



TE_xMaT | Texas Examinations for Master Teachers

Preparation Manual



092 Master Science Teacher 8–12

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PREFACE

The Texas Examinations for Master Teachers® (TExMaT®) program has its origins in legislation passed in 1999 (House Bill 2307) that required the creation of the Master Reading Teacher (MRT) Certificate, the development of standards for the certificate, and the development of a Master Reading Teacher examination. In 2001, the Texas legislature passed legislation creating two additional categories of Master Teacher Certificates, the Master Mathematics Teacher (three certificates: Early Childhood–Grade 4, Grades 4–8, and Grades 8–12) and Master Technology Teacher (Early Childhood–Grade 12).

The Master Science Teacher (MST) Certificate originated with the Texas Science Initiative, which calls for the development of a cadre of science experts in Texas public schools who can teach science and mentor other teachers in best practices for science instruction. The MST Certificate was created by the Texas legislature in 2003 as part of the state's new focus on improving student achievement in the core area of science. Three levels of Master Science Teacher Certificates were established: Early Childhood–Grade 4, Grades 4–8, and Grades 8–12.

A Master Science Teacher Certificate may be obtained by individuals who:

- hold a teaching certificate,
- have at least three years of teaching experience,
- complete an SBEC-approved Master Science Teacher preparation program, AND
- pass the TExMaT Master Science Teacher EC–4, 4–8, *or* 8–12 certification examination.

The development of the educator standards for the Master Science Teacher Certificates was completed in August 2004. The first SBEC-approved Master Science Teacher preparation programs became available in early 2005. The TExMaT Master Science Teacher certification examinations are scheduled to be implemented in Spring 2006.

This manual is designed to help examinees prepare for the new Master Science Teacher 8–12 test. Its purpose is to familiarize examinees with the competencies to be tested, test item formats, and pertinent study resources. Educator preparation program staff may also find this information useful as they help examinees prepare for careers as Texas Master Teachers.

More information about the new TExMaT tests and the educator standards can be found at <http://www.sbec.state.tx.us>.

KEY FEATURES OF THE MANUAL

List of competencies that will be tested

Strategies for answering test questions

Sample test items and answer key

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SECTION I

THE NEW TExMAT TESTS FOR MASTER TEACHERS

Successful performance on the TExMaT examination is required for the issuance of a Texas Master Teacher certificate. Each TExMaT test is a criterion-referenced examination designed to measure the knowledge and skills delineated in the corresponding TExMaT test framework. Each test framework is based on standards that were developed by Texas educators and other education stakeholders.

Each newly developed TExMaT test is designed to measure the requisite knowledge and skills that an initially-certified Texas Master Teacher in this field in Texas public schools must possess. This test includes both individual, or stand-alone, test items (questions) and a case study assignment for which candidates will construct a written response.

Development of the New TExMaT Tests

Committees of Texas educators and interested citizens guide the development of the new TExMaT tests by participating in each stage of the test development process. These working committees are comprised of Texas educators from public and charter schools, faculty from educator preparation programs, 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 TExMaT tests are described below.

1. **Develop Standards.** Committees are convened to recommend what an initially-certified Master Teacher in this field should know and be able to do. To ensure vertical alignment of standards across the range of instructional levels, individuals with expertise in early childhood, elementary, middle, or high school education meet jointly to articulate the critical knowledge and skills for a particular content area. Participants begin their dialogue using a "clean slate" approach with the Texas Essential Knowledge and Skills (TEKS) as the focal point. Draft standards are written to incorporate the TEKS and to expand upon that content to ensure that an initially-certified Master Teacher in this field possesses the appropriate level of both knowledge and skills to instruct successfully.
2. **Review Standards.** Committees review and revise the draft standards. The revised draft standards are then placed on the SBEC Web site 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.
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 TExMaT tests. The TExMaT competencies represent the critical components of the standards that can be measured with either a paper-and-pencil-based or a computer-based examination, as appropriate. 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 a Master Teacher 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 Items.** The test contractor develops draft items (multiple-choice items and case study assignments) that are designed to measure the competencies described in the test framework. Committees review the newly developed test items that have been written to reflect the competencies in the new test frameworks. Committee members scrutinize the draft items 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 Items.** All of the newly developed test items that have been deemed acceptable by the item 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 items are valid, reliable, and free from bias.
8. **Administer New TExMaT Tests.** New TExMaT 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 TExMaT test and to recommend a final passing standard for that test. The SBEC considers this recommendation as it establishes a passing score on the test.

Taking the TExMaT Master Science Teacher Test and Receiving Scores

Please refer to the current TExMaT registration bulletin for information on test dates, sites, fees, registration procedures, and policies.

You will be mailed a score report approximately four weeks after each test you take. 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 items answered correctly and is not determined by averaging the number of questions answered correctly in each domain.
 - For all TExMaT 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 a Master Teacher in this field in Texas public schools.
- a holistic score for your response to the case study assignment.
- 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.
- information to help you understand the score scale and interpret your results.

You will not receive a score report if you are absent or choose to cancel your score.

Additionally, unofficial score report information will be posted on the Internet on the score report date for each test administration. Information about receiving unofficial scores on the Internet, the score scale, and other score report topics may be found on the SBEC Web site at www.sbec.state.tx.us.

Educator Standards

Complete, approved educator standards are posted on the SBEC Web site at www.sbec.state.tx.us.

SECTION II

USING THE TEST FRAMEWORK

The Texas Examinations for Master Teachers (TExMaT) test measures the content and professional knowledge required of an initially-certified Master Teacher in this 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.

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 items that are included in this manual. These test questions represent only a *sample* of items. Thus, your test preparation should focus on the complete content eligible for testing, as specified in the competencies and descriptive statements.

Organization of the TExMaT 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 initially-certified Master Teacher in this field 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 8. These are then followed by a complete set of the framework's competencies and descriptive statements.

An example of a competency and its accompanying descriptive statements is provided on the next page.

Sample Competency and Descriptive Statements

Master Science Teacher 8–12

Competency:

The Master Science Teacher 8–12 understands the historical perspectives of science and how science interacts with and influences personal and societal decisions.

Descriptive Statements:

The Master Science Teacher:

- Demonstrates an understanding of the historical development of science and scientific knowledge.
- Analyzes the significance of key scientific and technological advances.
- Recognizes the contributions that diverse cultures and individuals have made to scientific knowledge and designs science instruction that is inclusive and accounts for these contributions.
- Analyzes how personal or societal needs and priorities can affect the direction, support, and applications of scientific research.
- Demonstrates an understanding of the role science can play in helping cause and/or resolve personal, societal, and global challenges.
- Knows how to apply scientific principles, the theory of probability, and the principles of risk-benefit analysis to analyze the advantages, disadvantages, or alternatives to a given decision or course of action.
- Recognizes how learning science enables students to function in an increasingly complex society.

Studying for the TExMaT Test

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

1. Identify the information the test will cover by reading through the test competencies (see the following pages in this section). *Within each domain* of this TExMaT 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 for possible resources to consult. Also, compile key materials from your preparation coursework that are aligned with the competencies.
4. Study this manual for approaches to taking the TExMaT test.
5. When using resources, concentrate on the key ideas and important concepts that are discussed in the competencies and descriptive statements.

NOTE: This preparation manual is the only TExMaT test study material endorsed by the SBEC for this field. Other preparation materials may not accurately reflect the content of the test or the policies and procedures of the TExMaT program.

TEST FRAMEWORK FOR FIELD 092: MASTER SCIENCE TEACHER 8–12

Domain I *Physical Science (approximately 18% of the test)*

Standards Assessed:

Master Science Teacher Standard I:

Content: The Master Science Teacher knows and understands and is able to mentor the teaching of the Texas Essential Knowledge and Skills (TEKS) in science.

Master Science Teacher Standard III:

Scientific Inquiry: The Master Science Teacher understands, applies knowledge of, and guides others to understand processes of scientific inquiry and the role of inquiry in science learning and teaching.

Master Science Teacher Standard V:

Safety: The Master Science Teacher understands, implements, models, and advocates: safe classroom, field, and laboratory experiences; safe use of equipment and technology; and ethical use of organisms and specimens and guides others to do the same.

Master Science Teacher Standard VI:

Inclusive Instruction: The Master Science Teacher uses and guides others to use a variety of instructional strategies and resources to meet the diverse needs of all learners.

Domain II *Life Science (approximately 18% of the test)*

Standards Assessed:

Master Science Teacher Standard I:

Content: The Master Science Teacher knows and understands and is able to mentor the teaching of the Texas Essential Knowledge and Skills (TEKS) in science.

Master Science Teacher Standard III:

Scientific Inquiry: The Master Science Teacher understands, applies knowledge of, and guides others to understand processes of scientific inquiry and the role of inquiry in science learning and teaching.

Master Science Teacher Standard V:

Safety: The Master Science Teacher understands, implements, models, and advocates: safe classroom, field, and laboratory experiences; safe use of equipment and technology; and ethical use of organisms and specimens and guides others to do the same.

Master Science Teacher Standard VI:

Inclusive Instruction: The Master Science Teacher uses and guides others to use a variety of instructional strategies and resources to meet the diverse needs of all learners.

Domain III Earth and Space Science (approximately 18% of the test)

Standards Assessed:

Master Science Teacher Standard I:

Content: The Master Science Teacher knows and understands and is able to mentor the teaching of the Texas Essential Knowledge and Skills (TEKS) in science.

Master Science Teacher Standard III:

Scientific Inquiry: The Master Science Teacher understands, applies knowledge of, and guides others to understand processes of scientific inquiry and the role of inquiry in science learning and teaching.

Master Science Teacher Standard V:

Safety: The Master Science Teacher understands, implements, models, and advocates: safe classroom, field, and laboratory experiences; safe use of equipment and technology; and ethical use of organisms and specimens and guides others to do the same.

Master Science Teacher Standard VI:

Inclusive Instruction: The Master Science Teacher uses and guides others to use a variety of instructional strategies and resources to meet the diverse needs of all learners.

Domain IV The History, Nature, and Context of Science; Scientific Inquiry; and Safety (approximately 18% of the test)

Standards Assessed:

Master Science Teacher Standard I:

Content: The Master Science Teacher knows and understands and is able to mentor the teaching of the Texas Essential Knowledge and Skills (TEKS) in science.

Master Science Teacher Standard II:

History, Nature, and Context of Science: The Master Science Teacher understands, applies knowledge of, and guides others to understand the historical perspectives of science, the nature of science, and how science interacts with and influences personal and societal decisions.

Master Science Teacher Standard III:

Scientific Inquiry: The Master Science Teacher understands, applies knowledge of, and guides others to understand processes of scientific inquiry and the role of inquiry in science learning and teaching.

Master Science Teacher Standard V:

Safety: The Master Science Teacher understands, implements, models, and advocates: safe classroom, field, and laboratory experiences; safe use of equipment and technology; and ethical use of organisms and specimens and guides others to do the same.

Domain V *Alignment and Integration, Instruction, and Assessment (approximately 14% of the test)*

Standards Assessed:

Master Science Teacher Standard IV:

Alignment and Integration: The Master Science Teacher understands, applies knowledge of, and guides others to understand the Texas Essential Knowledge and Skills (TEKS) and the national science standards and knows the importance of vertical alignment of the TEKS and integration of the science disciplines with one another and with other disciplines.

Master Science Teacher Standard VI:

Inclusive Instruction: The Master Science Teacher uses and guides others to use a variety of instructional strategies and resources to meet the diverse needs of all learners.

Master Science Teacher Standard VIII:

Student Assessment: The Master Science Teacher collaborates to select, construct, and administer aligned assessments, analyzes the results to modify instruction to improve student achievement, and develops those skills in others.

Domain VI *The Learning and Teaching Environment, Mentoring, and Shared Leadership (approximately 14% of the test)*

Standards Assessed:

Master Science Teacher Standard VII:

Learning and Teaching Environment: The Master Science Teacher demonstrates and promotes a positive attitude, high expectations, passion, and enthusiasm for science learning and teaching.

Master Science Teacher Standard IX:

Mentoring and Shared Leadership: The Master Science Teacher facilitates standards-based science instruction by: communicating and collaborating with educational stakeholders; exhibiting leadership, mentoring, coaching, and consulting with colleagues; facilitating professional development; and making decisions based on research.

DOMAIN I—PHYSICAL SCIENCE CONTENT AND PEDAGOGY

Competency 001 (Properties of Matter) Standard I

The Master Science Teacher 8–12 understands the physical and chemical properties of matter.

The Master Science Teacher:

- Analyzes physical, chemical, and nuclear changes, including changes in state, and factors that affect chemical reactions.
- Recognizes characteristics and applications of various types of reactions (e.g., oxidation-reduction, acid-base).
- Understands the characteristics of and differences between elements, compounds, and heterogeneous mixtures.
- Applies the law of conservation of matter to analyze a variety of situations.
- Applies the gas laws to predict gas behavior in a variety of situations and understands the relationship between the kinetic theory and the universal gas law.
- Understands atomic structure and relates it to the organization of the periodic table and the properties of different elements.
- Understands the different kinds of chemical bonds and intermolecular forces and their effects on properties of substances.
- Interprets chemical formulas, balances equations, and solves problems involving mass and mole relationships.

Competency 002 (Force and Motion) Standard I

The Master Science Teacher 8–12 understands the concepts of and relationship between force and motion.

