductive reasoning to simplify and justify algebraic processes.

H. Demonstrates how some problems that have no solution in the integer or rational number systems have solutions in the real number system.

COMPETENCY 002

THE TEACHER UNDERSTANDS THE COMPLEX NUMBER SYSTEM AND ITS STRUCTURE, OPERATIONS, ALGORITHMS AND REPRESENTATIONS.

The beginning teacher:

A. Demonstrates how some problems that have no solution in the real number system have solutions in the complex number system.

B. Understands the properties of complex numbers (e.g., complex conjugate, magnitude/modulus, multiplicative inverse).

C. Understands the algebraic structure of the complex number system and its subsets (e.g., complex numbers as a field, complex addition as vector addition).

D. Selects and uses appropriate representations of complex numbers (e.g., vector, ordered pair, polar, exponential) for particular situations.

E. Describes complex number operations (e.g., addition, multiplication, roots) using symbolic and geometric representations.

COMPETENCY 003

THE TEACHER UNDERSTANDS NUMBER THEORY CONCEPTS AND PRINCIPLES AND USES NUMBERS TO MODEL AND SOLVE PROBLEMS IN A VARIETY OF SITUATIONS.

The beginning teacher:

A. Applies ideas from number theory (e.g., prime numbers and factorization, the Euclidean algorithm, divisibility, congruence classes, modular arithmetic, the fundamental theorem of arithmetic) to solve problems.

B. Applies number theory concepts and principles to justify and prove number relationships.

C. Compares and contrasts properties of vectors and matrices with properties of number systems (e.g., existence of inverses, non-commutative operations).

D. Uses properties of numbers (e.g., fractions, decimals, percents, ratios, proportions) to model and solve real-world problems.

E. Applies counting techniques such as permutations and combinations to quantify situations and solve problems.

F. Uses estimation techniques to solve problems and judges the reasonableness of solutions.

DOMAIN II — PATTERNS AND ALGEBRA

COMPETENCY 004

THE TEACHER USES PATTERNS TO MODEL AND SOLVE PROBLEMS AND FORMULATE CONJECTURES.

The beginning teacher:

A. Recognizes and extends patterns and relationships in data presented in tables, sequences or graphs.

B. Uses methods of recursion and iteration to model and solve problems.

C. Uses the principle of mathematical induction.

D. Analyzes the properties of sequences and series (e.g., Fibonacci, arithmetic, geometric) and uses them to solve problems involving finite and infinite processes.

E. Understands how sequences and series are applied to solve problems in the mathematics of finance (e.g., simple, compound and continuous interest rates; annuities).

COMPETENCY 005

THE TEACHER UNDERSTANDS ATTRIBUTES OF FUNCTIONS, RELATIONS AND THEIR GRAPHS.

The beginning teacher:

A. Understands when a relation is a function.

B. Identifies the mathematical domain and range of functions and relations and determines reasonable domains for given situations.

C. Understands that a function represents a dependence of one quantity on another and can be represented in a variety of ways (e.g., concrete models, tables, graphs, diagrams, verbal descriptions, symbols).

D. Identifies and analyzes even and odd functions, one-to-one functions, inverse functions and their graphs.

E. Applies basic transformations [e.g., $k\,f(x)$, $f(x) + k$, $f(x - k)$, $f(kx)$, $|f(x)|$] to a parent function, f, and describes the effects on the graph of $y = f(x)$.

F. Performs operations (e.g., sum, difference, composition) on functions, finds inverse relations and describes results symbolically and graphically.

G. Uses graphs of functions to formulate conjectures of identities [e.g., $y = x^2 - 1$ and $y = (x - 1)(x + 1)$, $y = \log x^3$ and $y = 3 \log x$, $y = \sin(x + \frac{\pi}{2})$ and $y = \cos x$].

COMPETENCY 006

THE TEACHER UNDERSTANDS LINEAR AND QUADRATIC FUNCTIONS, ANALYZES THEIR ALGEBRAIC AND GRAPHICAL PROPERTIES AND USES THEM TO MODEL AND SOLVE PROBLEMS.

The beginning teacher:

A. Understands the concept of slope as a rate of change and interprets the meaning of slope and intercept in a variety of situations.

B. Writes equations of lines given various characteristics (e.g., two points, a point and slope, slope and y-intercept).

C. Applies techniques of linear and matrix algebra to represent and solve problems involving linear systems.

D. Analyzes the zeros (real and complex) of quadratic functions.

E. Makes connections between the $y = ax^2 + bx + c$ and the $y = a(x - h)^2 + k$ representations of a quadratic function and its graph.

F. Solves problems involving quadratic functions using a variety of methods (e.g., factoring, completing the square, using the quadratic formula, using a graphing calculator).

G. Models and solves problems involving linear and quadratic equations and inequalities using a variety of methods, including technology.

COMPETENCY 007

THE TEACHER UNDERSTANDS POLYNOMIAL, RATIONAL, RADICAL, ABSOLUTE VALUE AND PIECEWISE FUNCTIONS, ANALYZES THEIR ALGEBRAIC AND GRAPHICAL PROPERTIES AND USES THEM TO MODEL AND SOLVE PROBLEMS.

The beginning teacher:

A. Recognizes and translates among various representations (e.g., written, tabular, graphical, algebraic) of polynomial, rational, radical, absolute value and piecewise functions.

B. Describes restrictions on the domains and ranges of polynomial, rational, radical, absolute value and piecewise functions.

C. Makes and uses connections among the significant points (e.g., zeros, local extrema, points where a function is not continuous or not differentiable) of a function, the graph of the function and the function's symbolic representation.

D. Analyzes functions in terms of vertical, horizontal and slant asymptotes.

E. Analyzes and applies the relationship between inverse variation and rational functions.

F. Solves equations and inequalities involving polynomial, rational, radical, absolute value and piecewise functions using a variety of methods (e.g., tables, algebraic methods, graphs, use of a graphing calculator) and evaluates the reasonableness of solutions.

G. Models situations using polynomial, rational, radical, absolute value and piecewise functions and solves problems using a variety of methods, including technology.

COMPETENCY 008

THE TEACHER UNDERSTANDS EXPONENTIAL AND LOGARITHMIC FUNCTIONS, ANALYZES THEIR ALGEBRAIC AND GRAPHICAL PROPERTIES AND USES THEM TO MODEL AND SOLVE PROBLEMS.

The beginning teacher:

A. Recognizes and translates among various representations (e.g., written, numerical, tabular, graphical, algebraic) of exponential and logarithmic functions.

B. Recognizes and uses connections among significant characteristics (e.g., intercepts, asymptotes) of a function involving exponential or logarithmic expressions, the graph of the function and the function's symbolic representation.

C. Understands the relationship between exponential and logarithmic functions and uses the laws and properties of exponents and logarithms to simplify expressions and solve problems.

D. Uses a variety of representations and techniques (e.g., numerical methods, tables, graphs, analytic techniques, graphing calculators) to solve equations, inequalities and systems involving exponential and logarithmic functions.

E. Models and solves problems involving exponential growth and decay.

F. Uses logarithmic scales (e.g., Richter, decibel) to describe phenomena and solve problems.

G. Uses exponential and logarithmic functions to model and solve problems involving the mathematics of finance (e.g., compound interest).

H. Uses the exponential function to model situations and solve problems in which the rate of change of a quantity is proportional to the current amount of the quantity [i.e., $f'(x) = k\, f(x)$].

COMPETENCY 009

THE TEACHER UNDERSTANDS TRIGONOMETRIC AND CIRCULAR FUNCTIONS, ANALYZES THEIR ALGEBRAIC AND GRAPHICAL PROPERTIES AND USES THEM TO MODEL AND SOLVE PROBLEMS.

The beginning teacher:

A. Analyzes the relationships among the unit circle in the coordinate plane, circular functions and the trigonometric functions.

B. Recognizes and translates among various representations (e.g., written, numerical, tabular, graphical, algebraic) of trigonometric functions and their inverses.

C. Recognizes and uses connections among significant properties (e.g., zeros, axes of symmetry, local extrema) and characteristics (e.g., amplitude, frequency, phase shift) of a trigonometric function, the graph of the function and the function's symbolic representation.

D. Understands the relationships between trigonometric functions and their inverses and uses these relationships to solve problems.

E. Uses trigonometric identities to simplify expressions and solve equations.

F. Models and solves a variety of problems (e.g., analyzing periodic phenomena) using trigonometric functions.

G. Uses graphing calculators to analyze and solve problems involving trigonometric functions.

COMPETENCY 010

THE TEACHER UNDERSTANDS AND SOLVES PROBLEMS USING DIFFERENTIAL AND INTEGRAL CALCULUS.

The beginning teacher:

A. Understands the concept of limit and the relationship between limits and continuity.

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

C. Uses the first and second derivatives to analyze the graph of a function (e.g., local extrema, concavity, points of inflection).

D. Understands and applies the fundamental theorem of calculus and the relationship between differentiation and integration.

E. Models and solves a variety of problems (e.g., velocity, acceleration, optimization, related rates, work, center of mass) using differential and integral calculus.

F. Analyzes how technology can be used to solve problems and illustrate concepts involving differential and integral calculus.

DOMAIN III — GEOMETRY AND MEASUREMENT

COMPETENCY 011
THE TEACHER UNDERSTANDS MEASUREMENT AS A PROCESS.

