



**TE<sub>x</sub>MaT** | Texas Examinations for Master Teachers

# Preparation Manual



090 Master Science Teacher EC-4

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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 EC–4 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

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*List of competencies that will be tested*

*Strategies for answering test questions*

*Sample test items and answer key*

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## SECTION I

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# 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](http://www.sbec.state.tx.us).

## **Educator Standards**

Complete, approved educator standards are posted on the SBEC Web site at [www.sbec.state.tx.us](http://www.sbec.state.tx.us).



## SECTION II

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### 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 EC–4

#### Competency:

**The Master Science Teacher EC–4 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 090: MASTER SCIENCE TEACHER EC–4

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## 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

### Competency 001 (Properties of Matter) Standard I

**The Master Science Teacher EC–4 understands the physical and chemical properties of matter.**

The Master Science Teacher:

- Knows the properties of objects and materials.
- Analyzes physical and chemical changes, including changes in state.
- Differentiates between elements, compounds, and mixtures.
- Applies the law of conservation of matter to analyze a variety of situations.
- Understands the organization and use of the periodic table.

### Competency 002 (Force and Motion) Standard I

**The Master Science Teacher EC–4 understands the concepts of and relationship between force and motion.**

The Master Science Teacher:

- Analyzes changes in the position and motion of objects subjected to an unbalanced force.
- Applies knowledge of the relationship between force and motion to analyze common objects, experiences, and everyday situations.
- Recognizes forces that affect the motion of an object (e.g., friction, gravity, electric force, magnetic force).

### Competency 003 (Energy and Energy Transformations) Standard I

**The Master Science Teacher EC–4 understands forms of energy and energy transformations.**

The Master Science Teacher:

- Recognizes the properties of various forms of energy.
- Analyzes how energy is transferred and transformed from one form to another.
- Applies the law of conservation of energy to a variety of phenomena.
- Analyzes the relationship between electricity and magnetism.
- Analyzes the properties and behavior of light and sound.

**Competency 004 (Strategies, Resources, and Equipment) Standards III, V, and VI**  
**The Master Science Teacher EC–4 understands and uses a variety of strategies, resources, and scientific equipment for teaching developmentally appropriate physical science concepts.**

The Master Science Teacher:

- Applies knowledge of appropriate techniques, procedures, and tools to observe and record phenomena and changes 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 students' preconceptions and misconceptions about phenomena related to physical science.
- Plans, implements, and evaluates lessons that assist students in developing concepts and making generalizations associated with physical science.

**DOMAIN II—LIFE SCIENCE**

**Competency 005 (Characteristics and Needs of Organisms) Standard I**  
**The Master Science Teacher EC–4 understands the basic characteristics and needs of organisms.**

The Master Science Teacher:

- Recognizes stages in the life cycles of common plants and animals.
- Identifies characteristics of living and nonliving objects.
- Identifies characteristics and needs of plants and animals.
- Explains how structure and function are related in organisms, including humans.
- Analyzes the role of internal and external stimuli in the behavior of organisms.
- Understands regulatory mechanisms in organisms.

**Competency 006 (Reproduction, Heredity, and Evolution) Standard I**  
**The Master Science Teacher EC–4 understands reproduction, heredity, and evolution.**

The Master Science Teacher:

- Recognizes the processes by which plants and animals reproduce.
- Explains how hereditary information is passed from one generation to the next.
- Compares and contrasts inherited traits and learned characteristics.
- Identifies adaptive characteristics and explains how adaptations influence the survival of populations or species.
- Recognizes the mechanisms of how populations or species evolve over time.

**Competency 007 (Organisms within Ecosystems) Standard I**  
**The Master Science Teacher EC–4 understands relationships among organisms and between organisms and their environment.**

The Master Science Teacher:

- Recognizes ways living organisms depend on one another and their environment for basic needs.
- Analyzes the characteristics of various habitats within ecosystems.
- Identifies organisms, populations, or species with similar needs and analyzes how they compete with one another for resources.
- Analyzes energy transfers and the cycling of nutrients in food webs and food chains.