The Master Science Teacher:

- Applies Newton's laws of motion and the law of universal gravitation to analyze the behavior of objects and to solve a variety of practical problems (e.g., motion, force, mass).
- Analyzes the effects of balanced and unbalanced forces on the position and motion of objects, including interpreting free-body diagrams and graphical representations.
- Applies knowledge of the relationship between force and motion to analyze common systems, simple machines, and everyday situations.
- Analyzes factors affecting the motion of an object (e.g., friction, velocity, acceleration, inertial mass, momentum).

Competency 003 (Energy and Energy Transformations) Standard I
The Master Science Teacher 8–12 understands forms of energy and energy transformations.

The Master Science Teacher:

- Recognizes the properties of various forms of energy and analyzes how energy is transferred and transformed from one form to another in a variety of everyday situations.
- Applies the law of conservation of energy to a variety of phenomena and solves problems involving conservation of energy in physical systems.
- Understands the principles of electricity and magnetism and the application of these principles in technological devices.
- Applies the laws of thermodynamics to everyday situations.
- Applies knowledge of the properties and characteristics of waves (e.g., amplitude, frequency, velocity, wavelength) to analyze sound, light, and other wave phenomena.

Competency 004 (Strategies, Resources, and Equipment) Standards III, V, VI
The Master Science Teacher 8–12 understands and uses a variety of strategies and resources, including scientific equipment and technology, for teaching developmentally appropriate physical science concepts.

The Master Science Teacher:

- Applies knowledge of appropriate techniques, procedures, technology, and tools to observe, record, analyze, and communicate data related to phenomena associated with physical science.
- Knows how to select and safely adapt everyday materials for physical science activities and effectively uses a variety of instructional resources associated with physical science.
- Recognizes and assesses students' preconceptions and misconceptions about phenomena related to physical science.
- Plans, implements, and evaluates lessons, including field and laboratory activities, that assist students in understanding concepts and making generalizations associated with physical science.

DOMAIN II—LIFE SCIENCE CONTENT AND PEDAGOGY

Competency 005 (Characteristics and Needs of Organisms) Standard I

The Master Science Teacher 8–12 understands the basic characteristics and needs of organisms.

The Master Science Teacher:

- Explains how organisms and cells carry out life processes, including homeostasis, energy transformations (e.g., photosynthesis, cellular respiration), transportation of molecules, disposal of wastes, synthesis of new molecules, cellular reproduction, growth, and asexual and sexual reproduction.
- Compares the structure and functions of different kinds of biomolecules, such as carbohydrates, lipids, proteins, and nucleic acids.
- Recognizes levels of organization (e.g., cells, tissues, organs, organ systems) in a variety of organisms and the functions and interactions of types of cells, tissues, organs, and organ systems.
- Recognizes the role of internal and external stimuli in the behavior of organisms and identifies feedback mechanisms that allow organisms to maintain homeostasis.
- Understands stages in the life cycles of various organisms and the reproductive cycles of viruses.
- Understands the roles of microorganisms and viruses in maintaining health and causing illness or disease.

Competency 006 (Reproduction, Heredity, and the Principles of Evolution) Standard I

The Master Science Teacher 8–12 understands reproduction, the principles of heredity, and the evolution of life.

The Master Science Teacher:

- Understands the processes by which various organisms reproduce and explains how hereditary information is passed from one generation to the next, including predicting the probable outcomes of genetic combinations involving dominant and recessive traits.
- Understands the structure and replication of DNA and the process of protein synthesis.
- Describes the biological significance and causes of genetic variation in populations.
- Analyzes the role of natural selection in species variation, diversity, speciation, phylogeny, adaptation, behavior, and extinction.
- Analyzes how interactions with the surrounding environment (e.g., food availability, competition, geographic barriers, climate) can result in changes in gene frequency.
- Demonstrates understanding of the principles of and evidence for the theory of evolution, including how adaptations influence the survival of populations or species.
- Analyzes the characteristics of and relationships among organisms to determine their biological classifications.

Competency 007 (Organisms within Ecosystems) Standard I
The Master Science Teacher 8–12 understands relationships among organisms and between organisms and their environment.

The Master Science Teacher:

- Analyzes ways living organisms depend on one another and their environment for basic needs.
- Recognizes characteristics of major ecosystems and biomes and understands the consequences of species loss or introduction within a particular ecosystem.
- Understands and interprets various representations of the flow of energy and matter among organisms and within ecosystems (e.g., interrelationships among producers, consumers, and decomposers; characteristics of biogeochemical cycles).
- Demonstrates understanding of the concept of ecological niche and understands its relationship to characteristics of species in an ecosystem.
- Analyzes types of interactions among species (e.g., symbiosis, parasitism, competition) in an ecosystem.
- Understands ecological succession and analyzes the response of ecosystems to changes in the environment.

Competency 008 (Strategies, Resources, and Equipment) Standards III, V, VI
The Master Science Teacher 8–12 understands and uses a variety of strategies and resources, including scientific equipment and technology, for teaching developmentally appropriate life science concepts.

The Master Science Teacher:

- Applies knowledge of appropriate techniques, procedures, technology, and tools to observe, record, analyze, and communicate data related to phenomena associated with life science.
- Knows how to select and safely adapt everyday materials for life science activities and effectively uses a variety of instructional resources associated with life science.
- Recognizes and assesses students' preconceptions and misconceptions about phenomena related to life science.
- Plans, implements, and evaluates lessons, including field and laboratory activities, that assist students in developing concepts and making generalizations associated with life science.

DOMAIN III—EARTH AND SPACE SCIENCE CONTENT AND PEDAGOGY

Competency 009 (Earth Materials and Processes) Standard I

The Master Science Teacher 8–12 understands the properties of Earth materials and the structure, function, and history of Earth systems.

The Master Science Teacher:

- Describes properties and uses of minerals, fossils, rocks, soils, water, atmospheric gases, and other Earth materials, including renewable, nonrenewable, and inexhaustible resources.
- Describes theories and evidence regarding the formation and history of Earth and analyzes factors that influence the formation of rock types.
- Understands the structure and function of the lithosphere and its interactions with the biosphere, hydrosphere, and atmosphere.
- Analyzes changes in Earth systems resulting from natural events and human activities.
- Recognizes cycles in Earth systems (e.g., rock cycle, water cycle, carbon cycle, nitrogen cycle).
- Analyzes the evolution and characteristics of different landforms and the forces and processes that shape them (e.g., faulting, folding, plate movements, earthquakes, volcanic activity, weathering, erosion).

Competency 010 (Hydrosphere and Atmosphere) Standard I

The Master Science Teacher 8–12 understands the structure and function of the hydrosphere and characteristics of Earth's climate, weather, and atmosphere.

The Master Science Teacher:

- Recognizes the impact of the hydrosphere on land forms (e.g., erosion, weathering, coastal processes), organisms, and ecosystems.
- Identifies the components of the water cycle and their relationship to weather and climate.
- Knows how Earth's position, orientation, and surface features affect seasons, weather, and climate.
- Understands factors affecting climate and the causes of weather phenomena.
- Identifies chemical and physical characteristics of the atmosphere and analyzes changes in climate and weather caused by natural events and human activities.
- Understands the physical and chemical characteristics of oceans and analyzes ocean circulation and its effect on climate and the biosphere.
- Identifies and analyzes the characteristics of a watershed and the local and global factors that can affect the quality and quantity of groundwater and surface water resources.

Competency 011 (Solar System and Universe) Standard I

The Master Science Teacher 8–12 understands components and characteristics of the solar system and universe.

The Master Science Teacher:

- Understands the origin, history, and properties of the universe.
- Understands theories of the origin of solar systems, including the processes that form stars and the characteristic stages in the life cycle of a star.
- Describes how characteristics of stars, such as temperature, age, relative size, composition, and velocity, can be determined.
- Identifies, orders, and describes components of the solar system (e.g., physical characteristics of planets, moons, asteroids, comets) and their relationship to the sun and to each other.
- Identifies methods of exploring space and analyzes how data collected by the space program have contributed to scientific knowledge about Earth, the solar system, and the universe.
- Analyzes the effect of the sun on Earth systems (e.g., atmospheric circulation, ecosystems).
- Describes and analyzes the transfer of energy within the sun–Earth system and within Earth's subsystems.
- Relates the movements and orientations of the moon, Earth, and the sun to tides, phases, eclipses, and day and night.

Competency 012 (Strategies, Resources, and Equipment) Standards III, V, VI

The Master Science Teacher 8–12 understands and uses a variety of strategies and resources, including scientific equipment and technology, for teaching developmentally appropriate earth and space science concepts.

The Master Science Teacher:

- Applies knowledge of appropriate techniques, procedures, technology, and tools to observe, record, analyze, and communicate data related to phenomena associated with earth and space science.
- Knows how to select and safely adapt everyday materials for earth and space science activities and effectively uses a variety of instructional resources associated with earth and space science.
- Recognizes and assesses students' preconceptions and misconceptions about phenomena related to earth and space science.
- Plans, implements, and evaluates lessons, including field and laboratory activities, that assist students in developing concepts and making generalizations associated with earth and space science.

**DOMAIN IV—THE HISTORY, NATURE, AND CONTEXT OF SCIENCE; SCIENTIFIC INQUIRY;
AND SAFETY**

Competency 013 (Historical, Personal, and Societal Contexts) Standard II

The Master Science Teacher 8–12 understands the historical perspectives of science and how science interacts with and influences personal and societal decisions.

The Master Science Teacher:

- Demonstrates an understanding of the historical development of science and scientific knowledge.
- Analyzes the significance of key scientific and technological advances (e.g., Copernican revolution, relativity, atomic theory, cell theory, industrial revolution).
- Recognizes the contributions that diverse cultures and individuals have made to scientific knowledge and designs science instruction that is inclusive and accounts for these contributions.
- Analyzes how personal or societal needs and priorities can affect the direction, support, and applications of scientific research.
- Demonstrates an understanding of the role science can play in helping cause and/or resolve personal, societal, and global challenges.
- Knows how to apply scientific principles, the methods of statistical analysis and probability, and the principles of risk-benefit analysis to analyze the advantages, disadvantages, or alternatives to a given decision or course of action.
- Recognizes how learning science enables students to function in an increasingly complex society.

Competency 014 (Nature of Science and Unifying Themes) Standards I and II
The Master Science Teacher 8–12 understands the nature of scientific thought and how unifying themes form a conceptual framework to organize science and technology.

The Master Science Teacher:

- Demonstrates an understanding of the organizational, explanatory, and predictive power of scientific theories and models and recognizes the limitations to the kinds of questions that can be answered through scientific means.
- Knows that all scientific ideas are subject to refinement as new information challenges prevailing theories and as new theories cause previous observations to be interpreted in new ways.
- Recognizes the role of logical reasoning in developing, evaluating, and validating scientific explanations and is able to analyze, review, and critique hypotheses and theories using scientific evidence and information.
- Knows the roles of sharing research results and peer review in developing and validating scientific knowledge.
- Demonstrates an understanding of the principles of scientific ethics in conducting research and reporting results.
- Uses physical, conceptual, and mathematical models to describe and make predictions about natural phenomena and evaluates the strengths and limitations of various types of models.
- Demonstrates an understanding of how certain concepts and processes (i.e., systems, order, and organization; evidence, models, and explanation; change, constancy, and measurements; evolution and equilibrium; form and function; properties and patterns) form a unifying framework for science and technology and are applied to the various science disciplines.
- Analyzes systems in terms of cycles, structure, processes, properties, patterns, and the interactions that occur among the components of a given system or subsystem.

Competency 015 (Scientific Inquiry) Standard III

The Master Science Teacher 8–12 understands the processes of scientific inquiry and applies these processes in science learning and teaching and guides others to do so.

The Master Science Teacher:

- Knows the processes, tenets, and assumptions of different methods of inquiry leading to scientific knowledge and links investigations to students' prior knowledge and experiences.
- Demonstrates an understanding of the characteristics, applications, and design of scientific investigations using appropriate methods for experimental and nonexperimental research (e.g., controlled experiments, descriptive studies, comparative data analysis).
- Identifies potential sources of error in a given inquiry-based investigation.
- Recognizes patterns in collected data and observations of natural phenomena.
- Interprets data and applies methods of statistical analysis and measures (e.g., mean, median, mode, correlation).
- Plans and implements instruction that provides opportunities for all students to engage in scientific inquiry and to use higher-order thinking skills, logical reasoning, and problem solving to reach conclusions based on evidence.
- Knows how to assist students in identifying, refining, and focusing scientific ideas and questions that form the basis for an inquiry activity.
- Knows how to assist students in designing and conducting experimental and nonexperimental investigations.
- Knows how to guide students in making systematic observations and measurements, analyzing data, and recording and reporting results.
- Knows how to use and demonstrate the use of a variety of tools and techniques to access, gather, store, retrieve, organize, analyze, and communicate data.
- Knows how to manage groups of students in laboratory and field settings to optimize scientific inquiry.
- Develops criteria for assessing student participation in and understanding of the inquiry process.

Competency 016 (Safety) Standard V

The Master Science Teacher 8–12 understands, implements, models, and advocates for safe science learning environments, safe use of equipment and technology, and the ethical use and care of organisms and guides others to do so.