The beginning teacher:

A. 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.

B. Applies formulas for perimeter, area, surface area and volume of geometric figures and shapes (e.g., polygons, pyramids, prisms, cylinders, cones, spheres) to solve problems.

C. Recognizes the effects on length, area or volume when the linear dimensions of plane figures or solids are changed.

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

E. Relates the concept of area under a curve to the limit of a Riemann sum.

F. Uses integral calculus to compute various measurements associated with curves and regions (e.g., area, arc length) in the plane and measurements associated with curves, surfaces and regions in three-space.

COMPETENCY 012
THE TEACHER UNDERSTANDS GEOMETRIES, IN PARTICULAR EUCLIDEAN GEOMETRY, AS AXIOMATIC SYSTEMS.

The beginning teacher:

A. Understands axiomatic systems and their components (e.g., undefined terms, defined terms, theorems, examples, counterexamples).

B. Uses properties of points, lines, planes, angles, lengths and distances to solve problems.

C. Applies the properties of parallel and perpendicular lines to solve problems.

D. Uses properties of congruence and similarity to explore geometric relationships, justify conjectures and prove theorems.

E. Describes and justifies geometric constructions made using compass and straightedge, reflection devices and other appropriate technologies.

F. Demonstrates an understanding of the use of appropriate software to explore attributes of geometric figures and to make and evaluate conjectures about geometric relationships.

G. Compares and contrasts the axioms of Euclidean geometry with those of non-Euclidean geometry (i.e., hyperbolic and elliptic geometry).

COMPETENCY 013

THE TEACHER UNDERSTANDS THE RESULTS, USES AND APPLICATIONS OF EUCLIDEAN GEOMETRY.

The beginning teacher:

A. Analyzes the properties of polygons and their components.

B. Analyzes the properties of circles and the lines that intersect them.

C. Uses geometric patterns and properties (e.g., similarity, congruence) to make generalizations about two- and three-dimensional figures and shapes (e.g., relationships of sides, angles).

D. Computes the perimeter, area and volume of figures and shapes created by subdividing and combining other figures and shapes (e.g., arc length, area of sectors).

E. Analyzes cross-sections and nets of three-dimensional shapes.

F. Uses top, front, side and corner views of three-dimensional shapes to create complete representations and solve problems.

G. Applies properties of two- and three-dimensional shapes to solve problems across the curriculum and in everyday life.

COMPETENCY 014

THE TEACHER UNDERSTANDS COORDINATE, TRANSFORMATIONAL AND VECTOR GEOMETRY AND THEIR CONNECTIONS.

The beginning teacher:

A. Identifies transformations (i.e., reflections, translations, glide-reflections, rotations, dilations) and explores their properties.

B. Uses the properties of transformations and their compositions to solve problems.

C. Uses transformations to explore and describe reflectional, rotational and translational symmetry.

D. Applies transformations in the coordinate plane.

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

F. Uses coordinate geometry to derive and explore the equations, properties and applications of conic sections (i.e., lines, circles, hyperbolas, ellipses, parabolas).

G. Relates geometry and algebra by representing transformations as matrices and uses this relationship to solve problems.

H. Explores the relationship between geometric and algebraic representations of vectors and uses this relationship to solve problems.

DOMAIN IV — PROBABILITY AND STATISTICS

COMPETENCY 015

THE TEACHER UNDERSTANDS HOW TO USE APPROPRIATE GRAPHICAL AND NUMERICAL TECHNIQUES TO EXPLORE DATA, CHARACTERIZE PATTERNS AND DESCRIBE DEPARTURES FROM PATTERNS.

The beginning teacher:

A. Selects and uses an appropriate measurement scale (i.e., nominal, ordinal, interval, ratio) to answer research questions and analyze data.

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

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

D. Understands measures of central tendency (i.e., mean, median, mode) and dispersion (i.e., range, interquartile range, variance, standard deviation).

E. Applies linear transformations (i.e., translating, stretching, shrinking) to convert data and describes the effect of linear transformations on measures of central tendency and dispersion.

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

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

COMPETENCY 016

THE TEACHER UNDERSTANDS CONCEPTS AND APPLICATIONS OF PROBABILITY.

The beginning teacher:

A. Understands how to explore concepts of probability through sampling, experiments and simulations, and generates and uses probability models to represent situations.

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

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

D. Solves a variety of probability problems using combinations and permutations.

E. Solves a variety of probability problems using ratios of areas of geometric regions.

F. Calculates probabilities using the axioms of probability and related theorems and concepts such as the addition rule, multiplication rule, conditional probability and independence.

G. Understands expected value, variance and standard deviation of probability distributions (e.g., binomial, geometric, uniform, normal).

H. Applies concepts and properties of discrete and continuous random variables to model and solve a variety of problems involving probability and probability distributions (e.g., binomial, geometric, uniform, normal).

COMPETENCY 017

THE TEACHER UNDERSTANDS THE RELATIONSHIPS 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. Analyzes and interprets statistical information (e.g., the results of polls and surveys) and recognizes misleading as well as valid uses of statistics.

C. Understands random samples and sample statistics (e.g., the relationship between sample size and confidence intervals, biased or unbiased estimators).

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

E. Describes and analyzes bivariate data using various techniques (e.g., scatter plots, regression lines, outliers, residual analysis, correlation coefficients).

F. Understands how to transform nonlinear data into linear form in order to apply linear regression techniques to develop exponential, logarithmic and power regression models.

G. Uses the law of large numbers and the central limit theorem in the process of statistical inference.

H. Estimates parameters (e.g., population mean and variance) using point estimators (e.g., sample mean and variance).

I. Understands principles of hypotheses testing.

DOMAIN V — MATHEMATICAL PROCESSES AND PERSPECTIVES

COMPETENCY 018

THE TEACHER UNDERSTANDS MATHEMATICAL REASONING AND PROBLEM SOLVING.

The beginning teacher:

A. Understands the nature of proof, including indirect proof, in mathematics.

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

C. Uses inductive reasoning to make conjectures and uses deductive methods to evaluate the validity of conjectures.

D. Uses formal and informal reasoning to justify mathematical ideas.

E. Understands the problem-solving process (i.e., recognizing that a mathematical problem can be solved in a variety of ways, selecting an appropriate strategy, evaluating the reasonableness of a solution).

F. Evaluates how well a mathematical model represents a real-world situation.

COMPETENCY 019

THE TEACHER UNDERSTANDS MATHEMATICAL CONNECTIONS BOTH 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 a circle as a quadratic function of the radius, probability as the ratio of two areas, area of a plane region as a definite integral).

B. Understands how mathematics is used to model and solve problems in other disciplines (e.g., art, music, science, social science, business).

C. Translates mathematical ideas between verbal and symbolic forms.

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

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

F. Uses appropriate mathematical terminology to express mathematical ideas.

DOMAIN VI — MATHEMATICAL LEARNING, INSTRUCTION AND ASSESSMENT

COMPETENCY 020

THE TEACHER UNDERSTANDS HOW CHILDREN LEARN MATHEMATICS AND PLANS, ORGANIZES AND IMPLEMENTS INSTRUCTION USING KNOWLEDGE OF STUDENTS, SUBJECT MATTER AND STATEWIDE CURRICULUM (TEXAS ESSENTIAL KNOWLEDGE AND SKILLS [TEKS]).

The beginning teacher:

A. Applies research-based theories of learning mathematics to plan appropriate instructional activities for all students.

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

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 enhanced through the use of manipulatives, technology and other tools (e.g., stop watches, scales, rulers).

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

F. Understands a variety of instructional strategies and tasks that promote students' abilities to do the mathematics described in the TEKS.

G. 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.

H. Understands a variety of questioning strategies to encourage mathematical discourse and to help students analyze and evaluate their mathematical thinking.

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

COMPETENCY 021

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. Understands 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. Understands 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 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 022

THE TEACHER UNDERSTANDS HOW TO SELECT AND MANAGE LEARNING ACTIVITIES TO ENSURE THE SAFETY OF ALL STUDENTS AND THE CORRECT USE AND CARE OF ORGANISMS, NATURAL RESOURCES, MATERIALS, EQUIPMENT AND TECHNOLOGIES.

The beginning teacher:

A. Uses current sources of information about laboratory safety, including safety regulations and guidelines for the use of science facilities.

B. Recognizes potential safety hazards in the laboratory and in the field and knows how to apply procedures, including basic first aid, for responding to accidents.

C. Employs safe practices in planning and implementing and managing all instructional activities and designs, and implements rules and procedures to maintain a safe learning environment.

D. Understands procedures for selecting, maintaining and safely using chemicals, tools, technologies, materials, specimens and equipment, including procedures for the recycling, reuse and conservation of laboratory resources and for the safe handling and ethical treatment of organisms.

E. Knows how to use appropriate equipment and technology (e.g., Internet, spreadsheet, calculator) for gathering, organizing, displaying and communicating data in a variety of ways (e.g., charts, tables, graphs, diagrams, maps, satellite images, written reports, oral presentations).

F. Understands how to use a variety of tools, techniques and technology to gather, organize and analyze data, perform calculations, and how to apply appropriate methods of statistical measures and analyses.