**Competency 008 (Strategies, Resources, and Equipment) Standards III, V, and VI**  
**The Master Science Teacher EC–4 understands and uses a variety of strategies, resources, and scientific equipment for teaching developmentally appropriate life science concepts.**

The Master Science Teacher:

- Applies knowledge of appropriate techniques, procedures, and tools to observe and record phenomena and changes 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 students' preconceptions and misconceptions about phenomena related to life science.
- Plans, implements, and evaluates lessons that assist students in developing concepts and making generalizations associated with life science.

**DOMAIN III—EARTH AND SPACE SCIENCE**

**Competency 009 (Earth Materials and Processes) Standard I**  
**The Master Science Teacher EC–4 understands the properties of Earth materials and the structure and function of Earth systems.**

The Master Science Teacher:

- Identifies properties and uses of minerals, fossils, rocks, soils, water, atmospheric gases, and other Earth materials.
- Analyzes changes in Earth systems resulting from natural events and human activities.
- Understands characteristics of renewable, nonrenewable, and inexhaustible resources.
- Recognizes cycles in Earth systems (e.g., rock cycle, water cycle, carbon cycle, nitrogen cycle).
- Recognizes forces, processes, and human activities that change Earth's surface.

**Competency 010 (Hydrosphere and Atmosphere) Standard I**

**The Master Science Teacher EC–4 understands the hydrosphere and atmosphere as interacting systems that produce Earth's weather and climate.**

The Master Science Teacher:

- Recognizes the impact of bodies of water on land formations and ecosystems.
- Identifies components of the water cycle and their relationship to weather.
- Recognizes the causes of weather and factors affecting climate.
- Recognizes the structure of Earth's atmosphere and hydrosphere.

**Competency 011 (Solar System and Universe) Standard I**

**The Master Science Teacher EC–4 understands components and characteristics of the solar system and the universe.**

The Master Science Teacher:

- Understands theories of the origin of the universe.
- Identifies components of the universe.
- Identifies and describes components of the solar system and their relationship to the sun and to each other.
- Analyzes the effect of the sun on Earth systems (e.g., atmospheric and ocean circulation, climate, ecosystems).
- Relates the movements and relative positions of the moon, Earth, and the sun to tides, lunar phases, day and night, seasons, and time.

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

**The Master Science Teacher EC–4 understands and uses a variety of strategies, resources, and scientific equipment for teaching developmentally appropriate earth and space science concepts.**

The Master Science Teacher:

- Applies knowledge of appropriate techniques, procedures, and tools to observe and record phenomena and changes 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 students' preconceptions and misconceptions about phenomena related to earth and space science.
- Plans, implements, and evaluates lessons 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 EC–4 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.
- 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.

**Competency 014 (Nature of Science and Unifying Themes) Standards I and II**  
**The Master Science Teacher EC–4 understands the nature of science 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 roles of observation, logical reasoning, and the use of scientific evidence and information in developing, evaluating, and validating scientific explanations and is able to analyze, review, and critique hypotheses and theories.
- Knows that sharing research results and peer review assist 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, processes, and unifying themes form a conceptual 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 EC–4 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 value of inquiry in science and science instruction.
- Knows multiple methods of inquiry leading to scientific knowledge.
- 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 inquiry-based investigations.
- Recognizes patterns in collected data and observations of natural phenomena and develops, analyzes, and evaluates different explanations for the results of scientific investigations.
- Knows how to guide students in making systematic observations and measurements, analyzing data, and recording and reporting results.
- 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 use and demonstrate the use of a variety of tools and techniques to access, gather, store, retrieve, organize, and analyze data.
- Knows how to manage groups of students in classrooms, laboratories, and field investigations 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 EC–4 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 safety 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 to create, implement, and enforce policies, rules, and safety procedures to promote 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 maintain, inventory, and optimize quick and safe access to safety equipment (e.g., eyewash station, sink, safety shower, fire blanket, extinguisher).
- Demonstrates an understanding of appropriate procedures for storing, ordering, inventorying, maintaining, handling, using, disposing of, and performing safety checks on chemicals, materials and equipment, and for caring for specimens.