The Master Science Teacher:

- Knows sources of information about laboratory and field safety (e.g., *Texas Safety Standards for K–12*, *Texas Facilities Standards*) and interprets and appropriately applies safety regulations and guidelines.
- Knows procedures for responding to accidents or emergencies in the classroom, field, or laboratory.
- Knows how to work with the district and school personnel and students to create, implement, and enforce policies, rules, and safety procedures to promote good housekeeping and maintain a safe learning environment during laboratory and field activities.
- Knows strategies and resources for maintaining current safety training and promoting safety training for others.
- Knows how to create a safe, learner-centered environment that is flexible and supportive of scientific inquiry and that provides adequate laboratory space and equipment for all students, including those with special needs.
- Knows how to use and guide others to use safe practices in designing, planning, and implementing instructional activities in the laboratory, field, and classroom.
- Applies procedures to inventory and maintain safety equipment (e.g., chemical splash goggles, eyewash station, sink, safety shower, fire blanket, extinguisher) to optimize quick and safe access to this equipment.
- Demonstrates an understanding of appropriate and ethical procedures for storing, ordering, inventorying, performing safety checks on, handling, using, disposing of, caring for, and maintaining chemicals, materials, living and nonliving specimens, and equipment.
- Demonstrates an understanding of appropriate and ethical care and treatment of living organisms.

DOMAIN V—ALIGNMENT AND INTEGRATION, INSTRUCTION, AND ASSESSMENT

Competency 017 (Vertical Alignment and Integration) Standard IV

The Master Science Teacher 8–12 understands the Texas Essential Knowledge and Skills (TEKS) for Science and other science education initiatives, recognizes the importance of the vertical alignment of the TEKS, and applies strategies for integrating the science disciplines with one another and with other disciplines.

The Master Science Teacher:

- Knows the purpose, content, and organization of the Texas Essential Knowledge and Skills (TEKS) for Science and plans and implements TEKS-based, grade-appropriate instruction that is vertically aligned with the overall science curriculum.
- Demonstrates familiarity with the national science standards and their relationship to the Texas Essential Knowledge and Skills (TEKS) as well as other science education initiatives and applies information from related publications (e.g., *National Science Education Standards*, *Science for All Americans*, *Benchmarks for Science Literacy*) to science curriculum, instruction, and assessment.
- Applies knowledge of students' developmental levels, how people learn science, and the Texas Essential Knowledge and Skills (TEKS) to sequence learning activities.
- Recognizes how learning in one science discipline can support and enhance learning in other science disciplines and knows how to make connections among the science disciplines.
- Demonstrates an understanding of how science fits into the overall curriculum and is able to integrate content, materials, skills, and processes between science and other disciplines in the school curriculum in a meaningful way.
- Recognizes connections between science and daily life and uses common examples from students' daily lives to help explain or illustrate scientific processes, concepts, and principles.
- Knows how to evaluate and select instructional materials based on alignment with the Texas Essential Knowledge and Skills (TEKS), sound scientific principles, and learner-centered pedagogy.
- Knows how to provide guidance to other teachers regarding proper alignment and effective integration of science content.

Competency 018 (Science Instruction) Standard VI

The Master Science Teacher 8–12 plans and implements effective science instruction using a variety of strategies and resources to meet the diverse needs of all learners and guides others to do so.

The Master Science Teacher:

- Knows established theories and research on how all students learn science and develop scientific understanding, how teachers impact students' cognitive development, and how the developmental characteristics of students influence science learning.
- Determines, designs, and uses instructional approaches and activities supported by research evidence as being effective for developing important science content knowledge, concepts, process skills, problem-solving strategies, and critical- and analytical-thinking capacities.
- Recognizes how common preconceptions and misconceptions that students have about scientific phenomena influence learning and applies effective instructional strategies that build on students' prior knowledge and address these preconceptions and misconceptions.
- Knows effective motivational strategies for learning science and how to actively engage students in the learning process by using a variety of instructional formats that are based on research that supports their effectiveness with a range of students, including students who are at risk, English language learners, and students from traditionally underrepresented groups in the sciences.
- Recognizes the importance of taking into account the full diversity of the student population and cultural and gender biases in designing effective science instruction and selecting materials.
- Recognizes assistive technologies that enable students with disabilities and special needs to participate fully in science activities.
- Applies strategies that use instructional time and resources effectively.
- Knows when and how to use individual, small-group, and whole-class strategies to support student learning in science.
- Uses and translates among multiple ways of representing science content (e.g., verbal, concrete, tabular, graphic, pictorial, mathematical, symbolic) of science content.
- Selects and guides students' use of appropriate science tools, materials, media, and technological resources.
- Knows how to provide guidance and feedback to other teachers regarding lesson plans, instructional materials, and teaching strategies to help them develop their knowledge and skills in science instruction for all students.

Competency 019 (Student Assessment) Standard VIII

The Master Science Teacher 8–12 selects, constructs, and administers aligned student assessments; analyzes results to modify instruction; and develops these skills in others.

The Master Science Teacher:

- Recognizes the relationships between curriculum, student assessment, and instruction.
- Demonstrates an understanding of technical issues associated with testing (e.g., reliability, validity, absence of bias, clarity of language, appropriateness of level) and applies this knowledge to the evaluation, selection, design, and administration of student assessment materials and procedures.
- Selects, designs, and administers a variety of appropriate assessment instruments and/or methods (e.g., formal/informal, formative/summative, skills assessment, performance, portfolio, product, presentation, alternative) to monitor student understanding and progress in science and to guide and improve instructional practice.
- Knows the importance of sharing assessment criteria with students and of stating criteria clearly so that students can understand and derive meaning from them.
- Recognizes the role of student assessments as learning experiences and applies strategies for engaging students in meaningful self-assessment.
- Communicates effectively with other teachers about the development and use of student assessment techniques and the interpretation of results to guide instruction.
- Knows how to communicate assessment results to students and parents/guardians.
- Establishes criteria consistent with current ethical and legal principles regarding sharing of assessment results with students, parents/guardians, and appropriate school personnel.

DOMAIN VI—THE LEARNING AND TEACHING ENVIRONMENT, MENTORING, AND SHARED LEADERSHIP

Competency 020 (Learning and Teaching Environment) Standard VII

The Master Science Teacher 8–12 understands the importance of and strategies for creating a positive environment for the learning and teaching of science.

The Master Science Teacher:

- Knows how the attitudes and expectations of teachers and students and the environment inside and outside the school affect the learning of science.
- Reflects on his/her own behaviors and attitudes to ensure high expectations and equity in science instruction for all students.
- Applies the results from research to promote and create a positive learning environment with respect to linguistic, cultural, socioeconomic, and developmental diversity.
- Designs and manages the time, space, and resources needed to create a positive teaching and learning environment.
- Identifies and uses community resources to supplement the school science program in order to create a positive learning and teaching environment.
- Uses a variety of strategies to establish a collaborative scientific community among students and teachers that supports actively engaged learning (e.g., listening to and respecting students' ideas, modeling effective learning processes, conveying a sense of passion and enthusiasm about science).
- Knows how to advocate for students and science education in the school and community.
- Promotes careers in science and science education.
- Recognizes the importance of keeping up-to-date on current and emerging science topics and technology and uses effective strategies and resources for doing so.
- Promotes academic integrity in the learning environment.

Competency 021 (Leadership, Communication, and Collaboration) Standard IX
The Master Science Teacher 8–12 uses leadership skills and knows how to communicate and collaborate with educational stakeholders to facilitate implementation of standards-based science instruction.

The Master Science Teacher:

- Knows the dual role of the Master Science Teacher as teacher and mentor in the school community.
- Demonstrates an understanding of leadership, communication, and facilitation skills.
- Knows and applies principles, guidelines, and professional ethical standards regarding collegial and professional collaborations, including issues related to confidentiality.
- Understands the importance of collaborating with administrators, colleagues, parents/guardians, and other members of the school community to establish and implement the roles of the Master Science Teacher and ensure effective ongoing communication.
- Knows strategies for building trust and a spirit of collaboration with other members of the school community to effect positive change in the school science program and science instruction.
- Knows how to use leadership skills to ensure the effectiveness and ongoing improvement of the school science program, encourage support for the program, and engage others in improving the program.
- Knows how to collaborate with administrators to address the specific needs and concerns of novice teachers of science and factors that contribute to attrition.
- Knows learning processes and procedures that facilitate peer learning and self-learning and uses positive, constructive techniques for providing feedback to other teachers.
- Knows how to cultivate shared leadership among teachers and students in the school system and community at large.
- Knows how to improve scientific literacy in the community by discussing science-related issues with students, colleagues, administrators, parents/guardians, and the community.

**Competency 022 (Mentoring, Coaching, Consultation, and Professional Development)
Standard IX**

The Master Science Teacher 8–12 knows how to provide professional development through mentoring, coaching, and consultation with colleagues, and makes instructional decisions based on research about science and science learning.

The Master Science Teacher:

- Knows and applies research-based skills and strategies for mentoring, coaching, and consulting in the development, implementation, and evaluation of an effective standards-based science program.
- Knows the difference between collaborative consultation done by a mentor and evaluative supervision.
- Knows and applies learning processes and procedures for facilitating adult learning.
- Knows models and features of effective professional development programs that promote sustained application in classroom practice (e.g., demonstration, modeling, guided practice, feedback, coaching, follow-up).
- Knows how to use mentoring, coaching, and consultation to facilitate team building for identifying needs related to science instruction, developing strategies for addressing those needs, and promoting science learning.
- Uses consultation to work effectively with colleagues who have varying levels of skill and experience and/or different philosophical approaches to instruction to develop, implement, and monitor science programs based on the Texas Essential Knowledge and Skills (TEKS).
- Knows how to select and use strategies to maximize effectiveness as a Master Science Teacher, such as applying principles of time management and engaging in continuous self-assessment.
- Knows how to collaborate with teachers, administrators, and others to identify professional development needs, generate support for professional development programs, and ensure provision of effective professional development opportunities.
- Recognizes the importance of being an active participant in professional science and science education organizations.
- Knows sources for locating information about research on science and science learning and understands methods and criteria for reviewing research on science learning and selecting research for educational applications.

SECTION III

MULTIPLE-CHOICE ITEMS

The purpose of this section is to describe multiple-choice item formats that you will see on the TExMaT Master Science Teacher (MST) test and to suggest possible ways to approach thinking about and answering the multiple-choice items. In addition to the introduction to multiple-choice item formats and approaches, you will find sample multiple-choice items, explanations for the correct and incorrect responses for a select number of multiple-choice items, and an answer key.

The Master Science Teacher 8–12 test is designed to include 80 scorable multiple-choice items and approximately 10 nonscorable items. Your final scaled score will be based only on scorable items. The nonscorable multiple-choice items are pilot tested by including them in the test in order to collect information about how these questions will perform under actual testing conditions. Nonscorable test items are not considered in calculating your score, and they are not identified on the test.

All multiple-choice items on this test are designed to assess your knowledge of the content described in the test framework. The multiple-choice items assess your ability to recall factual information **and** to think critically about the information, analyze it, consider it carefully, compare it with other knowledge you have, or make a judgment about it.

When you are ready to answer a multiple-choice item, you must choose one of four *answer choices* labeled A, B, C, and D. Then you must mark your choice on a separate answer sheet.

In addition to the multiple-choice items, the MST test will include one case study assignment. Please see Section IV: Case Study Assignment.

Periodic Table of the Elements

A periodic table of the elements will be provided in your test booklet. A copy of this periodic table is also provided on page 28 of this preparation manual. For the MST 8–12 test, it is not necessary to memorize the names of the elements in the periodic table.

PERIODIC TABLE OF THE ELEMENTS

18 VIIIA																																																																																																									
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Kr 83.8		Br 79.9		Se 79.0		As 74.9		Ge 72.6		Ga 69.7		Zn 65.4		Cu 63.5		Ni 58.7		Co 58.9		Fe 55.8		Mn 54.9		Cr 52.0		V 50.9		Ti 47.9		Zr 91.2		Nb 92.9		Ta 180.9		W 183.9		Os 190.2		Ir 192.2		Pt 195.1		Au 197.0		Hg 200.6		Tl 204.4		Pb 207.2		Bi 209.0		Po (209)		At (210)		Rn (222)																																															
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103		102		101		100		99		98		97		96		95		94		93		92		91		90		89	
Lr (262)		No (259)		Md (258)		Fm (257)		Es (252)		Cf (251)		Bk (247)		Cm (247)		Am (243)		Pu (244)		Np (237)		U 238.0		Pa 231.0		Th 232.0		Ac (227)	

Lanthanide Series
Actinide Series

Some of the elements 110 and above have been reported but not fully authenticated and named.

For the MST 8–12 test, it is not necessary to memorize the names of the elements in the periodic table.

Multiple-Choice Item Formats

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

- Single items
- Items with stimulus material

You may have two or more items related to a single stimulus. When you have at least two items related to a single stimulus, the group of items is called a cluster. After the last item of a clustered item set containing two or more items, you will see the graphic illustrated below.



This graphic is used to separate these clustered items related to specific stimulus material from other items that follow.

SINGLE ITEMS

In the single item format, a problem is presented as a direct question or an incomplete statement, and four answer choices appear below the item. Read each item carefully and critically. Think about what it is asking and the situation it is describing. Eliminate any obviously wrong answer choices, select the correct answer, and mark it on your answer sheet.

ITEMS WITH STIMULUS MATERIAL

Some items are preceded by stimulus material that relates to the items. 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 an event to analyze, a problem to solve, or a decision to make.

One or more items may be related to a single stimulus. You can use several different approaches to answer these types of items. Some commonly used approaches are listed below.

- Strategy 1** Skim the stimulus material to understand its purpose, its arrangement, and/or its content, then read the item and refer again to the stimulus material to verify the correct answer.
- Strategy 2** Read the item *before* considering the stimulus material. The content of the item will help you identify the purpose of the stimulus material and locate the information you need to respond to the item.
- Strategy 3** Use a combination of both strategies; apply the "read the stimulus first" strategy with shorter, more familiar stimuli and the "read the item first" strategy with longer, more complex, or less familiar stimuli. You can experiment with the sample items 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 item, you should read it carefully and critically. You may want to underline its important points to help you respond to the item.