G. Knows how to apply techniques to calibrate measuring devices and understands concepts of precision, accuracy and error with regard to reading and recording numerical data from scientific instruments (e.g., significant figures).

H. Uses the International System of Units (i.e., metric system) and performs unit conversions within and across measurement systems.

COMPETENCY 023

THE TEACHER UNDERSTANDS THE NATURE OF SCIENCE, THE PROCESS OF SCIENTIFIC INQUIRY AND THE UNIFYING CONCEPTS THAT ARE COMMON TO ALL SCIENCES.

The beginning teacher:

A. Understands the nature of science, the relationship between science and technology, the predictive power of science and limitations to the scope of science (i.e., the types of questions that science can and cannot answer).

B. Knows the characteristics of various types of scientific investigations (e.g., descriptive studies, controlled experiments, comparative data analysis) and how and why scientists use different types of scientific investigations.

C. Understands principles and procedures for designing and conducting a variety of scientific investigations, with emphasis on inquiry-based investigations, and how to communicate and defend scientific results.

D. Understands how logical reasoning, verifiable observational and experimental evidence and peer review are used in the process of generating and evaluating scientific knowledge.

E. Understands how to identify potential sources of error in an investigation, evaluate the validity of scientific data and develop and analyze different explanations for a given scientific result.

F. Knows the characteristics and general features of systems; how properties and patterns of systems can be described in terms of space, time, energy and matter; and how system components and different systems interact.

G. Knows how to apply and analyze the systems model (e.g., interacting parts, boundaries, input, output, feedback, subsystems) across the science disciplines.

H. Understands how shared themes and concepts (e.g., systems, order and organization; evidence, models and explanation; change, constancy and measurements; evolution and equilibrium; and form and function) provide a unifying framework in science.

I. Understands the difference between a theory and a hypothesis, 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).

COMPETENCY 024

THE TEACHER UNDERSTANDS THE HISTORY OF SCIENCE, HOW SCIENCE IMPACTS THE DAILY LIVES OF STUDENTS AND HOW SCIENCE INTERACTS WITH AND INFLUENCES PERSONAL AND SOCIETAL DECISIONS.

The beginning teacher:

A. Understands the historical development of science, key events in the history of science and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge.

B. Knows how to use examples from the history of science to demonstrate the changing nature of scientific theories and knowledge (i.e., that scientific theories and knowledge are always subject to revision in light of new evidence).

C. Knows that science is a human endeavor influenced by societal, cultural and personal views of the world, and that decisions about the use and direction of science are based on factors such as ethical standards, economics and personal and societal biases and needs.

D. Understands the application of scientific ethics to the conducting, analyzing and publishing of scientific investigations.

E. Applies scientific principles to analyze factors (e.g., diet, exercise, personal behavior) that influence personal and societal choices concerning fitness and health (e.g., physiological and psychological effects and risks associated with the use of substances and substance abuse).

F. Applies scientific principles, the theory of probability and risk/benefit analysis to analyze the advantages of, disadvantages of or alternatives to a given decision or course of action.

G. Understands the role science can play in helping resolve personal, societal and global issues (e.g., recycling, population growth, disease prevention, resource use, evaluating product claims).

DOMAIN VIII — PHYSICS

COMPETENCY 025
THE TEACHER UNDERSTANDS FORCES AND MOTION AND THEIR RELATIONSHIPS.

The beginning teacher:

A. Generates, analyzes and interprets graphs describing the motion of a particle.

B. Applies vector concepts to displacement, velocity and acceleration in order to analyze and describe the motion of a particle.

C. Solves problems involving uniform and accelerated motion using scalar (e.g., speed) and vector (e.g., velocity) quantities.

D. Analyzes and solves problems involving projectile motion.

E. Analyzes and solves problems involving uniform circular and rotary motion.

F. Understands motion of fluids.

G. Understands motion in terms of frames of reference and relativity concepts.

COMPETENCY 026
THE TEACHER UNDERSTANDS THE LAWS OF MOTION.

The beginning teacher:

A. Identifies and analyzes the forces acting in a given situation and constructs a free-body diagram.

B. Solves problems involving the vector nature of force (e.g., resolving forces into components, analyzing static or dynamic equilibrium of a particle).

C. Identifies and applies Newton's laws to analyze and solve a variety of practical problems (e.g., properties of frictional forces, acceleration of a particle on an inclined plane, displacement of a mass on a spring, forces on a pendulum).

COMPETENCY 027

THE TEACHER UNDERSTANDS THE CONCEPTS OF GRAVITATIONAL AND ELECTROMAGNETIC FORCES IN NATURE.

The beginning teacher:

A. Applies the Law of Universal Gravitation to solve a variety of problems (e.g., determining the gravitational fields of the planets, analyzing properties of satellite orbits).

B. Calculates electrostatic forces, fields and potentials.

C. Understands the properties of magnetic materials and the molecular theory of magnetism.

D. Identifies the source of the magnetic field and calculates the magnetic field for various simple current distributions.

E. Analyzes the magnetic force on charged particles and current-carrying conductors.

F. Understands induced electric and magnetic fields and analyzes the relationship between electricity and magnetism.

G. Understands the electromagnetic spectrum and the production of electromagnetic waves.

COMPETENCY 028

THE TEACHER UNDERSTANDS APPLICATIONS OF ELECTRICITY AND MAGNETISM.

The beginning teacher:

A. Analyzes common examples of electrostatics (e.g., a charged balloon attached to a wall, behavior of an electroscope, charging by induction).

B. Understands electric current, resistance and resistivity, potential difference, capacitance and electromotive force in conductors and circuits.

C. Analyzes series and parallel DC circuits in terms of current, resistance, voltage and power.

D. Identifies basic components and characteristics of AC circuits.

E. Understands the operation of an electromagnet.

F. Understands the operation of electric meters, motors, generators and transformers.

COMPETENCY 029

THE TEACHER UNDERSTANDS THE CONSERVATION OF ENERGY AND MOMENTUM.

The beginning teacher:

A. Understands the concept of work.

B. Understands the relationships among work, energy and power.

C. Solves problems using the conservation of mechanical energy in a physical system (e.g., determining potential energy for conservative forces, conversion of potential to kinetic energy, analyzing the motion of a pendulum).

D. Applies the work-energy theorem to analyze and solve a variety of practical problems (e.g., finding the speed of an object given its potential energy, determining the work done by frictional forces on a decelerating car).

E. Understands linear and angular momentum.

F. Solves a variety of problems (e.g., collisions) using the conservation of linear and angular momentum.

COMPETENCY 030

THE TEACHER UNDERSTANDS THE LAWS OF THERMODYNAMICS.

The beginning teacher:

A. Understands methods of heat transfer (i.e., convection, conduction, radiation).

B. Understands the molecular interpretation of temperature and heat.

C. Solves problems involving thermal expansion, heat capacity and the relationship between heat and other forms of energy.

D. Applies the first law of thermodynamics to analyze energy transformations in a variety of everyday situations (e.g., electric light bulb, power generating plant).

E. Understands the concept of entropy and its relationship to the second law of thermodynamics.

COMPETENCY 031

THE TEACHER UNDERSTANDS THE CHARACTERISTICS AND BEHAVIOR OF WAVES.

The beginning teacher:

A. Understands interrelationships among wave characteristics such as velocity, frequency, wavelength and amplitude and relates them to properties of sound and light (e.g., pitch, color).

B. Compares and contrasts transverse and longitudinal waves.

C. Describes how various waves are propagated through different media.

D. Applies properties of reflection and refraction to analyze optical phenomena (e.g., mirrors, lenses, fiber-optic cable).

E. Applies principles of wave interference to analyze wave phenomena, including acoustical (e.g., harmonics) and optical phenomena (e.g., patterns created by thin films and diffraction gratings).

F. Identifies and interprets how wave characteristics and behaviors are used in medical, industrial and other real-world applications.

COMPETENCY 032

THE TEACHER UNDERSTANDS THE FUNDAMENTAL CONCEPTS OF QUANTUM PHYSICS.

The beginning teacher:

A. Interprets wave-particle duality.

B. Identifies examples and consequences of the Uncertainty Principle.

C. Understands the photoelectric effect.

D. Uses the quantum model of the atom to describe and analyze absorption and emission spectra (e.g., line spectra, blackbody radiation).

E. Explores real-world applications of quantum phenomena (e.g., lasers, photoelectric sensors, semiconductors, superconductivity).

DOMAIN IX — SCIENCE LEARNING, INSTRUCTION AND ASSESSMENT

COMPETENCY 033

THE TEACHER UNDERSTANDS RESEARCH-BASED THEORETICAL AND PRACTICAL KNOWLEDGE ABOUT TEACHING SCIENCE, HOW STUDENTS LEARN SCIENCE AND THE ROLE OF SCIENTIFIC INQUIRY IN SCIENCE INSTRUCTION.

The beginning teacher:

A. Knows research-based theories about how students develop scientific understanding and how developmental characteristics, prior knowledge, experience and attitudes of students influence science learning.

B. Understands the importance of respecting student diversity by planning activities that are inclusive and selecting and adapting science curricula, content, instructional materials and activities to meet the interests, knowledge, understanding, abilities, possible career paths and experiences of all students, including English-language learners.