## DOMAIN V—ALIGNMENT AND INTEGRATION, INSTRUCTION, AND ASSESSMENT

### Competency 017 (Vertical Alignment and Integration) Standard IV

**The Master Science Teacher EC–4 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 content areas.**

The Master Science Teacher:

- Knows the purpose, content, and organization of the Texas Essential Knowledge and Skills (TEKS) for Science and uses them to plan and implement grade-appropriate instruction that is vertically aligned with the overall science curriculum.
- Demonstrates familiarity with the national science standards and 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.
- Knows how students build scientific knowledge and skills and the relationship between students' cognitive development and vertical alignment of the Texas Essential Knowledge and Skills (TEKS) and uses this knowledge 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 content areas in the school curriculum.
- Recognizes connections between science and daily life and uses examples from students' experiences 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), scientific principles, and learner-centered pedagogy.
- Knows how to provide guidance to other teachers regarding alignment and integration of science content.

## **Competency 018 (Science Instruction) Standard VI**

**The Master Science Teacher EC–4 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 students learn science and develop scientific understanding and how the developmental characteristics of students influence science learning.
- Selects and uses research-based instructional approaches and activities to develop science content knowledge, concepts, process skills, problem-solving strategies, and critical and analytical thinking.
- Recognizes how preconceptions and misconceptions that students have about scientific phenomena influence learning.
- Applies effective instructional strategies to build on students' prior knowledge and address misconceptions.
- Uses a variety of research-based instructional formats to motivate students, including students who are at risk, English language learners, and students from traditionally underrepresented groups in the sciences, and actively engage them in the learning process.
- Recognizes the importance of taking into account the 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 representations of science content (e.g., verbal, concrete, tabular, graphic, pictorial, mathematical, symbolic).
- 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 EC–4 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 among 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) to monitor student understanding and progress in science.
- Uses ongoing formal and informal assessments of students' science understanding to guide and improve instructional practice.
- Knows the importance of sharing clearly stated assessment criteria with students prior to assessment.
- Recognizes the role of student assessments as learning experiences.
- Applies strategies for engaging students in meaningful self-assessments.
- Knows how to communicate assessment results to students and parents/guardians.
- Communicates effectively with other teachers about the development and use of student assessment techniques and the interpretation of results to guide instruction.
- 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 EC–4 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.
- Ensures high expectations and equity in science instruction for all students by reflecting on one's own behaviors and attitudes and encouraging others to do so.
- 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.
- Uses effective strategies and appropriate resources to stay current on emerging science topics and technology.
- Knows how to promote academic integrity in the learning environment.

**Competency 021 (Leadership, Communication, and Collaboration) Standard IX**  
**The Master Science Teacher EC–4 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 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 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, students, administrators, and the community.
- Knows how to improve scientific literacy among students, colleagues, administrators, parents/guardians, and the community.

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

**The Master Science Teacher EC–4 knows how to provide research-based professional development through mentoring, coaching, and consulting with colleagues.**

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 with a mentor and evaluation by a supervisor.
- Knows and applies learning processes and procedures for facilitating adult learning.
- 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 to promote professional development.
- 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 consulting to facilitate team building to support science instruction.
- Uses consultation to work effectively with colleagues who have varying levels of knowledge, skill, and experience and 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 based on data, 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 education organizations.

## SECTION III

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### 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 EC–4 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 27 of this preparation manual. For the MST EC–4 test, it is not necessary to memorize the names of the elements in the periodic table.