As you consider items set in educational contexts, try to use the identified teacher's point of view to respond to the items that accompany the stimulus. Be sure to consider the items in terms of only the information provided in the stimulus—not in terms of specific situations or individuals you may have encountered.

On the following pages, you will find samples of these commonly used item formats, along with explanations of the correct and incorrect responses. In the actual testing situation, you may mark the test items and/or write in the margins of your test booklet, **but your final response must be indicated on the answer sheet provided.**

Sample Multiple-Choice Items and Explanations

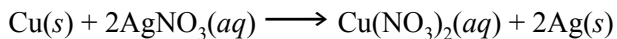
As part of your preparation for the test, sample multiple-choice items have been provided for you to review. To demonstrate how each competency may be assessed, each sample item is accompanied by the competency number that it measures. While studying, you may wish to read the competency before and after you consider each sample item. Please note that the competency numbers will not appear on the actual test form.

An explanation of the correct and incorrect responses is also provided. Each explanation offers one of perhaps many perspectives on why a given response is correct or incorrect in the context; there may be other explanations as well. Keep in mind when reviewing items and response options that there is one best response to each item.

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

Competency 001

Use the information below to answer the question that follows.



What mass of silver would be produced if 10.0 g of copper completely reacts with excess silver nitrate?

- A. 8.50 g
- B. 17.0 g
- C. 20.0 g
- D. 34.0 g

Option D is correct because at 63.55 g/mol, 10 g of Cu equals approximately 0.157 mol of Cu atoms; when this much Cu reacts with excess silver nitrate, approximately 34 g ($2 \times 0.157 \text{ mol}$ at 107.9g/mol) of Ag would be produced according to the equation given.

Option A is incorrect due to a math error caused by dividing the left side of the equation by 2, and ignoring the factor of 2 (Ag atoms) on the right.

Option B is incorrect due to a math error caused by ignoring the factor of 2 (Ag atoms) on the right side of the equation.

Option C is incorrect due to a math error caused by simply multiplying the original mass of Cu (10 g) by the factor of 2 Ag atoms on the right.

Competency 001

During a laboratory investigation, a student pours a clear, colorless liquid with the same composition throughout into a flask. After the flask is heated and the liquid evaporates, a white powdery substance remains. Based on these results, the original liquid most likely was:

- A. a heterogeneous mixture.
- B. a homogenous mixture.
- C. an element.
- D. a compound.

Option B is correct because a homogeneous mixture is defined as two or more substances that cannot be easily separated by common physical means (i.e., settling, filtration, etc.).

Option A is incorrect because a heterogeneous mixture is defined as consisting of two or more substances that can be easily separated by common physical means (i.e., settling, filtration, etc.).

Option C is incorrect because an element cannot be separated into simpler substances. An element is a pure substance that is composed of only one type of atom.

Option D is incorrect because a compound is made of the atoms of two or more elements that are chemically bonded and evaporation is a physical process that does not involve the breaking of chemical bonds.

Competency 002

Gravity acts on an orbiting satellite, pulling it toward Earth, yet the satellite never reaches the ground. This is possible because:

- A. satellites are propelled by fuel cells that keep them at a constant altitude in their orbit around Earth.
- B. the force of gravity at high altitudes above Earth is not enough to pull the satellite back to Earth.
- C. satellites travel at such a high speed that their curve of descent matches the curve of Earth.
- D. the force of gravity from the moon keeps the orbiting satellite's outward momentum constant.

Option C is correct because a stable orbit from Earth occurs when the gravitational force of attraction of Earth on the satellite is equal to the centripetal force on the same object.

Option A is incorrect because once in orbit a satellite does not require propulsion in its direction of motion.

Option B is incorrect because even at altitudes of several hundred miles, the gravitational force of attraction by Earth on a satellite is approximately 90% of its value at the surface.

Option D is incorrect because the gravitational force exerted by the moon on a satellite orbiting near Earth is insignificant.

Competency 003

A sample of an unknown substance is placed in a container surrounded by water. The entire apparatus is thermally insulated. The temperature of the water is measured, and an electronic igniter inside the container is used to ignite the unknown substance. After the substance has been completely consumed by the fire, the temperature of the water is measured again and compared to the water's original temperature. This procedure is most likely being used to determine:

- A. the molar heat capacity of the substance.
- B. the chemical formula of the substance.
- C. the coefficient of thermal expansion of the substance.
- D. the chemical bond energy of the substance.

Option D is correct because the energy transferred to the water is equal to the energy released by the burning of the unknown substance.

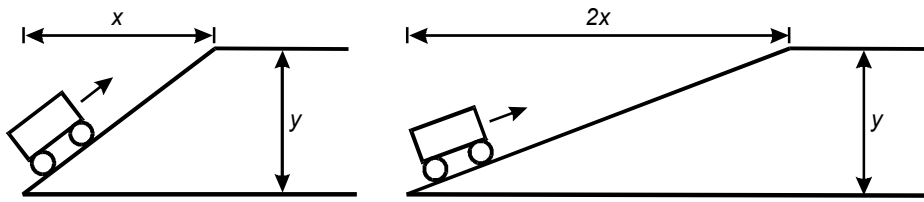
Option A is incorrect because the quantity and composition of the substance is unknown, so the molar heat capacity could not be determined.

Option B is incorrect because in this procedure, no information is available about the composition of the substance.

Option C is incorrect because no method of measuring information necessary to determine the change of volume is provided by the procedure.

Competency 004

Use the diagram below to answer the question that follows.



A teacher is using the apparatus in the diagram to find the force needed to move a cart up two inclined planes as shown in the diagram above. Both inclined planes have the same final height, but one inclined plane has twice the length of the other. The teacher is most likely demonstrating which of the following concepts?

- A. mechanical advantage
- B. force of gravity
- C. conservation of momentum
- D. kinetic and potential energy

Option A is correct because mechanical advantage, which is defined as the ability to multiply force, is effectively demonstrated by comparing the different forces required to move the cart a vertical distance, y .

Option B is incorrect because the force of gravity on the cart in both situations is the same.

Option C is incorrect because no measurement or calculation of momentum is included in the demonstration.

Option D is incorrect because although the change in potential energy of the cart is the same in both situations, no information is provided to determine its kinetic energy.

Competency 004

A chemistry class plans to collect and test water samples from a local pond to determine the dissolved oxygen content of the pond water. Which of the following procedures is critical in the collection and preparation of these samples to ensure accurate test results?

- A. The samples should be kept at room temperature for several days before being tested.
- B. The containers for collecting the samples should be filled to the very top and then sealed until testing.
- C. The samples should be taken from the pond's surface and left open for several hours before being tested.
- D. The containers for collecting the samples should be partially filled and then shaken before testing.

Option B is the correct response because the procedure described will minimize the possibility that the samples will absorb or lose oxygen during storage.

Option A is incorrect because the technique described does not address the issue of maintaining the sample's original oxygen levels during storage.

Option C is incorrect because the sampling and storage techniques described do not address the issue of maintaining the sample's original oxygen levels.

Option D is incorrect because there is a likelihood that the described technique will introduce additional oxygen into the sample.

Competency 005

In which of the following biomolecules are there three levels of structural complexity that affect its biological function?

- A. lipid
- B. protein
- C. carbohydrate
- D. glucose

Option B is correct because in proteins there are three superimposed levels of structure, including the amino acid sequence (primary structure), coiling or folding (secondary structure), and a tertiary structure consisting of irregular contortions from bonding between side chains of the various amino acid groups.

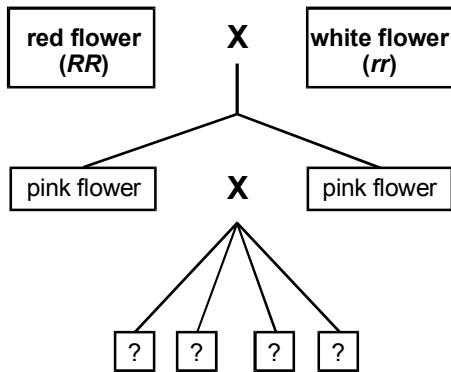
Option A is incorrect because lipids are water insoluble biomolecules containing fatty acids that do not have three levels of structural complexity that affect biological function.

Option C is incorrect because carbohydrates are chemical compounds of carbon, hydrogen, and oxygen, such as sugars, starches, and cellulose, that do not have three levels of structural complexity that affect biological function.

Option D is incorrect because glucose is a simple sugar that does not have three levels of structural complexity that affect biological function.

Competency 006

Use the diagram below to answer the question that follows.



In the diagram above, a rose that is homozygous for red flowers (RR) is crossed with a rose that is homozygous for white flowers (rr). All the offspring of this cross are roses that produce pink flowers. Two of these pink-flowered roses are crossed to produce a third generation of roses. Which of the following describes the third generation of roses that most likely will be produced from the cross of pink-flowered roses?

- A. 75% will be pink and 25% will be either red or white.
- B. 50% will be pink, 25% will be white, and 25% will be red.
- C. 50% will be red and 50% will be white.
- D. 25% will be red, 25% will be pink, and 50% will be white.

Option B is correct because crossing two homozygous individuals, in this case the red flower (genotype RR) and the white flower (genotype rr), produces heterozygous offspring, in this case pink flowers (genotype Rr). Crossing these heterozygous offspring produces the Mendelian ratio of 1:2:1, which in this case results in 25% red individuals (RR), 25% white individuals (rr), and 50% pink individuals (Rr). The fact that neither color dominates when the two different alleles are present is the result of incomplete dominance. As shown below, a Punnett square can be used to determine the ratio of pink-, white-, and red-flowered individuals that result from the crossing of heterozygous pink-flowered individuals.

	R	r
R	RR (red)	Rr (pink)
r	Rr (pink)	rr (white)

Option A is incorrect because it does not match the predicted Mendelian ratio for a heterozygous cross. As shown in the Punnett square above, the Rr genotype (pink flowers) will only occur in 50% of the offspring.

Option C is incorrect because it does not match the predicted Mendelian ratio for a heterozygous cross. Since the alleles are separated from each other during gamete formation (Mendel's law of segregation), the pink heterozygous offspring would produce pink, white, and red offspring, as shown in the Punnett square above.

Option D is incorrect because it does not match the predicted Mendelian ratio for a heterozygous cross. The outcome of the crossing of the heterozygous pink-flowered individuals results in 50% of the offspring being pink, not white, as shown in the Punnett square above.

Competency 008

When using a calorimeter to calculate the energy content of a food sample, it is most important to know the mass of:

- A. the water inside the calorimeter.
- B. the calorimeter.
- C. the air inside the calorimeter.
- D. the food sample.

Option A is correct because the energy released by the food sample will be equal to the increased energy of the water in the calorimeter. This can be found by $Q = mc\Delta T$, where m = mass of water in calorimeter, c = specific heat of water, and ΔT = the change in temperature of the water.

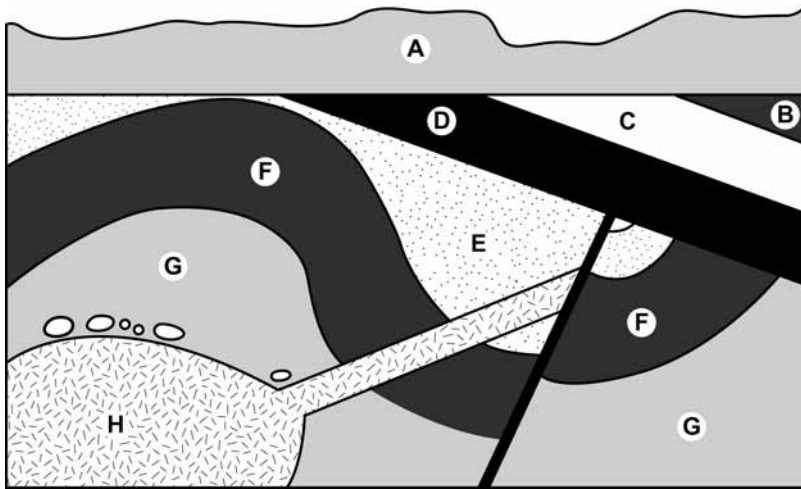
Option B is incorrect because the calorimeter should not absorb or release any energy into the experimental system.

Option C is incorrect because the heat capacity of the air is negligible compared to that of water.

Option D is incorrect because the question asks only for the energy of the food sample, not the energy per unit mass of the sample.

Competency 009

Use the figure below to answer the question that follows.



Which of the following principles of stratigraphy best explains why unit B is older than unit A?

- A. uniformitarianism
- B. lateral continuity
- C. superposition
- D. original horizontality

Option C is correct because the principle of superposition states that in any succession of strata that is not severely deformed, the oldest stratum lies at the bottom while successively younger ones are above.

Option A is incorrect because the principle of uniformitarianism refers to understanding the past based on geological processes that are occurring today.

Option B is incorrect because the principle of lateral continuity explains strata that extend in all directions with a thickness diminishing toward zero at the edges.

Option D is incorrect because the principle of original horizontality relates to geological layers formed by the settling of sedimentary particles in horizontal strata.

Competency 010

World climate patterns have been shown to be affected by the phenomenon known as the El Niño/Southern Oscillation. The dramatic effect this phenomenon has on climate in South and North America is most directly related to changes in:

- A. the frequency of storms in the Pacific Ocean.
- B. the location and configuration of the jet stream.
- C. the surface temperature of the Pacific Ocean.
- D. the frequency and intensity of solar storms.