C. Knows how to plan and implement strategies to encourage student self-motivation and engagement in their own learning (e.g., linking inquiry-based investigations to students' prior knowledge, focusing inquiry-based instruction on issues relevant to students, developing instructional materials using situations from students' daily lives, fostering collaboration among students).

D. Knows how to use a variety of instructional strategies to ensure all students comprehend content-related texts, including how to locate, retrieve and retain information from a range of texts and technologies.

E. Understands the science teacher's role in developing the total school program by planning and implementing science instruction that incorporates schoolwide objectives and the statewide curriculum as defined in the Texas Essential Knowledge and Skills (TEKS).

F. Knows how to design and manage the learning environment (e.g., individual, small-group, whole-class settings) to focus and support student inquiries and to provide the time, space and resources for all students to participate in field, laboratory, experimental and nonexperimental scientific investigation.

G. Understands the rationale for using active learning and inquiry methods in science instruction and how to model scientific attitudes such as curiosity, openness to new ideas and skepticism.

H. Knows principles and procedures for designing and conducting an inquiry-based scientific investigation (e.g., making observations; generating questions; researching and reviewing current knowledge in light of existing evidence; choosing tools to gather and analyze evidence; proposing answers, explanations and predictions; and communicating and defending results).

I. Knows how to assist students with generating, refining, focusing and testing scientific questions and hypotheses.

J. Knows strategies for assisting students in learning to identify, refine and focus scientific ideas and questions guiding an inquiry-based scientific investigation; to develop, analyze and evaluate different explanations for a given scientific result; and to identify potential sources of error in an inquiry-based scientific investigation.

K. Understands how to implement inquiry strategies designed to promote the use of higher-level thinking skills, logical reasoning and scientific problem solving in order to move students from concrete to more abstract understanding.

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

M. Knows how to sequence learning activities in a way that uncovers common misconceptions, allows students to build upon their prior knowledge and challenges them to expand their understanding of science.

COMPETENCY 034

THE TEACHER KNOWS HOW TO MONITOR AND ASSESS SCIENCE LEARNING IN LABORATORY, FIELD AND CLASSROOM SETTINGS.

The beginning teacher:

A. Knows how to use formal and informal assessments of student performance and products (e.g., projects, laboratory and field journals, rubrics, portfolios, student profiles, checklists) to evaluate student participation in and understanding of inquiry-based scientific investigations.

B. Understands the relationship between assessment and instruction in the science curriculum (e.g., designing assessments to match learning objectives, using assessment results to inform instructional practice).

C. Knows the importance of monitoring and assessing students' understanding of science concepts and skills on an ongoing basis by using a variety of appropriate assessment methods (e.g., performance assessment, self-assessment, peer assessment, formal/informal assessment).

D. Understands the purposes, characteristics and uses of various types of assessment in science, including formative and summative assessments, and the importance of limiting the use of an assessment to its intended purpose.

E. Understands strategies for assessing students' prior knowledge and misconceptions about science and how to use these assessments to develop effective ways to address these misconceptions.

F. Understands characteristics of assessments, such as reliability, validity and the absence of bias in order to evaluate assessment instruments and their results.

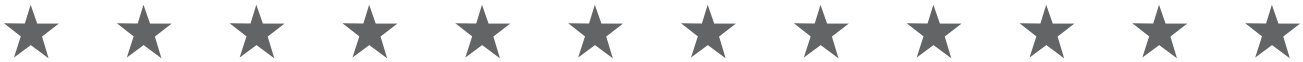
G. Understands the role of assessment as a learning experience for students and strategies for engaging students in meaningful self-assessment.

H. Recognizes the importance of selecting assessment instruments and methods that provide all students with adequate opportunities to demonstrate their achievements.

I. Recognizes the importance of clarifying teacher expectations by sharing evaluation criteria and assessment results with students.

Chapter 4

Succeeding on Multiple-Choice Questions



APPROACHES TO ANSWERING MULTIPLE-CHOICE QUESTIONS

The purpose of this section is to describe multiple-choice question formats that you will see on the Physics/Mathematics 8–12 test and to suggest possible ways to approach thinking about and answering the multiple-choice questions. However, these approaches are not intended to replace familiar test-taking strategies with which you are already comfortable and that work for you.

The Physics/Mathematics 8–12 test is designed to include a total of 120 multiple-choice questions, out of which 100 are scored. The number of scored questions will not vary; however, the number of questions that are not scored may vary in the actual test. Your final scaled score will be based only on scored questions. The questions that are not scored are being pilot tested in order to collect information about how these questions will perform under actual testing conditions. These questions are not identified on the test.

All multiple-choice questions on this test are designed to assess your knowledge of the content described in the test framework. In most cases, you are expected to demonstrate more than just your ability to recall factual information. You may be asked to think critically about the information, to analyze it, consider it carefully, compare it to other knowledge you have or make a judgment about it.

When you are ready to respond to a multiple-choice question, you must choose one of four answer options labeled A, B, C and D. Leave no questions unanswered. Nothing is subtracted from your score if you answer a question incorrectly. Questions for which you mark no answer or more than one answer are counted as incorrect. Your score will be determined by the number of questions for which you select the best answer.

Calculators. Some questions on the Physics/Mathematics 8–12 test are designed to be solved with a graphing calculator. It is strongly recommended that you bring a graphing calculator with you on the day of the test. Calculators will not be supplied. You may also bring a second calculator as a backup. Only the brands and models listed in the current TExES *Registration Bulletin* and on the ETS TExES website are approved for use. All calculators on the approved list are graphing calculators. Graphing calculators perform all the operations of typical scientific calculators. Test administrators will clear the memory of your calculator(s) both before and after the test session. Sharing of calculators will not be permitted. The approved calculator brands and models are subject to change. If there is a change, examinees will be notified.

Definitions and Formulas. A set of definitions and formulas will be provided as part of the test. A copy of those definitions and formulas is provided in Chapter 5 of this preparation manual.

Definitions and Physical Constants. A set of definitions and physical constants will be provided as part of the test. A copy of those definitions and physical constants is provided in Chapter 5 of this preparation manual.

QUESTION FORMATS

You may see the following types of multiple-choice questions on the test.

— Single Questions
— Questions with Stimulus Material
— Clustered Questions

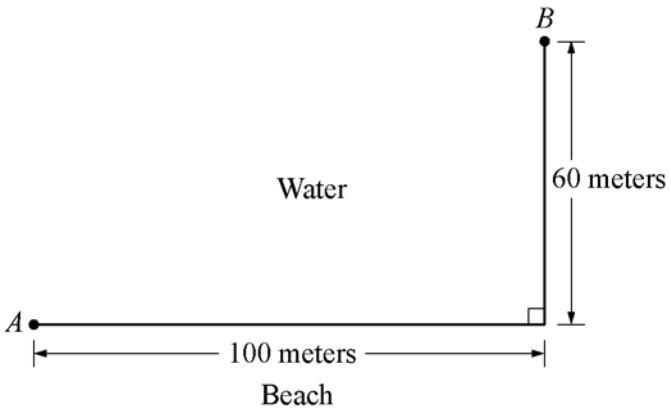
On this and the following pages, you will find descriptions of these commonly used question formats, along with suggested approaches for responding to each type of question. In the actual testing situation, you may mark the test questions and/or write in the margins of your test booklet. **Your final response must be indicated on the answer sheet provided.**

SINGLE QUESTIONS

In the single-question format, a problem is presented as a direct question or an incomplete statement, and four answer options appear below the question. The following question is an example of this type. It tests knowledge of Physics/Mathematics 8–12 Competency 010: *The teacher understands and solves problems using differential and integral calculus.*

EXAMPLE

Use the diagram below to answer the question that follows.



A lifeguard sitting on a beach at point *A* sees a swimmer in distress at point *B*. The lifeguard can run at a rate of 3 meters per second and can swim at a rate of 1.5 meters per second. To minimize the amount of time it takes to reach the swimmer, how far along the beach should the lifeguard run before entering the water?

A. 40 meters

B. 65 meters

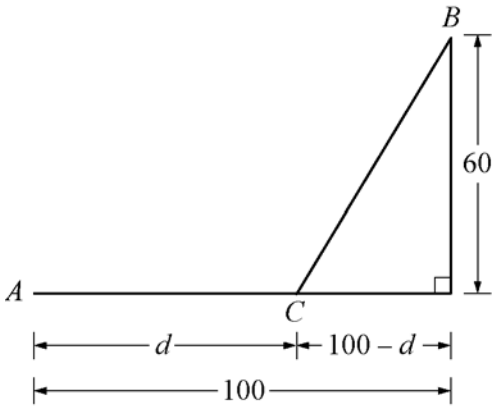
C. 73 meters

D. 100 meters

SUGGESTED APPROACH

Read the question carefully and critically. Think about what it is asking and the situation it is describing. Eliminate any obviously wrong answers, select the correct answer choice and mark your answer.