# PERIODIC TABLE OF THE ELEMENTS

18 <b>VIIIA</b>																			
2 <b>He</b> 4.00		17 <b>F</b> 19.00		16 <b>O</b> 16.00		15 <b>N</b> 14.01		14 <b>C</b> 12.01		13 <b>B</b> 10.81									
10 <b>Ne</b> 20.18		9 <b>F</b> 19.00		8 <b>O</b> 16.00		7 <b>N</b> 14.01		6 <b>C</b> 12.01		5 <b>B</b> 10.81		12 <b>IIB</b>		11 <b>IB</b>		10 <b>VIIIB</b>			
18 <b>Ar</b> 39.9		17 <b>Cl</b> 35.5		16 <b>S</b> 32.1		15 <b>P</b> 31.0		14 <b>Si</b> 28.1		13 <b>Al</b> 27.0		30 <b>Zn</b> 65.4		29 <b>Cu</b> 63.5		28 <b>Ni</b> 58.7			
36 <b>Kr</b> 83.8		35 <b>Br</b> 79.9		34 <b>Se</b> 79.0		33 <b>As</b> 74.9		32 <b>Ge</b> 72.6		31 <b>Ga</b> 69.7		48 <b>Cd</b> 112.4		47 <b>Ag</b> 107.9		46 <b>Pd</b> 106.4			
54 <b>Xe</b> 131.3		53 <b>I</b> 126.9		52 <b>Te</b> 127.6		51 <b>Sb</b> 121.8		50 <b>Sn</b> 118.7		49 <b>In</b> 114.8		80 <b>Hg</b> 200.6		79 <b>Au</b> 197.0		78 <b>Pt</b> 195.1			
86 <b>Rn</b> (222)		85 <b>At</b> (210)		84 <b>Po</b> (209)		83 <b>Bi</b> 209.0		82 <b>Pb</b> 207.2		81 <b>Tl</b> 204.4		112 112		111 111		110 110			
118		117		116		115		114		113									
1 <b>H</b> 1.01		2 <b>He</b> 4.00		3 <b>Li</b> 6.94		4 <b>Be</b> 9.01		5 <b>B</b> 10.81		6 <b>C</b> 12.01		7 <b>N</b> 14.01		8 <b>O</b> 16.00		9 <b>F</b> 19.00		10 <b>Ne</b> 20.18	
11 <b>Na</b> 23.0		12 <b>Mg</b> 24.3		13 <b>Al</b> 27.0		14 <b>Si</b> 28.1		15 <b>P</b> 31.0		16 <b>S</b> 32.1		17 <b>Cl</b> 35.5		18 <b>Ar</b> 39.9		19 <b>K</b> 39.1		20 <b>Ca</b> 40.1	
19 <b>K</b> 39.1		20 <b>Ca</b> 40.1		21 <b>Sc</b> 45.0		22 <b>Ti</b> 47.9		23 <b>V</b> 50.9		24 <b>Cr</b> 52.0		25 <b>Mn</b> 54.9		26 <b>Fe</b> 55.8		27 <b>Co</b> 58.9		28 <b>Ni</b> 58.7	
37 <b>Rb</b> 85.5		38 <b>Sr</b> 87.6		39 <b>Y</b> 88.9		40 <b>Zr</b> 91.2		41 <b>Nb</b> 92.9		42 <b>Mo</b> 95.9		43 <b>Tc</b> 98.9		44 <b>Ru</b> 101.1		45 <b>Rh</b> 102.9		46 <b>Pd</b> 106.4	
55 <b>Cs</b> 132.9		56 <b>Ba</b> 137.3		57-71		72 <b>Hf</b> 178.5		73 <b>Ta</b> 180.9		74 <b>W</b> 183.9		75 <b>Re</b> 186.2		76 <b>Os</b> 190.2		77 <b>Ir</b> 192.2		78 <b>Pt</b> 195.1	
87 <b>Fr</b> (223)		88 <b>Ra</b> (226)		89-103		104 <b>Rf</b> (261)		105 <b>Db</b> (262)		106 <b>Sg</b> (263)		107 <b>Bh</b> (264)		108 <b>Hs</b> (265)		109 <b>Mt</b> (268)		110 110	

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

Lanthanide Series

Actinide Series

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

For the MST EC-4 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

Vinegar and a small amount of baking soda are put in a resealable plastic bag. The bag expands. Which of the following explains this change?

- A. The liquid vinegar vaporizes into a gas, increasing the volume it occupies.
- B. A chemical reaction produces excess heat, causing the air in the bag to expand.
- C. The baking soda dissolves in the vinegar, increasing the volume of the mixture.
- D. A newly formed gas produced by the reaction takes up more space, causing the bag to expand.

---

Option D is correct because it describes a chemical reaction that produces a gas that would take up additional space, causing the bag to expand. The reaction between vinegar (a dilute solution of acetic acid) and baking soda (sodium bicarbonate) produces carbon dioxide, which is a gas at room temperature.

Option A is incorrect because the vinegar does not vaporize into a gas.

Option B is incorrect because the expansion of the air in the bag as heat energy is released during the reaction would be insignificant.