Option C is correct because variations in surface water temperatures of the ocean affect temperature and rainfall patterns over continental areas.

Option A is incorrect because although storm frequency affects short-term weather patterns, it does not play a major role in influencing changes in climate.

Option B is incorrect because, although the jet stream does affect global climate patterns, it does not play a major role in causing the climate changes associated with the El Niño/Southern Oscillation climate phenomenon.

Option D is incorrect because, although solar storms do affect climate, there is no known direct connection between solar activity and the El Niño/Southern Oscillation climate phenomenon.

Competency 012

The location of an earthquake's epicenter is most effectively located by:

- A. analyzing the speed of travel of the different earthquake waves.
- B. measuring the magnitude of the waves at the seismograph closest to the earthquake.
- C. comparing readings from three or more seismographs.
- D. determining the effect of different rock layers on the travel of earthquake waves.

Option C is correct because using data from three or more seismographs allows scientists to use triangulation to locate the source of the original disturbance.

Option A is incorrect because the speed of earthquake waves is determined primarily by the depth and type of rock through which the disturbance travels.

Option B is incorrect because using only one seismograph reading will provide information about distance, but not direction of the epicenter.

Option D is incorrect because although different rock layers will have an effect on the speed of pressure waves due to earthquake activity, this information is not adequate to locate the earthquake's epicenter.

Competency 013

Which of the following is an example of a scientific solution to the problem of environmental damage caused by the release of crude oil into marine ecosystems?

- A. requiring all supertankers to be double-hulled
- B. using pipelines to transport oil from a limited number of designated ports
- C. developing strains of bacteria that feed on hydrocarbons
- D. prohibiting cleaning of holds of empty tankers at sea

Option C is correct because it describes an example of how scientific research could be used to resolve the problem of environmental damage caused by accidental releases of crude oil.

Option A is incorrect because it describes an engineering design approach to solving the problem.

Option B is incorrect because it does not provide a solution to the problem of the environmental damage caused by the accidental release of crude oil into marine ecosystems.

Option D is incorrect because it suggests a legal solution to just one aspect of the problem of crude oil contaminating marine ecosystems.

Competency 014

As part of a science unit on weather, students are observing and recording daily weather information. They notice that a drop in barometric pressure precedes rainy days and decide to research a possible causal relationship. Which of the following steps should the students take *first*?

- A. organizing the collected data and observations in a table or graph
- B. finding the average barometric pressure for the study period
- C. calculating the degree of accuracy of the measurement equipment
- D. determining dependent and independent variables

Option A is correct because having organized data in either a table or a graph will allow patterns in the information to be discerned.

Option B is incorrect because the variations in barometric pressure and not the average value of barometric pressure is relevant to the students' investigation.

Option C is incorrect because the study is looking at a correlation based on changes in the relative values of atmospheric pressure readings rather than the precision of the actual readings.

Option D is incorrect because a pattern within the set of data will be evident regardless of which data are considered dependent and which are independent.

Competency 016

A novice high school chemistry teacher inventorying the chemistry laboratory prior to the start of the school year discovers several old containers of chemicals no longer considered safe for use in the school. Which of the following should the Master Science Teacher recommend that the novice teacher do with the chemicals?

- A. Pack the containers in boxes to prevent breakage and seal them in biohazard bags to be placed in the school dumpster.
- B. Flush them down the drain with ample fresh water while keeping the room well ventilated.
- C. Ensure that the containers are stored safely and contact a chemical disposal company to have them removed.
- D. Inventory the containers and have the janitor arrange for proper disposal of the materials.

Option C is correct because any chemicals or materials that are potentially hazardous should be safely stored until a certified disposal company can remove them.

Option A is incorrect because disposal via the dumpster will most likely result in contamination of the ground, air, or water supply.

Option B is incorrect because if flushed down the drain, the chemicals will either enter the ecosystem via a septic tank or wastewater treatment plant.

Option D is incorrect because the janitor may not be familiar with appropriate procedures for dealing with chemistry lab materials.

Competency 017

In a physics lab, students safely investigate the operation of a simple cell by measuring the voltages produced by various combinations of electrode materials and electrolyte solutions. This activity is most closely related to which of the following topics in another science discipline?

- A. photon emission in chemistry
- B. photosynthesis in biology
- C. oxidation-reduction in chemistry
- D. osmosis in biology

Option C is correct because oxidation-reduction reactions provide the basis for understanding the operation of chemical cells.

Option A is incorrect because photon emission due to the photoelectric effect does not involve electrodes and electrolyte solutions.

Option B is incorrect because photosynthesis does not involve electrode materials and electrolytes.

Option D is incorrect because osmosis does not involve the production of a voltage produced by electrode materials and electrolytes.

Competency 018

In an inquiry-based science class that has many students who are English language learners, inclusive instruction for the English language learners is best accomplished by which of the following strategies?

- A. correcting students' English grammar when they speak and write, so that they will improve their language skills
- B. adapting the content to suit the needs of the students, so that each language group has its own expected level of achievement
- C. arranging for a translator to be available for each language group, so that the students can increase their vocabularies
- D. dispersing the students throughout the activity groups, providing help as needed, so that they benefit from interactions with their peers

Option D is correct because this technique provides a supportive environment for the English language learners while including them in course learning activities.

Option A is incorrect because it places undue attention on the English language learners and does not address the course content.

Option B is incorrect because an appropriately high level of expectations for success should be applied to all students equally.

Option C is incorrect because providing the services of a translator does not ensure that students will be actively engaged in collaborative work with their peers.

Competency 020

A Master Science Teacher intends to submit a request to the principal for additional funding for new lab equipment, and anticipates having to justify the request due to a shortage in school funds. Which of the following would be the most effective argument for the Master Science Teacher to use in a presentation to the principal?

- A. The new lab equipment will enable students to carry out data analyses of results of science experiments.
- B. The existing lab equipment makes it difficult for students to carry out individual science experiments.
- C. The new lab equipment is essential for students to be able to meet state-required learning goals in science.
- D. The existing lab equipment is virtually obsolete for the current science processes that need to be taught to students.

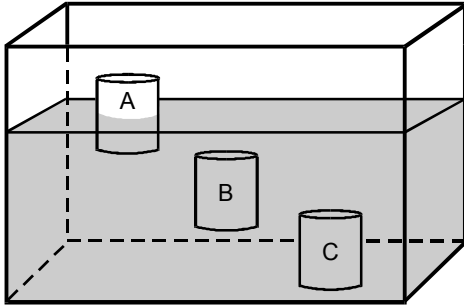
Option C is the correct option because the school system must make every effort to provide the instruction and materials necessary to allow students to meet the state's learning goals.

Option A is incorrect because although this is a valid reason for wanting to update lab equipment, it is not the most effective of the suggested options.

Option B is incorrect because although it may be advantageous for students to work on experiments individually, this is not the most effective of the options suggested.

Option D is incorrect because although this argument has significant merit, it is not as effective as referencing a need to meet state learning goals.

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



In the experiment shown in the diagram above, three sealed cans are placed in an aquarium filled with tap water. Can A floats partially submerged at the surface, Can B is entirely submerged and floats between the top and bottom of the aquarium, and Can C sinks to the bottom.

Competency 001

Which of the following best explains why the cans settle at different levels in the aquarium water?

- A. The aquarium water has the same density as Can B, is less dense than Can C, and is more dense than Can A.
 - B. The aquarium water is more dense than Can C, is less dense than Can A, and has the same density as Can B.
 - C. The aquarium water has the same density as Can A, is slightly less dense than Can B, and is much less dense than Can C.
 - D. The aquarium water is slightly less dense than Can B, is more dense than Can C, and has the same density as Can A.
-

Option A is correct because the diagram represents a situation in which the density of Can B is equal to the density of the water. As a result, the weight of Can B is equal to the buoyant force acting on it and it would neither float to the surface or sink to the bottom of the aquarium. Because the density of Can A is less than the density of the water, the weight of Can A is less than the buoyant force acting on it, causing it to float to the surface of the water. Because the density of Can C is greater than the density of the water, the weight of Can C is greater than the buoyant force acting on it, causing it to sink to the bottom of the aquarium.

Option B is incorrect because it states that the density of Can C is less than the density of the water, which means that Can C should float because the weight of Can C would be less than the buoyant force acting on it. In addition, Can A is assigned an inappropriate density.

Option C is incorrect because Can A and Can B are assigned inappropriate densities.

Option D is incorrect because all three cans are assigned inappropriate densities.

Competency 001

Which of the following methods could be used to raise Can B from its position in the middle of the aquarium to a position at the surface where Can A is?

- A. Add a cup of rubbing alcohol to the aquarium.
- B. Reduce the level of the water in the aquarium by several inches.
- C. Add several tablespoons of salt to the aquarium.
- D. Raise the temperature of the water in the aquarium.

Option C is correct because adding salt to the water would result in a solution with a density greater than the density of the tap water. The density of Can B could then become less than the density of the surrounding solution. The result could then be that the weight of Can B could become less than the buoyant force acting on it and Can B could float to the surface.

Option A is incorrect because adding rubbing alcohol to the water would result in a solution that would have a density less than the density of the tap water, causing Can B to sink.

Option B is incorrect because reducing the water level would not change the density of the water and therefore would not affect the buoyant force acting on Can B.

Option D is incorrect because raising the temperature of the water would decrease the density of the water as the water expands. The result would be a reduction in the buoyant force acting on Can B, causing it to sink.

Additional Sample Multiple-Choice Items and Answer Key

This section presents additional sample multiple-choice items for you to review in preparation for the test. The competency number that each item measures is also listed in order to demonstrate how each competency may be assessed. You may wish to read the competency before and after you consider each sample item. Please note that the competency numbers will not appear on the actual test form.

An answer key is also provided and follows the additional multiple-choice items. The answer key lists the correct answer for each sample test item. Please note that the answer key also lists the competency assessed by each item and that the sample items are not necessarily presented in competency order.

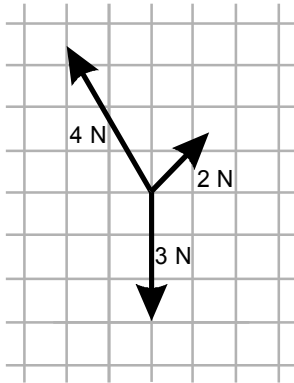
The sample items are included to illustrate the formats and types of items you will see on the test; however, your performance on the sample items should not be viewed as a predictor of your performance on the actual examination.

Competency 001

1. The active ingredient in aspirin is the weak acid acetylsalicylic acid ($C_9H_8O_4$). Titration with a solution of which of the following substances could be used to determine the amount of acetylsalicylic acid in an aspirin tablet?
 - A. KOH
 - B. HCl
 - C. $MgSO_4$
 - D. NaCl

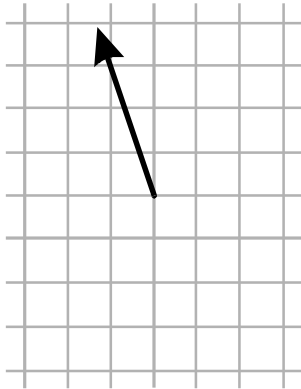
Competency 002

2. Use the diagram below to answer the question that follows.

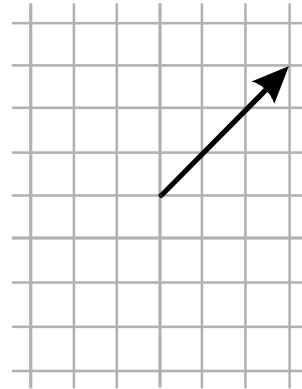


The vector diagram above shows three forces acting on an object. Which of the following diagrams shows the approximate direction of the acceleration that results?

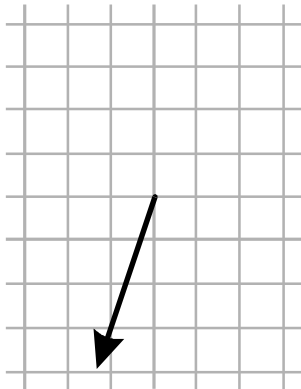
A.



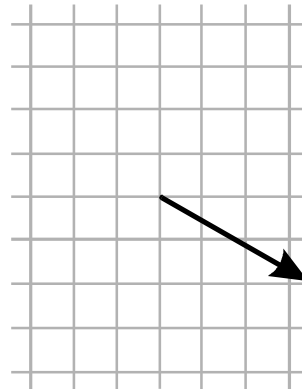
B.



C.



D.

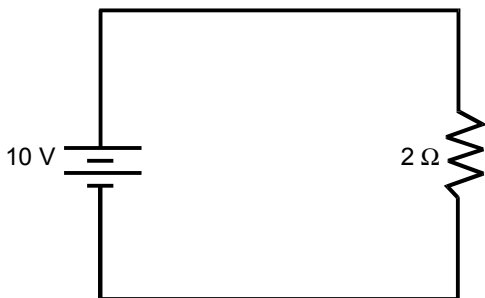


Competency 002

3. A circus trapeze artist performs over a net for protection in the event of a fall. Landing in a net is less likely to result in injury to a falling person than is landing on the ground because the net:
- A. catches the person before he or she reaches terminal velocity.
 - B. concentrates the upward force that stops the person's fall over a smaller area of the body.
 - C. spreads the person's impact over the entire area of the net.
 - D. slows the person's fall by exerting a smaller force over a longer period of time.

Competency 003

4. Use the circuit diagram below to answer the question that follows.



The circuit shown above consists of a 10-volt battery and a 2-ohm resistor. Neglecting the resistance of the conductor and battery, what is the amperage of the current in this circuit?