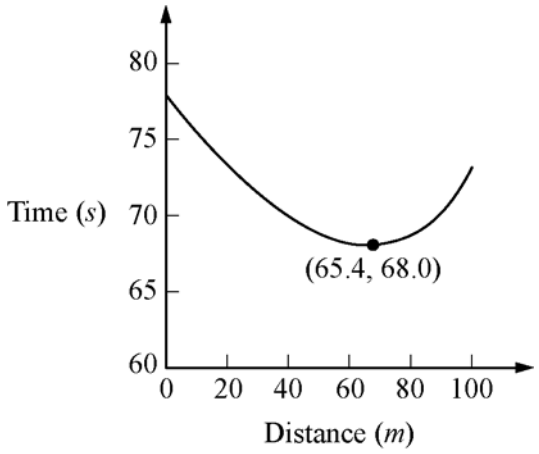
In analyzing this problem, redrawing the diagram to highlight the important information may be helpful.



Let d represent the distance in meters that the lifeguard runs along the beach. Then by an application of the Pythagorean theorem, the distance traveled in water is represented by $\sqrt{60^2 + (100 - d)^2}$.

Since *distance* = *rate* × *time* and the lifeguard can run at 3 meters per second and swim at 1.5 meters per second, the time it takes the lifeguard to run along the beach, t_b, can be represented by $\frac{d}{3}$, and the time it takes the lifeguard to swim in the water t_w, can be represented by $\frac{\sqrt{60^2 + (100 - d)^2}}{1.5}$. Thus the total time, t, it takes the lifeguard to travel to the swimmer can be represented by $t_b + t_w$.

To solve the problem, we need to find the value of d that minimizes the function $t = t_b + t_w = \frac{d}{3} + \frac{\sqrt{60^2 + (100 - d)^2}}{1.5}$. This can be done using either differential calculus or a graphing approach. We will use a graphing approach. A graphing calculator can be used to produce a graph similar to the one below.



Using the capabilities of the calculator, you see that the minimum value of the function t occurs when d is approximately 65 meters, or option B.

Option A results from dividing 60 by 1.5, which is the time required to swim 60 meters. Option C results from misusing parentheses when entering the equation for t into the graphing utility; i.e., entering $\sqrt{\frac{60^2 + (100 - d)^2}{1.5}}$ instead of $\frac{\sqrt{60^2 + (100 - d)^2}}{1.5}$. Option D results from minimizing the function $t_w = \frac{\sqrt{60^2 + (100 - d)^2}}{1.5}$ instead of the expression for t, the total time required to reach the swimmer.

QUESTIONS WITH STIMULUS MATERIAL

Some questions on this test are preceded by stimulus material that relates to the question. Some types of stimulus material included on the test are reading passages, graphics, tables or a combination of these. In such cases, you will generally be given information followed by questions that ask you to analyze the material, solve a problem or make a decision.

You can use several different approaches to respond to these types of questions. Some commonly used strategies are listed below.

Strategy 1 Skim the stimulus material to understand its purpose, its arrangement and/or its content. Then read the question and refer again to the stimulus material to obtain the specific information you need to answer the question.

Strategy 2 Read the question *before* considering the stimulus material. The theory behind this strategy is that the content of the question will help you identify the purpose of the stimulus material and locate the information you need to answer the question.

Strategy 3 Use a combination of both strategies. Apply the "read the stimulus first" strategy with shorter, more familiar stimuli and the "read the question first" strategy with longer, more complex or less familiar stimuli. You can experiment with the sample questions in this manual and then use the strategy with which you are most comfortable when you take the actual test.

Whether you read the stimulus before or after you read the question, you should read it carefully and critically.

As you consider questions set in educational contexts, try to enter into the identified teacher's frame of mind and use that teacher's point of view to answer the questions that accompany the stimulus. Be sure to consider the questions in terms of only the information provided in the stimulus — not in terms of your own class experiences or individual students you may have known.

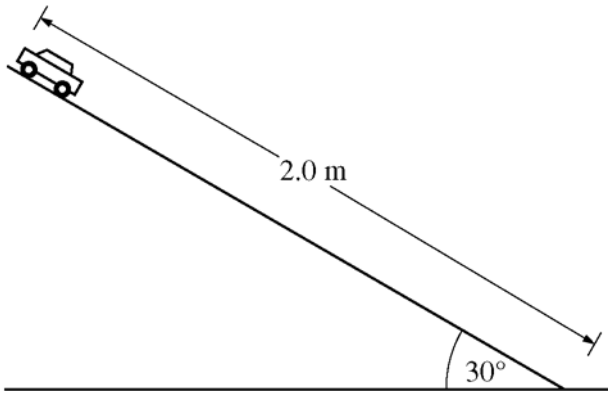
EXAMPLE 1

First read the stimulus (a description of a physics experiment along with a data table).

Use the information below to answer the two questions that follow.

A group of students is measuring how long it takes a toy car released from rest to roll down a straight inclined track. The data from the experiment are summarized below.

Mass of car	0.10 kg
Length of incline	2.0 m
Slope of incline	30°
Average time	1.2 s



Now you are prepared to address the first of the two questions associated with this stimulus. The first question measures Physics/Mathematics 8–12 Competency 026: *The teacher understands the laws of motion.*

1. What is the magnitude of the gravitational force acting on the car in the direction of the toy car's motion down the track?

   A. 0.10 N

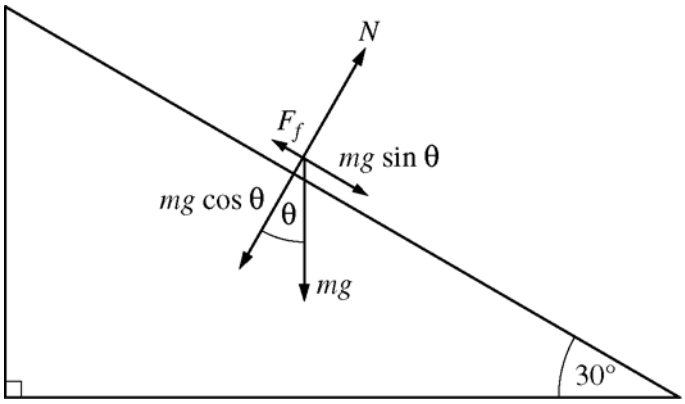
   B. 0.49 N

   C. 0.85 N

   D. 0.98 N

SUGGESTED APPROACH

The first step is to identify the forces acting on the car. In this case, the forces acting on the car are the force of gravity, the force of friction and the normal force from the inclined plane on the car. The next step is to draw a free body diagram showing these forces resolved into their appropriate components.



To determine the magnitude of the gravitational force acting on the car in the direction of the car's motion down the track, it is necessary to determine the component of the gravitational force along the incline. For an inclined plane, this component is given by $F = mg \sin \theta$, where m is the mass of the car, g is the acceleration due to gravity (9.8 m/s^2), and sin θ is the sine of the angle of the incline with the horizontal. Substituting the given values into the expression and using the fact that sin 30° = 0.5 results in the numerical value for the force component acting along the plane, or F = 0.49 N. This is option B.

Option A is the mass of the car and is therefore incorrect. Option C results from incorrectly using mg cos 30° for the component of the gravitational force in the direction of the car's motion. Option D is the weight of the car, which is equal to the magnitude of the gravitational force mg toward the center of the earth.

Now you are ready to answer the next question. The second question also measures Physics/Mathematics 8–12 Competency 026: *The teacher understands the laws of motion.*

2. Assuming the acceleration of the car down the track is constant, what is the net force acting on the car in the direction of the car's motion down the track?

   A. 0.21 N

   B. 0.28 N

   C. 0.56 N

   D. 0.98 N

SUGGESTED APPROACH

The second question for this stimulus asks for the net force acting on the car in the direction of the car's motion. According to Newton's second law of motion, the net force on any object in the direction of the object's motion is equal to the object's mass multiplied by its acceleration, or $F_{\text{net}} = ma$. Since the mass of the car is known, it is necessary to find the acceleration of the car. The question tells us to assume the acceleration is constant. Also, it is given from the original stimulus data that the car starts from rest and travels a distance of 2.0 m in 1.2 s. The expression for the distance traveled by an object undergoing constant acceleration, $x = \frac{1}{2}at^2 + v_0t + x_0$, simplifies to $x = \frac{1}{2}at^2$. In this problem, therefore, solving for a yields $a = \frac{2x}{t^2} = \frac{2(2.0)}{(1.2)^2} = 2.8\ \text{m/s}^2$. Multiplying this value by the mass of the car results in 0.28 N, which is option B.

Option A results from incorrectly calculating the acceleration as the distance the object travels divided by the time required, or $\frac{2.0}{1.2}$, and using this value to find the force. Option C results from correctly determining the acceleration and multiplying the result by the mass of the car, but then incorrectly trying to find the component of the force parallel to the plane by dividing the result by sin 30°, or 0.5. Option D is the force of gravity on the object.

CLUSTERED QUESTIONS

You may have one or more questions related to a single stimulus. When you have at least two questions related to a single stimulus, the group of questions is called a cluster.

Chapter 5

Multiple-Choice Practice Questions

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

SAMPLE MULTIPLE-CHOICE QUESTIONS

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

An answer key follows the sample questions. The answer key lists the question number and correct answer for each sample test question. Please note that the answer key also lists the competency assessed by each question and that the sample questions are not necessarily presented in competency order.

The sample questions are included to illustrate the formats and types of questions you will see on the test; however, your performance on the sample questions should not be viewed as a predictor of your performance on the actual test.