Option C is incorrect because the increase in the volume of the vinegar solution as baking soda dissolves would be insignificant.

**Competency 002**

A meteorite is moving toward the planet Mars. Which of the following best describes the meteorite's motion as it approaches the atmosphere of Mars?

- A. Its velocity decreases because the force of friction increases.
- B. The rate of its acceleration does not change because the force of gravity is constant.
- C. Its velocity is constant because it is not acted on by an unbalanced force.
- D. The rate of its acceleration increases because the force of gravity increases.

---

Option D is correct because gravitational force increases as the distance between the planet and the meteorite decreases. According to Newton's second law of motion, the acceleration of the meteorite will increase as the distance between the planet and meteorite decreases.

Option A is incorrect because as the meteorite approaches the Martian atmosphere it is still outside the atmosphere and therefore no frictional forces would develop.

Option B is incorrect because as the meteorite gets closer to the planet, the force of gravity increases.

Option C is incorrect because the velocity of the meteorite increases due to the unbalanced gravitational force acting on the meteorite.

**Competency 003**

Which of the following phenomena is most directly associated with the magnifying property of optical lenses?

- A. reflection
- B. polarization
- C. refraction
- D. diffraction

---

Option C is correct because optical lenses have a curved surface, causing incident light to change direction and speed as it enters the lens. This bending of light as it passes from one transparent medium to another is referred to as refraction.

Option A is incorrect because it refers to the process of incident light, or other forms of electromagnetic radiation, striking the boundary between two mediums and reflecting off of the boundary rather than entering the new medium.

Option B is incorrect because it refers to the process of using filters to select and then either block or transmit specific planes of electromagnetic radiation.

Option D is incorrect because it refers to the process of electromagnetic radiation changing direction as it passes by a sharp edge of an obstacle.

**Competency 006**

A population of giraffes contains individuals with necks of different lengths. Those individuals with longer necks are better able to obtain nutrition from the leaves of trees during the dry season, when other food sources are scarce. According to Darwin's theory of natural selection, this differing ability to obtain food will cause which of the following changes in the population?

- A. The proportion of giraffes with longer necks will increase in the population.
- B. The neck muscles of the giraffes with shorter necks will increase in length.
- C. The group of giraffes with longer necks will develop into a different species.
- D. The digestive systems of giraffes with shorter necks will adapt to other sources of nutrition.

---

Option A is correct because giraffes with longer necks will have greater access to a food supply during the dry season and therefore will have a greater probability of surviving and reproducing.

Option B is incorrect because the length of a giraffe's neck is an inherited trait and cannot be appreciably altered by physical activity.

Option C is incorrect because the temporary decrease in food supply during the dry season is not a persistent enough change in habitat to necessarily cause the evolution of a new species.

Option D is incorrect because the temporary decrease in food supply during the dry season is not persistent enough to result in a change in digestive biochemistry.

**Competency 006**

Which of the following provides an example of a learned behavior, rather than an innate or inherited behavior?

- A. A songbird uses different types of calls for warning about different kinds of threats.
- B. The male frigate bird attracts its mate by inflating a colorful pouch on its chest.
- C. A songbird reproduces the song of its foster parent of a different species.
- D. The cuckoo hatches from an egg and rolls any remaining eggs out of the nest.

---

Option C is correct because a young bird's learning of the song of a genetically unrelated foster parent is an example of learned behavior and not an inherited or innate behavior.

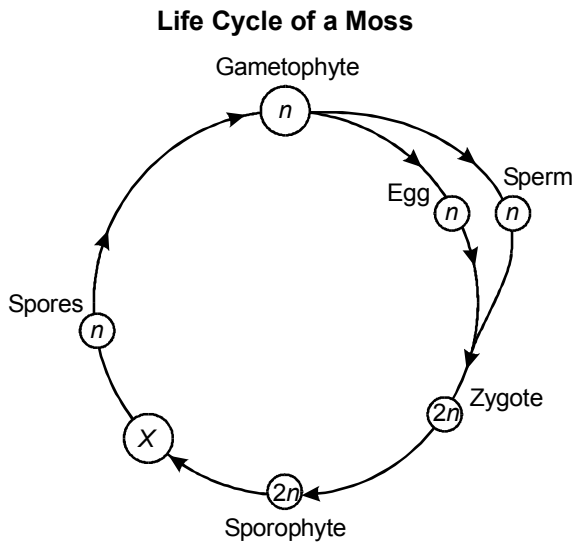
Option A is incorrect because the variety of warning calls of a songbird are a part of a repertoire of natural responses that have been developed through the process of natural selection.