- A. 5 A
- B. 8 A
- C. 12 A
- D. 20 A

Competency 003

5. Aluminum has a specific heat of $900 \text{ J/kg} \cdot \text{C}^\circ$. How many joules of energy are required to raise the temperature of a 2 kg piece of aluminum from 10°C to 14°C ?
- A. $(900)(2)$
 - B. $(900)(4)(2)$
 - C. $(900)(14)$
 - D. $(900)(10)(14)$

Competency 004

6. A penny and a feather rest at the bottom of a clear tube from which the air has been evacuated. A teacher holds the tube in a horizontal position and then turns it to a vertical position, allowing the penny and feather to fall to the other end of the tube. This presentation is an effective way to address a common misconception concerning:
- A. gravity's effect on the acceleration of different masses.
 - B. the vector nature of the gravitational force.
 - C. the relationship between gravity and weight.
 - D. the relationship between inertia and gravitational potential energy.

Competency 005

7. Which of the following best describes the transport mechanism that provides oxygen to all the cells in the body?
- A. Oxygen dissolved in the blood permeates the circulatory system by osmosis, making it available for cellular reactions.
 - B. White blood cells collect dissolved oxygen in the blood, delivering it to the tissues where it is needed.
 - C. Oxygen bonds to hydrogen in the blood and is transported to cells in the body where it is released for cellular respiration.
 - D. Red blood cells transport dissolved oxygen in the blood and release it for cellular respiration.

Competency 005

8. Which of the following describes the primary mechanism used by the human body to control the ratio of solutes to water in the body?
- A. hormonal regulation of water reabsorption in urine production
 - B. collection of water formed through cellular respiration
 - C. active transport of salts from the blood to the intestines
 - D. removal of sodium-rich water through perspiration

Competency 006

9. Which of the following best describes a fundamental difference in the molecular structure of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA)?
- A. One of the four nitrogen bases in the DNA molecule is different from that found in the RNA molecule.
 - B. DNA molecules are held together by covalent bonds, while the bonds in RNA are ionic.
 - C. One of the compounds found in DNA molecules is a phosphate group that is absent from RNA molecules.
 - D. DNA is a single stranded molecule, while RNA is composed of two matching strands.

Competency 006

10. Which of the following best explains how animal species become better adapted to a particular habitat over time?
- A. Physiological changes that develop in response to available food types are passed on to the next generation.
 - B. Stresses in the environment induce large-scale mutations that give rise to more efficient survival strategies.
 - C. Physical conditions are altered by the population to produce a more favorable environment.
 - D. Genetic mutations that improve the reproductive success of individuals spread within the population.

Competency 007

11. Significant levels of industrial chemicals have been found in the tissues of swordfish; however, smaller species in the same ecosystem have only trace quantities. Which of the following best describes the pathway responsible for the higher concentrations in swordfish?
- A. Wind currents concentrate the chemicals near the surface of the ocean, where larger fish tend to feed.
 - B. The chemicals are concentrated at each higher level in the food chain as upper-level consumers eat large numbers of smaller organisms.
 - C. Large fish take in greater volumes of water in order to breathe, leading to higher blood concentrations of the chemicals.
 - D. The chemicals move from polluted rivers and become concentrated in estuaries and bays where many marine predators feed.

Competency 007

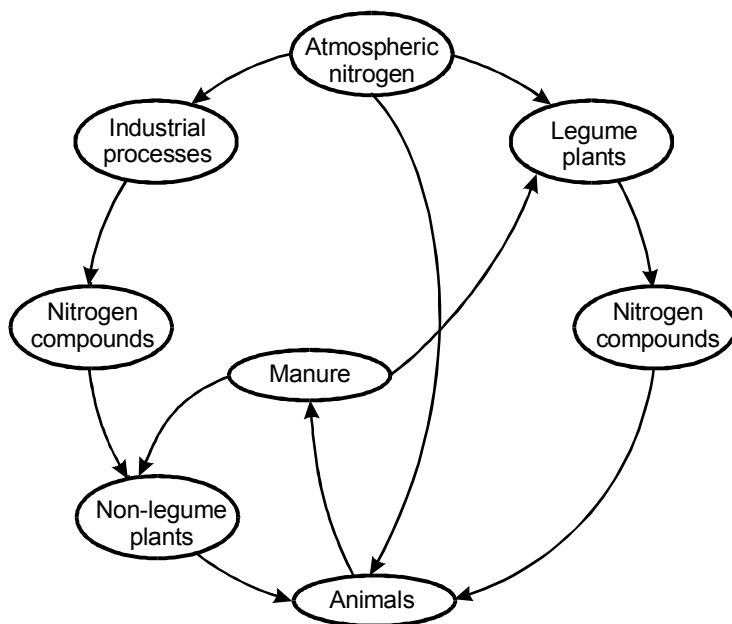
12. The Laguna Madre lagoon system of the Texas coast contains extensive sea grass meadows. Protection of these sea grass meadows is seen as important to scientists primarily because:
- A. the various plant species in the ecosystem are a critical food source for migratory birds.
 - B. the extensive root systems absorb excess nitrogen and phosphorus from fertilizer runoff.
 - C. the plants' metabolic activity helps regulate the salinity of the local ecosystem.
 - D. the plants provide critical nursery habitat for a variety of fish and shellfish species.

Competency 007

13. Although all nutrients are cycled through earth systems, the cycling of carbon and nitrogen differs significantly from the cycling of calcium and phosphorus. Which of the following is a fundamental difference in the biogeochemical cycles of carbon and nitrogen compared with the biogeochemical cycles of calcium and phosphorus?
- A. the nature of the primary abiotic reservoirs for the two groups of elements
 - B. the greater importance of calcium and phosphorus in biological systems
 - C. the manner in which the two groups of elements are broken down during decay of organic matter
 - D. the greater abundance of carbon and nitrogen in the earth's crust and oceans

Competency 008

14. Use the diagram below to answer the question that follows.



Which of the following misconceptions is revealed in the student-created concept map shown above?

- A. Plants require nitrogen compounds from industrial processes.
- B. Animal wastes replenish atmospheric nitrogen.
- C. All plants synthesize nitrogen compounds.
- D. Animals acquire nitrogen for growth directly from the atmosphere.

Competency 008

15. Several students in a life science class have the misconception that natural selection is a process that happened only in the distant past and is not taking place in the contemporary living world. Which of the following would be the most appropriate example to cite to help counter this misconception?
- A. the development of antibiotic resistance in strains of bacteria
 - B. the hybridization of two closely related species where their ranges overlap
 - C. the increase in red blood cell count in humans who spend extended times at high altitudes
 - D. the occurrence of genetic mutations in organisms exposed to radiation

Competency 009

16. Which of the following geologic features is forming as a result of mountain-building processes that are occurring along an active tectonic plate boundary?
- A. Davis Mountains of western Texas
 - B. Cascade Mountains of Washington and Oregon
 - C. Appalachian Mountains of the eastern United States
 - D. Rocky Mountains of Colorado and Wyoming

Competency 009

17. Scientists have demonstrated that broad areas of the land in Canada and northernmost Europe have risen steadily over the past 10,000 years. This is believed to be the result of the:
- A. expansion of the lithosphere due to warming following the end of the Pleistocene glaciation.
 - B. uplift of the lithosphere due to the northward shift of the tectonic plates underlying the continents.
 - C. isostatic rebound of the lithosphere following the melting of continental glaciers that covered the region.
 - D. changes in the gravitational pull of the sun and moon on the dense lithosphere underlying the region.

Competency 010

18. The most common problem associated with drinking-water supplies in the developing world is:
- A. pollution from industrial waste.
 - B. runoff of agricultural chemicals.
 - C. infection from disease pathogens.
 - D. contamination with brackish water.

Competency 010

19. Which of the following phenomena is responsible for the blue color of the sky?
- A. differential scattering of electromagnetic radiation
 - B. refraction of sunlight at temperature boundaries in the atmosphere
 - C. differential absorption of the electromagnetic spectrum
 - D. reflection of sunlight by water vapor in the atmosphere

Competency 011

20. Which of the following best explains why a solar eclipse does not occur each time the moon passes between the sun and the earth?
- A. The moon's orbit is elliptical and therefore the moon is frequently too far from the earth to block the sun's light.
 - B. The earth's orbit and axial tilt put the earth in direct alignment with the sun and moon on the solstices.
 - C. The moon's orbit around the earth is tilted with respect to the earth's orbit around the sun.
 - D. The earth's orbit is elliptical and therefore the moon is frequently too far from the sun to create a shadow on the earth.

Competency 011

21. Which of the following best explains why elemental hydrogen, which is the most abundant element in the universe, is very rare in the earth's atmosphere?
- A. The earth's gravity is too weak to prevent hydrogen atoms from being swept away by the charged particles of the solar wind.
 - B. Hydrogen was very rare in the central part of the cloud of dust and gas that formed the solar system.
 - C. Extensive volcanism during the earth's history has ignited and burned the flammable hydrogen that was present in the atmosphere.
 - D. Hydrogen in the early atmosphere combined with other elements and was locked in silicate rocks.

Competency 013

22. In which of the following ways did Aristotelian science differ from the scientific research design developed by Sir Isaac Newton and other seventeenth-century scientists?
- A. Aristotelian science recognized the influence of a prime mover on the universe.
 - B. Newtonian science attempted to identify the ultimate purposes of natural objects or processes.
 - C. Aristotelian science depended on descriptive investigations of naturally occurring phenomena.
 - D. Newtonian science used experimental investigations to help understand hidden natural laws.

Competency 014

23. Use the examples below to answer the question that follows.

- Biologists have observed that many animals have physical attributes that increase their chances of survival.
- Chemists synthesize molecules to perform a specific task.
- Engineers design structures for specific purposes.

Which of the following unifying themes best applies to the three examples listed above?

- A. order and organization
- B. properties and patterns
- C. scale and proportion
- D. form and function

Competency 015

24. Students in an environmental science class analyze data on the amount of trash generated weekly by town households. They determine that the correlation between household size and discarded food is 0.09 and that the correlation between household size and discarded paper is 0.46. These correlations support the conclusion that the number of people in a household:

- A. is related to the amount of paper that is thrown away but has little relationship to the amount of food that is thrown away.
- B. is related both to how much food and how much paper is thrown away.
- C. is related to the amount of food that is thrown away but has little relationship to the amount of paper that is thrown away.
- D. has little relationship to the amounts of food and paper that are thrown away.

Competency 015

25. During a unit on weather, a science teacher has students collect daily temperature data at their homes using portable thermometers. The data will be used in a subsequent class to study factors affecting microclimates in the study area. Which of the following is most important for the teacher to include in the instructions for the activity?
- A. Record the temperature once early in the morning and once in the late afternoon to determine the range.
 - B. Review data each night and make improvements on procedures to increase its accuracy.
 - C. Take readings in the same location and at the same specified time throughout the collection period.
 - D. Compensate for missed readings by averaging the temperatures recorded for the previous and following days.

Competency 016

26. The Master Science Teacher at a high school has observed that not all science teachers follow the school's current laboratory policies. She would like to initiate changes to ensure that teachers comply with district safety standards. Which of the following is likely to be the most effective *first* step for the Master Science Teacher to use to achieve this goal?
- A. surveying other school districts about their policies and the relative success of those policies
 - B. soliciting input from teachers about the current policies and what changes might make them more effective
 - C. calculating what the financial burden and time commitment would be to make changes to the policies
 - D. consulting with school administrators to determine what legal issues might arise from changing the policies

Competency 017

27. An eighth-grade math teacher is working with students on proportions and ratios. The science teacher would like to integrate a lab activity with the content covered in the math class. Which of the following earth science activities would most effectively integrate the concepts being taught in the math class?
- A. analyzing the kinds of sediments deposited by different streams
 - B. identifying various mineral samples by determining their densities
 - C. assessing chemical weathering of limestone under variable conditions
 - D. making weather predictions based on atmospheric conditions

Competency 019

28. A Master Science Teacher regularly uses formative assessments to provide students with feedback about their progress toward the achievement of instructional objectives. She then gives them the opportunity to revise their work in light of the feedback. This approach is likely to have a positive effect on student achievement because it:
- A. provides students with a chance to communicate the reasoning behind their responses.
 - B. encourages students to recognize their personal strengths and address their weaknesses.
 - C. sends students a clear message that they are capable of learning and continually improving.
 - D. identifies the steps students need to take to achieve the desired learning goals.

Competency 021

29. At a department meeting, a Master Science Teacher announces that she has set up a searchable database where she would like teachers to post science lesson plans that they have found to be effective and feel might be of benefit to other teachers. Several veteran teachers object, saying that the work required to input information into the database outweighs its potential benefits. The Master Science Teacher most likely could have avoided this resistance to the database by:
- A. selecting a few teachers to create and present a prototype of the database at the meeting.
 - B. asking the principal to announce the plan for the database and strongly encourage full participation by the faculty.
 - C. providing the teachers with a detailed outline of the database prior to the meeting.
 - D. proposing the idea for the database at the meeting and asking for input and for volunteers to collaborate in its creation.

Competency 021

30. A Master Science Teacher is preparing to meet with a novice teacher after an observation. When providing feedback to the teacher, it is important for the Master Science Teacher to remember that in order to be effective, the feedback should:
- A. provide the novice teacher with solutions to problem areas in the lesson.
 - B. highlight the major concerns of the observer.
 - C. refer to specific teacher and student behaviors that took place during the lesson.
 - D. begin with a critique of the overall effectiveness of the lesson.