Definitions and Formulas for Mathematics 8-12

CALCULUS

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

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

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 $\quad i^2 = -1$

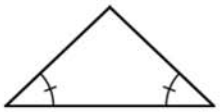
A^{-1} inverse of matrix A

$A = P\left(1 + \frac{r}{n}\right)^{nt}$ 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

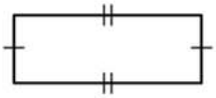
$[x] = n$ Greatest integer function, where n is the integer such that $n \le x < n + 1$

GEOMETRY

Congruent Angles



Congruent Sides



Parallel Sides

Circumference of a Circle

$C = 2\pi r$

VOLUME

Cylinder: (area of base) × height

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

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

Prism: (area of base) × height

AREA

Triangle: $\frac{1}{2}$(base × height)

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

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

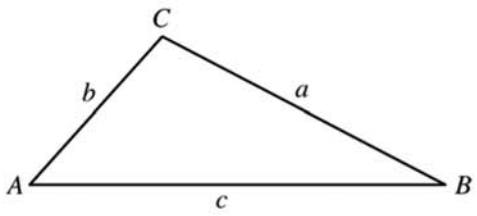
Sphere: $4\pi r^2$

Circle: πr^2

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

TRIGONOMETRY

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



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

Definitions and Physical Constants for Physics/Mathematics 8–12

The value of 9.8 m/s^2 is used for the acceleration of gravity near Earth's surface.

The universal gas constant is 8.314 J/K-mol or 0.08206 L-atm/K-mol.

Planck's constant is 6.6256×10^{-34} J-s.

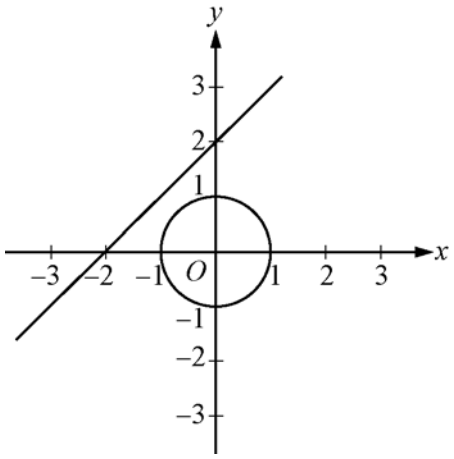
Avogadro's number is 6.022×10^{23}.

The right-hand rule is used with conventional current (the flow of positive charge from the positive terminal to the negative terminal).

END OF DEFINITIONS AND PHYSICAL CONSTANTS

COMPETENCY 002

1. **Use the figure below to answer the question that follows.**



The figure above shows a line and a circle in the *xy*-plane. Which of the following is a possible value of x in the set of complex numbers such that the pair (x, y), where y is also a complex number, is a solution to the system of equations whose graphs are shown above?

A. $-2 + \sqrt{2}\,i$

B. $-1 + \frac{1}{2}i$

C. $-1 + \frac{\sqrt{2}}{2}i$

D. $-1 + 2\sqrt{2}\,i$

COMPETENCY 003

2. Which of the following statements about real numbers and $n \times n$ real matrices is true?

A. The product of two real numbers is a real number, but the product of two $n \times n$ real matrices might not be an $n \times n$ real matrix.

B. All real numbers have an additive inverse, but some $n \times n$ real matrices do not.

C. Multiplication of real numbers is commutative, but multiplication of $n \times n$ real matrices is not.

D. The set of real numbers form a group under addition, but the set of $n \times n$ real matrices do not.

COMPETENCY 008

3. The population of a mold, $P(t)$, is modeled by an exponential function of the form $P(t) = Ae^{bt}$. The table below gives the population at two different times.

Time (hours)	Population Size
0	150
10	450

What is the value of b ?

A. $\ln 3$

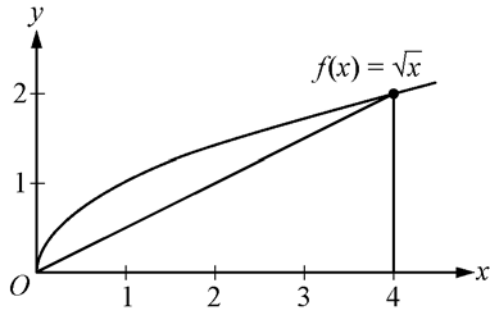
B. $\frac{\ln 3}{10}$

C. $\ln \frac{1}{3}$

D. $\ln 10 - \ln 3$

COMPETENCY 010

4. **Use the figure below to answer the question that follows.**



The area of the region in the first quadrant of the *xy*-plane below the graph of the function $f(x) = \sqrt{x}$ between $x = 0$ and $x = 4$ is estimated by using the triangle shown above. What is the difference between the estimate and the actual value of the area?

A. $\frac{2}{9}$

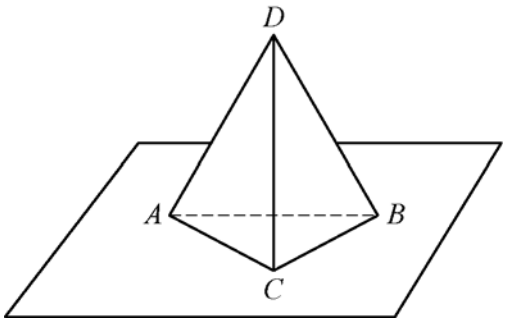
B. $\frac{4}{3}$

C. $\frac{5}{3}$

D. 4

COMPETENCY 012

5. **Use the diagram below to answer the question that follows.**



In the diagram above, $\overline{DC}$ is perpendicular to the plane of $\triangle ABC$ and $\triangle ABC$ is equilateral. Which of the following justifies the assertion that $\triangle ACD \cong \triangle BCD$?

A. AAA

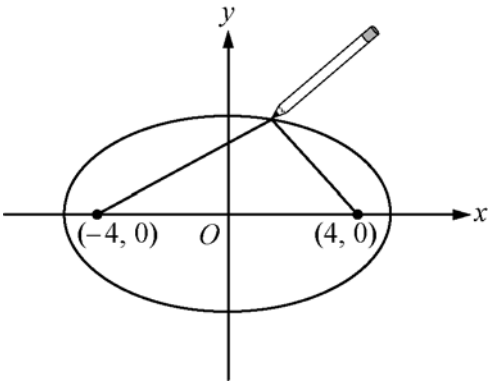
B. SAS

C. SAA

D. SSS

COMPETENCY 014

6. **Use the figure below to answer the question that follows.**



In the figure above, two thumbtacks are placed at the points $(-4, 0)$ and $(4, 0)$. The ends of a piece of string are attached to the tacks, one end to each tack, and the string is pulled tight as a pencil traces out an ellipse. If the equation of the ellipse is $\frac{x^2}{25} + \frac{y^2}{9} = 1$, how many units long is the piece of string?

A. 5

B. 8

C. 10

D. 16

COMPETENCY 015

7. Students in a high school class have collected data on the gas mileage of their parents' cars. The data are summarized in the table below.

Gas Mileage (miles per gallon)	
Mean	22.7
Median	24
Variance	16.8

The students would like to convert the results to kilometers per liter to compare the results with those of a class in Holland. If 1 mile per gallon ≈ 0.425 kilometer per liter, which of the following tables shows the correct conversions for each statistical measure?

A.

Gas Mileage (kilometers per liter)	
Mean	9.65
Median	24
Variance	16.8

C.

Gas Mileage (kilometers per liter)	
Mean	9.65
Median	10.20
Variance	7.14

B.

Gas Mileage (kilometers per liter)	
Mean	9.65
Median	10.20
Variance	16.8

D.

Gas Mileage (kilometers per liter)	
Mean	9.65
Median	10.20
Variance	3.03

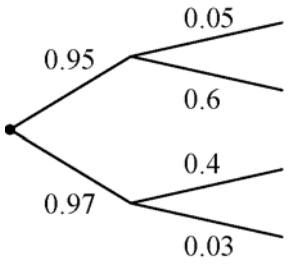
COMPETENCY 016

8. **Use the information below to answer the question that follows.**

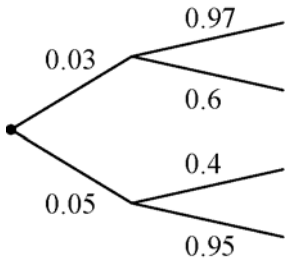
> A factory that makes air conditioners uses two assembly lines. Line 1 produces 6000 units per year, and 3% of the units are defective. Line 2 produces 4000 units per year, and 5% of the units are defective. A quality control inspector chooses a unit at random from among all the units produced last year and finds it to be defective.

Which of the following tree diagrams would be most useful to the inspector in calculating the probability that the defective unit came from assembly line 2?

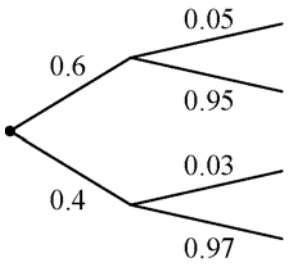
A.



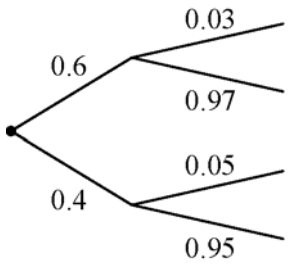
C.



B.



D.