Option B is incorrect because the pouch is an inherited structure and its use involves an inherited and not learned behavior designed to maximize reproductive success of the individual.

Option D is incorrect because the cuckoo hatchling's behavior occurs before there is an opportunity to observe an instructive behavior.

**Competency 006**

Use the life cycle diagram below to answer the question that follows.



In the diagram above, the arrow labeled  $X$  represents which of the following processes?

- A. ovulation
- B. mitosis
- C. fertilization
- D. meiosis

---

Option D is correct because layers of haploid cells undergo meiosis inside the spore capsule of the sporophyte, resulting in the formation of spores.

Option A is incorrect because ovulation does not occur in moss.

Option B is incorrect because mitosis is the process in which cells divide to produce daughter cells with the same number of chromosomes.

Option C is incorrect because fertilization refers to the union of the haploid sperm cell with the haploid egg cell that results in a diploid zygote.

**Competency 007**

Which of the following is a typical strategy used by plant species to survive in seasonally dry environments?

- A. growing extensive systems of near-surface roots to take advantage of all available moisture
- B. maximizing the size of leaves to capture and absorb any available precipitation or water vapor
- C. producing drought-tolerant seeds that can germinate during the next period of water availability
- D. reproducing asexually from dried plant tissue once there is adequate moisture available

---

Option C is correct because it is a typical strategy used by plants to survive a dry season. It is an effective strategy because it allows the plant to utilize optimal growing conditions during the wet season and avoid the harsh conditions of the dry season.

Option A is incorrect because the soil nearest to the surface experiences the most drying during extended periods without precipitation.

Option B is incorrect because larger leaves would likely increase water loss through transpiration.

Option D is incorrect because plant cells are typically not viable once they have been completely dried out.

**Competency 008**

A class is studying insects, including moths and butterflies. Many of the students are confused about caterpillars, however, and think they are worms rather than insects. Which of the following features of caterpillars is contradictory to a characteristic students are commonly told to use to identify insects?

- A. They have more than three pairs of legs.
- B. They have an exoskeleton that molts as they grow.
- C. They have paired antennae on their anterior end.
- D. They undergo the process of metamorphosis.

---

Option A is correct because insects are typically identified as having three pairs of legs, while caterpillars have up to five additional pairs of abdominal prolegs.

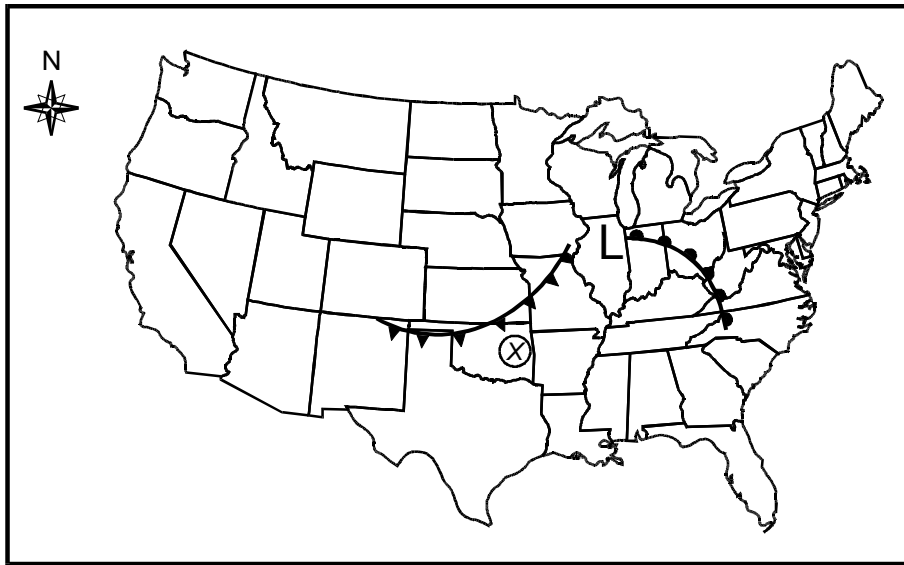
Option B is incorrect because caterpillars do not have an exoskeleton.