Answer Key		
Item Number	Correct Answer	Competency
1	A	001
2	A	002
3	D	002
4	A	003
5	B	003
6	A	004
7	D	005
8	A	005
9	A	006
10	D	006
11	B	007
12	D	007
13	A	007
14	D	008
15	A	008
16	B	009
17	C	009
18	C	010
19	A	010
20	C	011
21	A	011
22	D	013
23	D	014
24	A	015
25	C	015
26	B	016
27	B	017
28	C	019
29	D	021
30	C	021

SECTION IV

CASE STUDY ASSIGNMENT

In addition to the multiple-choice section, the Master Science Teacher (MST) test will include one case study assignment that requires a written response. The written-response score will be combined with the multiple-choice score to produce a total test scaled score.

Included in this section is a description of the case study assignment, an explanation of how case study assignment responses will be scored, one sample case study assignment, and examples of a strong and a weak response to the assignment.

On the actual test, candidates will be given a different case study assignment from the sample provided in this preparation manual.

How Case Study Assignment Responses Are Scored

Responses will be scored on a four-point scale (see next page). Each point on the scale represents the degree to which the performance characteristics (see below) are demonstrated in the response.

The score point descriptions reflect typical responses at each score point. Although the score assigned corresponds to one of the score points, individual responses may include attributes of more than one score point.

PERFORMANCE CHARACTERISTICS

PURPOSE	The extent to which the candidate responds to the components of the assignment in relation to relevant competencies in the Master Science Teacher 8–12 test framework.
APPLICATION OF KNOWLEDGE	Accuracy and effectiveness in the application of knowledge as described in relevant competencies in the Master Science Teacher 8–12 test framework.
SUPPORT	Quality and relevance of supporting details in relation to relevant competencies in the Master Science Teacher 8–12 test framework.
RATIONALE	Soundness of reasoning and depth of understanding of the assigned task in relation to relevant competencies in the Master Science Teacher 8–12 test framework.
SYNTHESIS	The extent to which the candidate is able to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher 8–12 in an applied context.

SCORE SCALE

Score	Score Point Description
4	<p>The "4" response reflects thorough knowledge and understanding of relevant competencies in the Master Science Teacher 8–12 test framework.</p> <ul style="list-style-type: none"> • The response addresses all components of the assignment and fully completes the assigned task. • The response demonstrates an accurate and very effective application of relevant knowledge. • The response provides strong supporting evidence with specific and relevant examples. • The response demonstrates clear, logical reasoning and a comprehensive understanding of the assigned task. • The response demonstrates strong ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher 8–12.
3	<p>The "3" response reflects sufficient knowledge and understanding of relevant competencies in the Master Science Teacher 8–12 test framework.</p> <ul style="list-style-type: none"> • The response addresses most or all components of the assignment and sufficiently completes the assigned task. • The response demonstrates a generally accurate and effective application of relevant knowledge; minor problems in accuracy or effectiveness may be evident. • The response provides sufficient supporting evidence with mostly specific and relevant examples. • The response demonstrates sufficient reasoning and an overall understanding of the assigned task. • The response demonstrates sufficient ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher 8–12.
2	<p>The "2" response reflects partial knowledge and understanding of relevant competencies in the Master Science Teacher 8–12 test framework.</p> <ul style="list-style-type: none"> • The response addresses at least some components of the assignment and/or partially completes the assigned task. • The response demonstrates a partial and/or ineffective application of relevant knowledge; significant inaccuracies may be evident. • The response provides minimal supporting evidence with few relevant examples; some extraneous or unrelated information may be evident. • The response demonstrates limited reasoning and understanding of the assigned task. • The response demonstrates partial ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher 8–12.
1	<p>The "1" response reflects little or no knowledge or understanding of relevant competencies in the Master Science Teacher 8–12 test framework.</p> <ul style="list-style-type: none"> • The response addresses few components of the assignment and/or fails to complete the assigned task. • The response demonstrates a largely inaccurate and/or ineffective application of relevant knowledge. • The response provides little or no supporting evidence, few or no relevant examples, or many examples of extraneous or unrelated information. • The response demonstrates little or no reasoning or understanding of the assigned task. • The response demonstrates little or no ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher 8–12.
U	<p>The "U" (Unscorable) will be assigned to responses that are off topic/off task, illegible, primarily in a language other than English, or are too short or do not contain a sufficient amount of original work to score.</p>
B	<p>The "B" (Blank) will be assigned to written response booklets that are completely blank.</p>

Scoring Process

Case study assignment responses are scored on a scale of 1 to 4. Typically, each response is scored by two or more qualified readers. All scorers have successfully completed standardized orientation and are calibrated to the scoring criteria throughout the scoring session. If two scores assigned are discrepant, additional scoring will determine the final score.

Analytic Notation

Examinees who do not pass the test and do not perform satisfactorily on the case study assignment will receive information concerning specific aspects of the written response that show a need for improvement. This information will be provided for examinees to use in preparing to retake the test.

If you do not pass the test or perform satisfactorily on the case study assignment, your score report will indicate one or more of the following areas for improvement in your written response. These areas are based on the performance characteristics in the score scale.

- Purpose
- Application of Knowledge
- Support
- Rationale
- Synthesis

Preparing for the Case Study Assignment

Following is one sample case study assignment that represents the type of question you will see on the MST test.

In preparing for the case study assignment component of the test, you may wish to draft a response to the question by reading the case study and planning, writing, and revising your essay. Although you can choose how much time to spend during the test session to respond to the case study assignment, the assignment has been created so that an acceptable response could be written within 90 minutes. Also, since no reference materials will be available during the test, it is recommended that you refrain from using a dictionary, a thesaurus, or textbooks while writing your practice response.

After you have written your practice response, review your response in light of the score point descriptions. You may also wish to review your response and the score scale with staff in your MST preparation program.

General Directions for Responding to the Case Study Assignment

DIRECTIONS FOR CASE STUDY ASSIGNMENT Master Science Teacher 8–12

General Directions:

This section of the test consists of one case study assignment. For this assignment, you are to prepare a written response and record it in the area provided in the written response booklet.

Read the case study assignment carefully before you begin to write. Think about how you will organize what you plan to write. You may use any blank space provided in this test booklet to make notes, create an outline, or otherwise prepare your response. ***Your final response, however, must be written in the written response booklet.***

Evaluation Criteria:

Your written response will be evaluated based on the extent to which it demonstrates the knowledge and skills required to perform the roles of the Master Science Teacher 8–12. You may draw from research and your professional experience. (Citing specific research is not required.)

Read the assignment carefully to ensure that you address all components. Your response to the assignment will be evaluated based on the following criteria:

- **PURPOSE:** The extent to which you respond to the components of the assignment in relation to relevant competencies in the Master Science Teacher 8–12 test framework.
- **APPLICATION OF KNOWLEDGE:** Accuracy and effectiveness in the application of knowledge as described in relevant competencies in the Master Science Teacher 8–12 test framework.
- **SUPPORT:** Quality and relevance of supporting details in relation to relevant competencies in the Master Science Teacher 8–12 test framework.
- **RATIONALE:** Soundness of reasoning and depth of understanding of the assigned task in relation to relevant competencies in the Master Science Teacher 8–12 test framework.
- **SYNTHESIS:** The extent to which you are able to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher 8–12 in an applied context.

The assignment is intended to assess knowledge and skills required to perform the roles of the Master Science Teacher 8–12, not writing ability. Your response, however, must be communicated clearly enough to permit a valid judgment about your knowledge and skills. Your response should be written for an audience of educators knowledgeable about the roles of the Master Science Teacher 8–12.

The final version of your response should conform to the conventions of edited American English. Your response should be your original work, written in your own words, and not copied or paraphrased from other work. You may, however, use citations when appropriate.

Sample Case Study Assignment

Classroom Context: This case study focuses on a physics teacher, Mr. Colson, who is teaching his class a lesson on projectile motion. The science instruction time is a 90-minute class. The class is composed of students who achieve at various levels.

Master Science Teacher Task: Mr. Colson has asked the Master Science Teacher (MST) to observe his class during a lesson on projectile motion and to provide him with feedback. The MST has agreed to observe his class. Mr. Colson shows the MST information about the lesson he plans to teach. On the following pages, you will find:

- information from Mr. Colson regarding previous instruction for this class;
- information about the lesson;
- an assignment given by Mr. Colson to his class;
- excerpts of the data collected by the MST while observing Mr. Colson's class; and
- representative samples of student work from his class.

Using these materials, write a response in which you demonstrate your knowledge of science, science instruction, and mentoring by analyzing this case study.

Your response should include the following information:

1. An analysis of one significant strength and two significant weaknesses in the effectiveness of the lesson. Cite evidence from the case study to support your observations.
2. A full description of two instructional strategies that would be effective for Mr. Colson to use to address the two weaknesses you have identified. Be sure to describe one strategy for each of the weaknesses you have identified.
3. An explanation of why each of the strategies you have described would be effective in improving Mr. Colson's instruction.
4. A full description of a plan of action you would develop as a mentor-teacher specifically to guide Mr. Colson in implementing the strategies you have described.

Information from Mr. Colson regarding previous instruction: The students in this class have learned that, in the absence of air friction, the forward velocity of a projectile is constant and the upward or downward velocity is not constant. Students have practiced using algebraic formulas to describe the motion of objects. Mr. Colson feels that the students are prepared to predict the landing point of a projectile. Students have been provided with a description of the procedures for the lesson's activity.

INFORMATION ABOUT THE LESSON

Objectives:

- **Make quantitative observations and measurements with precision.**
- **Analyze examples of uniform and accelerated motion.**

Introduction	Discuss the formulas that can be used to predict the landing point of a projectile.
Materials	<ul style="list-style-type: none"> • stopwatch • metersticks • masking tape • curved plastic ramp • steel ball • string and weight
Activity	<ol style="list-style-type: none"> 1. Place a ramp at one end of a long table so that a steel ball can roll down the ramp and across a flat surface before reaching the edge of the table. 2. Measure the distance from the base of the ramp to the edge of the table and, with a stopwatch, measure the time it takes the steel ball to roll from the base of the ramp to the edge of the table. Next, using these two measurements, calculate to the nearest tenth of a second the velocity of the steel ball over the distance you measured. Important note: Catch the steel ball at the edge of the table. 3. Repeat step 2 three times and record the data. 4. Measure the height of the table above the floor and use this measurement to calculate how much time is required for a steel ball to fall from the table to the floor. Use the formula $d = \frac{1}{2}gt$. 5. Use the forward speed of the ball on the table and the time it will take the ball to fall to the floor to calculate how far from the table the steel ball will land. 6. Use the string and weight as a plumb line to locate a point on the floor that is directly under the point where the ball will leave the table. 7. Locate the predicted landing point of the ball on the floor. 8. Notify your teacher when you are ready to test your prediction.
Discussion	Discuss sources of error in the activity.
Homework	Complete the assignment "Hit the Target."*

*A copy of the assignment follows this description of the lesson.

ASSIGNMENT

Hit the Target

Complete the table below with data and calculations from the class activity.

	Distance on the Table	Time on the Table	Velocity on the Table	Distance the Ball Falls	Time the Ball Falls	Predicted Distance from the Table
Trial 1						
Trail 2						
Trail 3						
Avg.						

1. Why are there two different formulas to analyze the motion of a projectile?
2. What was the forward velocity of the ball while it was a projectile?
3. Why did the forward velocity of the ball stay constant while it was a projectile?
4. What might be the principal source of error in this activity?

SELECTED EXCERPTS FROM THE MST'S OBSERVATIONS

- Mr. Colson begins class by saying, "Today you are going to predict the landing point of a projectile. Look over the activity sheet carefully." After they have had a chance to look at the sheet, Mr. C asks, "Do any of you have questions about the procedures that you are going to use?"
 - A student asks, "Why do we need to catch the ball at the edge of the table during each time trial in step 2 of the procedure?" Mr. C replies, "I don't want you to use trial and error to locate a landing point. I want you to use the two different formulas to predict the landing point of a projectile. I will take the accuracy of your prediction into account when I assess your lab reports. I have a paper cup that will be placed at your predicted landing point. If the ball goes into the cup, everyone in the group will get a prize." Mr. C shows them the cup.
 - A third student asks, "What if we do everything right and the ball still doesn't go into the cup?" Mr. C replies, "Only the teams that get the ball in the cup get a prize." The student says, "That doesn't seem fair." Mr. C replies, "In this activity if you use the two formulas correctly to calculate the landing spot and are very careful during the trials, you should be able to get the ball in the cup. Getting the ball in the cup is a measure of how hard you try."
 - The student then says, "I don't understand why there are two different formulas to analyze the motion of a projectile." Mr. C writes the two formulas on the board and says, "Just remember, $d = vt$ is used to analyze the motion of an object moving at a constant velocity, and $d = \frac{1}{2}gt^2$ is used to analyze the motion of an accelerating object." The student says, "But we are only using one ball." Mr. C replies, "When the ball is rolling across the table, you can assume that it is moving forward at a constant speed. However, when the ball leaves the edge of the table and becomes a projectile, it has a forward motion that is independent of the downward motion. Remember that once the ball leaves the edge of the table, it cannot change its forward direction."
- Mr. C asks students to move the tables in the room so that each group of students has a landing area that won't interfere with another group's landing area. Mr. C circulates around the room as students set up their ramps and begin their trials.
 - A student says, "We completed our first trial and caught the ball at the edge of the table. How can we know which way the ball will go once it leaves the edge of the table?" Mr. C replies, "Get together with your group and decide what you can do to have the ball always move in the same direction as it rolls across the table." The student asks, "Are we allowed to do more than three trials?" Mr. C replies, "No. Every group has just three practice trials."
 - A student in another group asks, "How can we know which way the ball will go once it leaves the edge of the table?" Mr. C replies, "Perhaps someone in your group can recall what we discussed at the beginning of the lesson."
 - A student asks, "What is the bottom row of the data table for?" Mr. C replies, "That is a row to average data in the columns. Then you can calculate the predicted distance from the table. You can also calculate the predicted distance from the table for each trial and average those values."