COMPETENCY 018

9. Students are using a graphing calculator to explore how changing the value of m in an equation of the form $y = mx$ changes the graph of the equation. The students view several graphs and are then asked to make a generalization about how the value of m affects the graph of the equation. This is an example of using

   A. a counterexample to evaluate a mathematical relationship.

   B. an axiomatic system to generate a mathematical relationship.

   C. inductive reasoning to conjecture a mathematical relationship.

   D. deductive reasoning to prove a mathematical relationship.

COMPETENCY 024

10. At the end of a unit on Newton's laws, a teacher introduces students to the fundamental concepts of the theory of special relativity and compares and contrasts relativity with Newtonian mechanics. Which of the following is a possible benefit of this approach?

    A. It demonstrates how the direction of scientific research is influenced by cultural biases

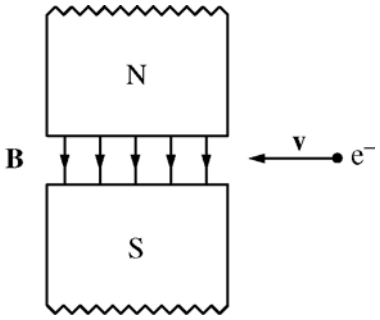
    B. It is a good example of how and why scientists use different types of scientific investigations

    C. It illustrates the role of uncertainty and probability in modern physics as compared to classical physics

    D. It is a good example of how scientific theories are subject to revision in light of new evidence

COMPETENCY 027

11. **Use the diagram below to answer the question that follows.**



An electron with velocity vector **v** enters a magnetic field. The velocity vector is perpendicular to the magnetic field vector. What is the initial direction of the force on the electron?

A. Into the page

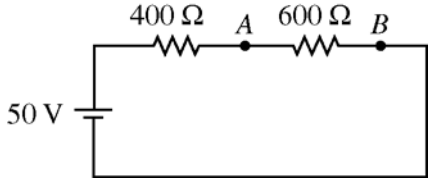
B. Out of the page

C. Toward the north pole of the magnet

D. Toward the south pole of the magnet

COMPETENCY 028

12. **Use the diagram below to answer the question that follows.**



What is the potential difference across *AB*?

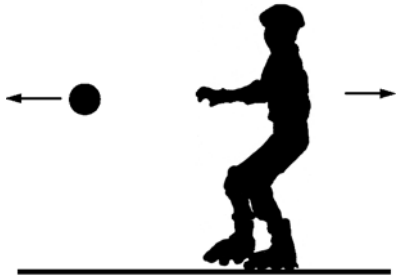
A. 20 V

B. 30 V

C. 33 V

D. 50 V

Use the diagram and the information below to answer the two questions that follow.



A 60 kg teenager on in-line skates initially at rest holds a 0.5 kg ball. The teenager throws the ball horizontally at a speed of 12 m/s relative to the ground and recoils backwards.

COMPETENCY 029

13. Ignoring friction, what is the recoil speed of the skater?

    A. 0.02 m/s

    B. 0.10 m/s

    C. 2.50 m/s

    D. 12.00 m/s

COMPETENCY 033

14. The example in the diagram could be used to help students understand the dynamics of which of the following propulsion systems?

    A. Automobile

    B. Submarine

    C. Helicopter

    D. Rocket

COMPETENCY 030

15. An ideal gas in a piston absorbs heat from an external heat bath. The gas expands from volume V_1 to volume V_2 and does work by pushing against the piston. The temperature remains constant during this process. Which of the following is true for this process?

    A. The heat capacity of the gas increases

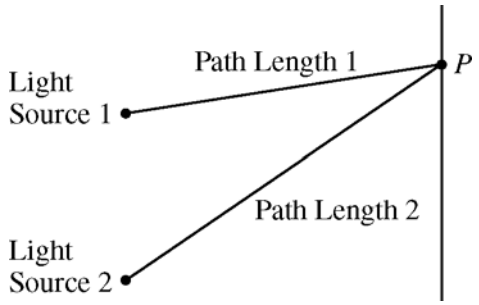
    B. The average momentum of the gas molecules increases

    C. The entropy of the gas increases

    D. The average kinetic energy of the gas molecules increases

COMPETENCY 031

16. **Use the diagram below to answer the question that follows.**



The diagram represents two coherent light sources emitting light of equal intensity and wavelength λ. The intensity of the light at point P is zero. Which of the following could be the difference in path length taken by the light in traveling from each source to point P ?

A. 0

B. $\frac{1}{4}\lambda$

C. $\frac{1}{2}\lambda$

D. λ

COMPETENCY 032

17. A neon lamp emits red light of frequency f. How many photons are emitted by a 100-watt neon light during a time period of 5 seconds (h = Planck's constant)?

    A. $20hf$

    B. $\frac{hf}{20}$

    C. $500hf$

    D. $\frac{500}{hf}$

ANSWER KEY

Question Number	Correct Answer	Competency
1	C	002
2	C	003
3	B	008
4	B	010
5	B	012
6	C	014
7	D	015
8	D	016
9	C	018
10	D	024
11	A	027
12	B	028
13	B	029
14	D	033
15	C	030
16	C	031
17	D	032

Chapter 6

Are You Ready? – Last-Minute Tips

PREPARING TO TAKE THE TEST

CHECKLIST

Complete this checklist to determine if you are ready to take your test.

- ✓ Do you know the testing requirements for your teaching field?
- ✓ Have you followed the test registration procedures?
- ✓ Have you reviewed the test center identification document requirements in the *Registration Bulletin* or on the ETS TExES website at **www.texes.ets.org**?
- ✓ Do you know the test frameworks that will be covered in each of the tests you plan to take?
- ✓ Have you used the study plan sheet at the end of this manual to identify what content you already know well and what content you will need to focus on in your studying?
- ✓ Have you reviewed any textbooks, class notes and course readings that relate to the frameworks covered?
- ✓ Do you know how long the test will take and the number of questions it contains? Have you considered how you will pace your work?
- ✓ Are you familiar with the test directions and the types of questions for your test?
- ✓ Are you familiar with the recommended test-taking strategies and tips?
- ✓ Have you practiced by working through the sample test questions at a pace similar to that of an actual test?
- ✓ If constructed-response questions are part of your test, do you understand the scoring criteria for these questions?
- ✓ If you are repeating a test, have you analyzed your previous score report to determine areas where additional study and test preparation could be useful?

THE DAY OF THE TEST

You should have ended your review a day or two before the actual test date. Many clichés you may have heard about the day of the test are true. You should:

- Be well rested.
- Take the appropriate identification document(s) with you to the test center (identification requirements are listed in the *Registration Bulletin* and on the ETS TExES website at **www.texes.ets.org**).
- Take 3 or 4 well-sharpened soft-lead (No. 2 or HD) pencils with good erasers.
- Eat before you take the test.
- Be prepared to stand in line to check in or to wait while other test takers are being checked in.
- Stay calm. You can't control the testing situation, but you can control yourself. Test administrators are well trained and make every effort to provide uniform testing conditions, but don't let it bother you if a test doesn't start exactly on time. You will have the necessary amount of time once it does start. Using the *Reducing Test Anxiety* booklet in the days before you test may be helpful in mentally and emotionally preparing yourself to test. It is available free at **www.texes.ets.org**.

You can think of preparing for this test as training for an athletic event. Once you have trained, prepared and rested, give it everything you've got. Good luck.

Appendix A

Study Plan Sheet

STUDY PLAN						
Content covered on test	**How well do I know the content?**	**What material do I have for studying this content?**	**What material do I need for studying this content?**	**Where can I find the materials I need?**	**Dates planned for study of content**	**Date completed**

Appendix B

Preparation Resources

PREPARATION RESOURCES

The resources listed below may help you prepare for the TExES test in this field. These preparation resources have been identified by content experts in the field to provide up-to-date information that relates to the field in general. You may wish to use current issues or editions to obtain information on specific topics for study and review.

MATHEMATICS

Journals

American Mathematical Monthly, Mathematical Association of America.

Journal for Research in Mathematics Education, National Council of Teachers of Mathematics.

Mathematics Magazine, Mathematical Association of America.

Mathematics Teacher, National Council of Teachers of Mathematics.

Other Resources

Bittenger, M. L., and Ellenbogen, D. (2005). *Elementary Algebra: Concepts and Applications*, Seventh Edition. Menlo Park, Calif.: Addison-Wesley.

Bock, D., Velleman, P., and De Veaux, R. (2009). *Stats: Modeling the World*, Third Edition. Boston, Mass.: Pearson Education, Inc.

Brahier, D. J. (2009). *Teaching Secondary and Middle School Mathematics*, Fourth Edition. Needham Heights, Mass.: Allyn & Bacon.

Brumbaugh, D. K., and Rock, D. (2006). *Teaching Secondary Mathematics*, Third Edition. Mahwah, N.J.: Lawrence Erlbaum Associates.

Burger, E., and Starbird, M. (2005). *The Heart of Mathematics: An Invitation to Effective Thinking*, Second Edition. Emeryville, Calif.: Key College Publishing.

COMAP (2008). *For All Practical Purposes: Mathematical Literacy in Today's World*, Eighth Edition. New York, N.Y.: W. H. Freeman & Company.

Connally, E., Hughes-Hallett, D., Gleason, A., et al. (2007). *Functions Modeling Change: A Preparation for Calculus*, Third Edition. Hoboken, N.J.: John Wiley & Sons, Inc.