Option C is incorrect because paired anterior antennae are not commonly used to help identify insects.

Option D is incorrect because many other insect species undergo metamorphosis.

**Competency 010**

Use the weather map below to answer the question that follows.



In the weather map shown above, a cold front is moving south across the south-central United States into a mass of warm humid air flowing north from the Gulf of Mexico. As the cold front passes through the location marked with an X on the map, which of the following kinds of weather will most likely develop at that location?

- A. partly cloudy and breezy
- B. windy with thunderstorms
- C. light rain and poor visibility
- D. cool and dry with wind gusts

---

Option B is correct because as the cold front moves into the region it will force the warm, humid air to rise quickly. This series of events commonly generates thunderstorms.

Options A is incorrect because the movement of a cold front into a warm and humid air mass does not typically produce these conditions.

Option C is incorrect because the movement of a cold front into a warm and humid air mass does not typically produce these conditions.

Option D is incorrect because these are weather conditions that often occur after a cold front has passed through a region rather than during the time that the cold front is moving through the region.

**Competency 010**

Which of the following is one of the major causes of plankton blooms in marine waters?

- A. above-average water temperature resulting from warm rains
- B. high nutrient concentrations due to upwelling of deep-ocean water
- C. above-average turbidity resulting from windy conditions
- D. high nutrient concentrations due to evaporation of surface water

---

Option B is correct because it describes the source of large quantities of nutrients that would support an increase in the plankton population.

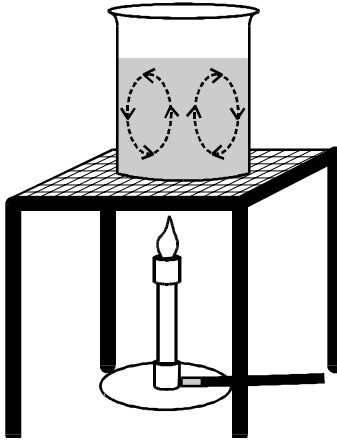
Option A is incorrect because the increase in the water temperature from freshwater rainfall would not have an appreciable effect on the plankton population.

Option C is incorrect because an increase in turbidity would decrease the amount of sunlight available for primary production in the ocean's near-surface layers.

Option D is incorrect because evaporation by itself would not significantly increase the level of nutrients in ocean waters needed to support a plankton bloom.

**Competency 012**

Use the diagram below to answer the question that follows.



A teacher fills a beaker with water, adds a small amount of food coloring, and places the beaker over a Bunsen burner. The students observe currents having the pattern shown in the diagram above. The demonstration is most likely intended to model which of the following kinds of currents?

- A. currents that create the jet stream
- B. currents that produce ocean waves
- C. currents that move tectonic plates
- D. currents that create mountain chains

---

Option C is correct because the convection currents that are apparent in the heated beaker of water are most similar to the convection currents in Earth's interior that are believed to be responsible for the movement of tectonic plates.

Option A is incorrect because the rapid horizontal motion of air known as the jet stream results primarily from pressure gradients in the tropopause and the deflection of winds by the Coriolis effect.

Option B is incorrect because ocean waves are caused by wind moving across the ocean surface.

Option D is incorrect because mountain ranges are produced by a variety of geologic forces. Only some of these forces are related to convection currents within Earth's interior and tectonic plate movements.

**Competency 012**

A teacher boils 10 mL of water in the bottom of an aluminum soda can until almost all of the water has boiled away. She then lifts the soda can with tongs and places it upside down in a pan of cold water. The can suddenly contracts, much to the surprise of the class. Which of the following is most effectively demonstrated with this activity?

- A. the thermal conductivity of metals
- B. the importance of water vapor in weather phenomena
- C. the specific heat of water
- D. the relationship between temperature and pressure in a gas

---

Option D is correct because the pressure of air inside the can decreases as the moist air inside the can is cooled. As a result, the higher pressure outside of the can causes the collapse of the can.

Option A is incorrect because the rate at which the aluminum conducts heat energy does not cause the large difference in air pressure inside and outside of the can.