SELECTED EXCERPTS FROM THE MST'S OBSERVATIONS (*continued*)

- A student in the third group asks, "Why do we record the distance the ball falls in the fourth column of the data table?" Mr. C replies, "So you can use one of the motion formulas to calculate the time that it takes the ball to fall." The student asks, "Couldn't we just use a stopwatch to measure the time it takes for the ball to fall?" Mr. C replies, "Just solve for time in the formula that analyzed the motion of an accelerating object." The student asks, "What distance do we use in that formula?" Mr. C replies, "Use the distance that the ball falls."
- A student in another group says, "We have completed three trials. The time for our third trial was a bit different than the time for the first two trials. May we repeat the third trial?" Mr. C replies, "No, you may not. Every group will have only three trials before testing a prediction of a landing point. I want you to focus on making accurate measurements." The student asks, "Can we reject data from the third trial?" Mr. C says, "No. You need to use the data from all three trials." Mr. C announces to the class, "Be sure to use data from all three trials when you predict the distance the ball will go away from the table when it becomes a projectile."
- A group of students announces that they are ready to test their prediction of a landing point. Mr. C asks everyone to gather around the group's landing area. The class eagerly waits as Mr. C asks the students in that group where he should place the paper cup.
 - A student in the group points to a spot on the floor and asks the student holding the ball on the ramp to wait a minute before releasing it. The student says, "I still think that we need to compensate for the fact that the ball seemed to slow down the first time it rolled across the table." The student moves the cup a centimeter toward the table and says, "O.K., let it roll."
 - The ball is released, rolls down the ramp, across the table, and off the edge of the table. Everyone in the class watches as the ball knocks the cup over as it hits the side of the cup closest to the table. The student who moved the paper cup from its original position on the floor seems very upset and says, "I should have moved the cup closer to the table, but I didn't think that the speed of the ball changed that much during the first trial."
 - The second group to test their prediction has the ball land in the cup. One of the students in the group says, "See, I told you that it didn't matter that the time for our third trial was less than the first two trials."
- After all of the groups have finished their trials, Mr. C asks students to put the supplies away, straighten out the tables, and get seated. He then asks, "For those of you who didn't get the ball in the cup, what do you think went wrong?"
 - A student responds, "Our team came very close, but I think we had one bad trial. If we had used the average of the first two trials we would have gotten the ball in the cup. I think the ball bounced a little when it came off the ramp and that may have slowed it down." Another student says, "Our team really misjudged how much the table would slow it down and so we moved the ramp closer to the edge of the table after each trial. That might have been part of our problem."
- Mr. C says, "We can talk more about it tomorrow when we run through the calculations. All in all, I think you all gave it a good try, but remember if you're launching a spaceship to Mars you don't have a chance to say, 'Oops, we goofed. Let's try that again.'"

STUDENT A
COMPLETED ASSIGNMENT

Hit the Target

Complete the table below with data and calculations from the class activity.

	Distance on the Table	Time on the Table	Velocity on the Table	Distance the Ball Falls	Time the Ball Falls	Predicted Distance from the Table
Trial 1	<i>1.2 m</i>	<i>1.93 s</i>	<i>0.62 m/s</i>	<i>0.745 m</i>	<i>0.3899 s</i>	—
Trial 2	<i>1.0 m</i>	<i>1.41 s</i>	<i>0.71 m/s</i>	<i>0.745 m</i>	<i>0.3899 s</i>	—
Trial 3	<i>0.76 m</i>	<i>1.01 s</i>	<i>0.75 m/s</i>	<i>0.745 m</i>	<i>0.3899 s</i>	—
Avg.	<i>0.986 m</i>	<i>1.45 s</i>	<i>0.69 m/s</i>	<i>0.745 m</i>	<i>0.3899 s</i>	<i>0.26 m</i>

1. Why are there two different formulas to analyze the motion of a projectile?

Because a projectile goes in two different directions at the same time.

2. What was the forward velocity of the ball while it was a projectile?

That changed as we shortened the distance the ball rolled on the table. So we used the average forward speed of the three trials to get the forward speed we used to make our prediction.

3. Why did the forward velocity of the ball stay constant while it was a projectile?

Because there wasn't any more friction on the table to slow it down.

4. What might be the principal source of error in this activity?

Our ball landed several centimeters short of the cup. Maybe it was due to the decrease in the speed of the ball during the first time trial. We probably should have just used the data from the third time trial.

**STUDENT B
COMPLETED ASSIGNMENT**

Hit the Target

Complete the table below with data from the class activity.

	Distance on the Table	Time on the Table	Velocity on the Table	Distance the Ball Falls	Time the Ball Falls	Predicted Distance from the Table
Trial 1	<i>0.98 m</i>	<i>0.81 s</i>	<i>1.21 m/s</i>	<i>0.76 m</i>	<i>0.3938 s</i>	<i>.48 m</i>
Trial 2	<i>0.98 m</i>	<i>0.82 s</i>	<i>1.19 m/s</i>	<i>0.76 m</i>	<i>0.3938 s</i>	<i>.47 m</i>
Trial 3	<i>0.98 m</i>	<i>0.86 s</i>	<i>1.14 m/s</i>	<i>0.76 m</i>	<i>0.3938 s</i>	<i>.45 m</i>
Avg.	—	—	—	—	—	<i>.466 m</i>

1. Why are there two different formulas to analyze the motion of a projectile?

Because the forward motion of a projectile is independent of the upward or downward motion of a projectile.

2. What was the forward velocity of the ball while it was a projectile?

The average forward speed was 1.18 meters per second.

3. Why did the forward velocity of the ball stay constant while it was a projectile?

The steel ball was smooth, so there wasn't much air friction.

4. What might be the principal source of error in this activity?

Our ball just barely made it into the cup. If we had not used the data from the third trial, then the ball would probably have landed in the center of the cup.

Sample Case Study Responses

MST 8–12 Strong Response

A strength of this lesson is that Mr. Colson provides students with an opportunity to predict the landing point of a projectile using motion equations they have learned previously. Students make measurements in the lab and use these in the equations. They observe the actual landing point of the projectile and can discover the relationship between calculated or expected results and actual or experimental results.

One weakness in the lesson is that Mr. C does not allow students to repeat a trial or reject the results of a trial. He also limits students to exactly three trials. When one group notes that one of their trials is different, Mr. C says that they must use their data and can only have three trials. This restriction limits the value of the lesson.

An instructional strategy that would address this weakness and make the lesson more valuable would be to have students focus on sources of experimental error and the value of a large number of trials. Mr. C should encourage students to first make trial runs to see that they have set up the equipment properly before recording any data. Students should also be encouraged to observe carefully during each trial for correct procedure and to ask "why" if one trial seems out of line. They should be allowed to repeat a "bad" trial.

This strategy would be effective in improving instruction, as it makes students aware of the importance in science of accounting for experimental error as data is being collected. Students are developing observational and

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analytical skills. They also become aware of the need to reject “bad” data and to have enough trials to get reliable results.

A second weakness is that Mr. C did not provide guidance or make suggestions to students. Students in two different groups asked, “How can we know which way the ball will go once it leaves the edge of the table?” Mr. C directs students to “recall what we discussed” or “get with your group and decide.” These responses were not helpful to the students.

A good instructional strategy in this case would have been to discuss the question with the groups. A teacher should first ask questions that guide the students to recall what they know and then make suggestions if necessary. Ask leading questions such as, what will affect the path of the ball? What does each equation calculate? What do you think is the expected direction?

This strategy would be effective in encouraging students to reflect on what they have learned and transfer it to the lab setting. It would help students to be observant and enable them to find the answers to their own questions

To help Mr. Colson implement these strategies, I would meet with him immediately after the lesson and guide him in reflecting on what he perceived as strengths and weaknesses of the lesson. Questions such as which groups he saw as being most successful, why they were successful, and what changes he would make if he did this activity again would also be asked. We would look at the students’ completed homework assignments and use them to reflect on additional strengths and weaknesses of the lesson.

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I would encourage Mr. C to continue to give students hands-on experiences and experiences in teamwork. I would provide, if needed, suggestions as to resources for lab activities and references for learning more about team/group work strategies.

During our conversation, I would suggest that Mr. C give students the opportunity to model the best practices in collecting and analyzing data. In this activity, for example, the procedure should include a greater number of trials. I would also emphasize using student questions as opportunities to guide and encourage students.

I would plan to meet again with Mr. C after he has had a chance to reflect on the lesson and our discussion. We could continue to meet periodically to share ideas and collaboratively plan future lessons.

MST 8–12 Weak Response

This seemed to be an effective lesson overall. Mr. Colson showed strength as a teacher when he stuck to his experiment design and would not let the students do more trials than had been planned. Some teachers would have given in to the students' requests for more tries, but that would show a lack of control in the classroom. One weakness is that he didn't spend enough time reviewing the algebra formulas the students would use to make their calculations. Some of the groups seemed to have trouble making their calculations and that affects the results of the experiment. One group wants to skip the formulas and just time the ball dropping. Another weakness is that the cup used to catch the ball was probably too small. Even if a group did all the calculations correctly, the ball might still knock the cup over because it was too small or too light to stop the momentum of the ball. That happened to one group where the ball hit the cup but didn't stay in it.

A strategy for helping students understand the algebra formulas would be to give them more practice problems to work. If Mr. Colson reviewed the concepts and assigned a number of practice problems, the students would be more comfortable with the process and be more accurate in their answers. I think that more groups would have had the ball go in the cup if their formulas were more accurate. A second strategy is to make sure the materials used in the experiment are adequate. The cups in this case were too light and small for the students' needs. Even if the students did

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everything right, they could still not win the prize because their cup fell over. A larger heavier container would have been a better choice for this experiment.

Reviewing and practicing the algebra formulas would ensure that the students would not get stuck on a minor part of the lesson. You don't want the class struggling with simple math and missing the "big picture" or purpose of the lesson. When the students are comfortable with working the formulas, they can then concentrate on the science.

Using appropriate materials is important in any experiment. The bad part of this situation is that some students missed out on winning the prize because the cup was too small to hold the ball. They should not be penalized just because the teacher made a poor choice. Again, the students should be able to think about the science involved rather than worry about little things.

A plan of action for the mentor-teacher would be to "debrief" Mr. Colson after the class. I would use the written assignments to point out where the lesson needed improvement. I would encourage him to collaborate with me on his next lesson plan so I could make sure he was using appropriate materials and including enough practice time for students. I would also suggest he attend a teacher conference on designing classroom experiments.

SECTION V

PREPARATION RESOURCES

The resources listed below may help you prepare for the TExMaT 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.

Journals

American Biology Teacher, National Association of Biology Teachers

Science and Children, National Science Teachers Association

The Earth Scientist, National Earth Science Teachers Association

The Physics Teacher, American Association of Physics Teachers

The Science Teacher, National Science Teachers Association

The Texas Science Teacher, Science Teachers Association of Texas

Web Sites

TAKS Science Objectives

www.tea.state.tx.us/student.assessment/taas2/objectives/science.pdf

TAKS Science revised Information Booklet (Educator Guides)

www.tea.state.tx.us/student.assessment/taks/booklets/index.html

TAKS study guides

www.tea.state.tx.us/student.assessment/resources/guides/study

Resources on Graduation Requirements for Science

www.tea.state.tx.us/curriculum/side1.doc

Resources for Certification Requirements and PD Provider Number

www.sbec.state.tx.us

Teacher Toolkit; Safety; Facilities; TEXTeams; Charles A. Dana Center

www.utdanacenter.org/sciencetoolkit

Texas Regional Collaboratives for Excellence in Science Teaching

www.thetrc.org

The TEKSlink project

www.libraries.risd.org/tekslink

Science Teacher Toolbag
www.tea.state.tx.us/tchrtoolbag/ProDev_Sci.html
www.tea.state.tx.us/tchrtoolbag/CurRes_Science.html

Science Teachers Association of Texas Convention: October 27–29; Houston, TX; 2005
www.statweb.org

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

National Association of Biology Teachers
www.nabt.org

American Chemical Society
www.acs.org

American Association of Physics Teachers
www.aapt.org

Texas Earth Science Teachers Association
www.statweb.org/TESTA

Texas Marine Education Association
www.stateweb.org/TMEA

National Earth Science Teachers Association
www.nestanet.org

Albert Einstein: Person of the Century (Time)
www.time.com/time/time100/poc/home.html

2005 "World Year of Physics"
www.physics2005.org

Physics Question of the Week
www.physics.umd.edu/lecdem/outreach/QOTW/active/questions.htm

Physical Sciences Resource Center (PSRC)
www.psrc.aapt.org

Physics Interactive Puzzle
www.brl.ntt.co.jp/people/hara/fly.swf

What Works Clearinghouse
www.w-w-c.org

UTOPIA: University of Texas Web site for educators
www.utopia.utexas.edu

IBM science resource
www.tryscience.org

NASA's The Space Place
www.spaceplace.nasa.gov

NCLB: A Teacher Toolkit
www.ed.gov/teachers/nclbguide/nclb-teachers-toolkit.pdf

Earth Science Week Materials; October 9–15, 2005
www.earthscienceworld.org/week

Other Sources

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