Cooney, T., Brown, S., Dossey, J., Schrage, G., and Wittmann, E. (1999). *Mathematics, Pedagogy, and Secondary Teacher Education*. Portsmouth, N.H.: Heinemann.

Coxford, A., Usiskin, Z., and Hirschhorn, D. (1998). *The University of Chicago School of Mathematics Project: Geometry*. Glenview, Ill.: Scott, Foresman and Company.

Crouse, R. J., and Sloyer, C. W. (1987). *Mathematical Questions from the Classroom — Parts I and II*. Providence, R.I.: Janson Publications.

Danielson, C., and Marquez, E. (1998). *A Collection of Performance Tasks and Rubrics: High School Mathematics*. Larchmont, N.Y.: Eye on Education.

Demana, F., Waits, B. K., Clemens, S. R., and Foley, G. D. (1997). *Precalculus: A Graphing Approach*, Fourth Edition. Menlo Park, Calif.: Addison-Wesley.

Farlow, S. J. (1994). *Finite Mathematics and Its Applications*, Second Edition. Boston, Mass.: WCB McGraw-Hill.

Foerster, P. A. (2005). *Calculus Concepts and Applications*, Second Edition. Berkeley, Calif.: Key Curriculum Press.

Garfunkel, Godbold, and Pollak. (1999). *Mathematics: Modeling Our World. Books 1, 2 & 3*. New York, N.Y.: W. H. Freeman & Co.

Greenburg, M. (2008). *Euclidean and Non-Euclidean Geometries: Development and History*, Fourth Edition. New York, N.Y.: W. H. Freeman and Company.

Hughes-Hallett, D., Gleason, A., McCallum, W., et al. (2008). *Calculus: Single Variable*, Fifth Edition. Hoboken, N.J.: John Wiley & Sons, Inc.

Hungerford, T. W. (2004). *Contemporary College Algebra and Trigonometry: A Graphing Approach*, Second Edition. Philadelphia, Pa.: Harcourt College Publishers.

Johnson, K., Herr, T., Kysh, J. (2004). *Problem Solving Strategies: Crossing the River with Dogs*, Third Edition. Emeryville, Calif.: Key College Publishing.

Kilpatrick, J., Swafford, J., and Finell, B. (Eds.) (2001). *Adding It Up: Helping Children Learn Mathematics*. Washington, District of Columbia: National Academy Press.

Kinsey, L., and Moore, T. (2002) *Symmetry, Shape, and Space: An Introduction to Mathematics Through Geometry*. Emeryville, Calif.: Key College Publishing.

Larson, R., Hostetler, R., and Edwards, B. (2005). *Calculus of a Single Variable*, Eighth Edition. Boston, Mass.: Houghton Mifflin Harcourt.

Lay, S. (2005). *Analysis: With an Introduction to Proof*, Fourth Edition. Upper Saddle River, N.J.: Pearson Education, Inc.

Leitzel, James R. C. (1991). *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics*. Washington, District of Columbia: Mathematical Association of America.

National Council of Teachers of Mathematics. (1995). *Assessment Standards for School Mathematics*. Reston, Va.: The National Council of Teachers of Mathematics, Inc.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. Reston, Va.: The National Council of Teachers of Mathematics, Inc.

National Council of Teachers of Mathematics. (1991). *Professional Standards for Teaching Mathematics*. Reston, Va.: The National Council of Teachers of Mathematics, Inc.

National Council of Teachers of Mathematics. (2009). *Focus in High School Mathematics: Reasoning and Sense Making*. Reston, Va.: The National Council of Teachers of Mathematics, Inc.

Newmark, J. (1997). *Statistics and Probability in Modern Life*, Sixth Edition. Philadelphia, Pa.: Saunders College Publishing.

Northey, S. (2005). *Handbook on Differentiated Instruction for Middle and High Schools*. Larchmont, N.Y.: Eye on Education.

Robbins, N. (2006). *Beginning Number Theory*, Second Edition. Sudbury, Mass.: Jones and Bartlett Publishers.

Rosen, K. (2006). *Discrete Mathematics and Its Applications*, Sixth Edition. Boston, Mass.: McGraw-Hill Higher Education.

Serra, M. (2007). *Discovering Geometry: An Investigative Approach*, Fourth Edition. Emeryville, Calif.: Key Curriculum Press.

Shaughnessy, J., Chance, B., and Kranendonk, H. (2009). *Focus in High School Mathematics: Reasoning and Sense Making in Statistics and Probability*. Reston, Va.: The National Council of Teachers of Mathematics, Inc.

Strang, G. (2005). *Linear Algebra and its Applications*, Fourth Edition. Pacific Grove, Calif.: Brooks Cole Publishers.

Texas Education Agency. (2009). *Texas Essential Knowledge and Skills (TEKS)*.

Triola, M. F. (2001). Elementary Statistics, Eighth Edition. Boston, Mass.: Addison Wesley Longman, Inc.

Usiskin, Z., Peressini, A., Marchisotto, E., and Stanley, D. (2003). *Mathematics for High School Teachers: An Advanced Perspective*. Upper Saddle River, N.J.: Pearson Education, Inc.

Williams, G. (2004). *Applied College Algebra: A Graphing Approach*, Second Edition. Philadelphia, Pa.: Harcourt College Publishers.

Wolf, R. (1998). *Proof, Logic, and Conjecture: The Mathematician's Toolbox*. New York, N.Y.: W. H. Freeman and Company.

Wright, D. (1999). *Introduction to Linear Algebra*. Boston, Mass.: WCB McGraw-Hill.

Online Resources

Mathematical Association of America — www.maa.org

Math Forum at Drexel — www.mathforum.org

National Council of Teachers of Mathematics — www.nctm.org

National Research Council — http://sites.nationalacademies.org/NRC

Wolfram MathWorld — www.mathworld.wolfram.com

PHYSICS

Journals

American Scientist, Sigma XI, the Scientific Research Society.

Texas Science Teacher, Science Teachers Association of Texas.

The Physics Teacher, American Association of Physics Teachers.

The Science Teacher, National Science Teachers Association.

Other Resources

Arons, A. B. (1997). *Teaching Introductory Physics*. Wiley.

Center for Science, Mathematics, and Engineering Education: National Research Council. (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*. Washington, District of Columbia: National Academy Press.

Chiappetta, E. L., Koballa, T. R., and Collette, A. T. (2009). *Science Instruction in the Middle and Secondary Schools*, Seventh Edition. Allyn & Bacon.

Crotts, D. (1995). *Critical Thinking Skills: Science*. Frank Schaffer Publications, Inc.

Cunningham, J., and Herr, N. (1994). *Hands-on Physics Activities with Real-Life Applications: Easy-to-Use Labs and Demonstrations for Grades 8–12*. West Nyack, N.Y.: Center for Applied Research in Education.

Ebenezer, J., and Haggerty, S. (1999). *Becoming a Secondary School Science Teacher*, First Edition. Prentice-Hall.

Haber-Schaim, U., et al. (1991). *PSSC Physics*, Seventh Edition. Kendall/Hunt.

Halliday, D., Resnick, R., and Walker, J. (2010). *Fundamentals of Physics*, Ninth Edition. Wiley.

Hewitt, P., Suchocki, J., and Hewitt, L. A. (2007). *Conceptual Physical Science*, Fourth Edition. Addison-Wesley.

Joyce, B. R., Weil, M., and Calhoun, E. (2003). *Models of Teaching*, Seventh Edition. Allyn & Bacon.

National Research Council. (1996). *National Science Education Standards*. Washington, District of Columbia: National Academy Press.

Ostlund, K. L. (1992). *Science Process Skills: Assessing Hands-On Student Performance*. Addison-Wesley.

Project 2061 (American Association for the Advancement of Science). (1993). *Benchmarks for Science Literacy*. New York, N.Y.: Oxford University Press.

Rakow, S. J. (Ed.). (1998). *NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice*, Middle School Edition. Arlington, Va.: National Science Teachers Association.

Ramig, J., Bailer, J., and Ramsey, J. (1995). *Teaching Science Process Skills*. Frank Schaffer Publications.

Rezba, R., et al. (2008). *Learning and Assessing Science Process Skills*, Fifth Edition. Kendall/Hunt Publishing Company.

Santa, C. M., and Alverman, D. E. (Eds.). (1991). *Science Learning: Processes and Applications*. Newark, Del.: International Reading Association, Inc.

Serway, R. A., Vuille, C., and Faughn, J. S. (2009). *College Physics*, Eighth Edition. Brooks Cole.

Texas Education Agency. (2010). *Texas Essential Knowledge and Skills (TEKS)*.

Texas Education Agency. (2010). *Texas Safety Standards: Kindergarten through Grade 12*, Fourth Edition.

Tipler, P. A., and Llewellyn, R. A. (2007). *Modern Physics*, Fifth Edition. W. H. Freeman.

Trowbridge, L. W., Bybee, R. W., and Powell, J. C. (2008). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy*, Ninth Edition. Prentice-Hall.

Online Resources

American Association for the Advancement of Science — www.aaas.org

American Association of Physics Teachers — www.aapt.org

American Physical Society — www.aps.org

National Science Teachers Association — www.nsta.org

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