Option B is incorrect because the decrease in the density of the air inside the can as the air became humid would not result in an air pressure difference significant enough to cause the can to collapse.

Option C is incorrect because the specific heat of water is not measured or effectively illustrated by this demonstration.

**Competency 014**

Third-grade students have been studying the ecology of a local wooded area that may soon be cleared to make room for a housing development. Which of the following questions related to this study can the students address most easily through scientific means?

- A. What economic impact will the proposed change have?
- B. What species will be affected by the proposed change?
- C. What effect will the proposed change have on nearby habitats?
- D. What environmental regulations apply in this situation?

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Option B is correct because students would have an opportunity to collect data as they conduct a survey of plant and animal species that occupy the wooded area and then could hypothesize the effect the housing development might have on the surveyed plant and animal populations.

Option A is incorrect because the economic impact of the housing development is primarily a social and economic study, not an appropriate question for third graders to address through scientific investigation.

Option C is incorrect because students would need to study the nearby habitats first in order to analyze the effect development would have on those adjacent areas.

Option D is incorrect because identifying which regulations apply in this situation is a research question that does not necessarily involve the use of science.

**Competency 014**

When a third-grade teacher explains to students that objects expand when they are heated and contract when they are cooled, some of the students express skepticism. The teacher would like to use this opportunity to reinforce a recent lesson on scientific methods and the nature of science. Which of the following questions would be most appropriate for the teacher to ask?

- A. Where could we find more information on this topic?
- B. Who in the class has seen an example of this happening?
- C. Why do scientists believe temperature has this effect?
- D. How could we find out whether or not this is true?

---

Option D is correct because the question encourages students to design an experimental strategy in order to reach a valid conclusion based on evidence.

Option A is incorrect because the question limits the activity of students to obtaining information about the topic.

Option B is incorrect because asking for testimony concerning the phenomenon only elicits comments from students' memories and does not involve applying or thinking about the methods of science.

Option C is incorrect because the question seeks confirmation of the teacher's explanation of the phenomenon rather than encouraging students to think about how the problem could be resolved scientifically.

### Competency 015

Students are studying factors that affect the dissolution of salt in water. The teacher has asked student teams to mix 5 g of salt into 100 mL of water until the salt dissolves and record the time it takes to dissolve. They are to repeat the experiment three times using different temperatures of water and graph their data. In this experiment which of the following is the dependent variable?

- A. volume of water used
- B. water temperature
- C. time needed for salt to dissolve
- D. amount of salt used

---

Option C is correct because a dependent variable changes in response to the change made by the person conducting the experiment. In this activity, the time for the solute to dissolve in water at different temperatures is the dependent variable.

Option A is incorrect because the volume of water is kept constant in each trial and thus is a controlled variable.

Option B is incorrect because water temperature is changed by students during the experiment and thus is an independent variable.

Option D is incorrect because the amount of salt used is held constant in each trial and is thus a controlled variable.

**Competency 018**

A teacher wants to help third-grade students use critical-thinking skills to distinguish reptiles from amphibians in a set of photographs. Which of the following strategies is most likely to promote this type of thinking in students?

- A. asking students to describe similarities and differences among the photographs
- B. asking students to draw or make a model of one of the animals in the photographs
- C. asking students to organize the photographs on a large flowchart provided by the teacher
- D. asking students to locate similar photographs in a life science textbook

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Option A is correct because the teacher is encouraging students to compare the pictures and think critically about what similarities and differences exist among the animals in the photographs that might be used to distinguish the amphibians from the reptiles.

Option B is incorrect because the teacher is limiting the student activity to observing and modeling one of the creatures with no comparative analysis.

Option C is incorrect because the teacher is asking students to place photographs of reptiles and amphibians into a preestablished system for organizing observations.

Option D is incorrect because the teacher is limiting the activity to locating additional images of reptiles and amphibians.

## Competency 020

Science teachers at an elementary school want to familiarize the school's parents/guardians and members of the larger community with the goals and methods of the school's science program. Which of the following would be the most effective way to achieve this result?

- A. Provide parents/guardians and community members with resources that describe the strategies used for delivering science education.
- B. Invite parents/guardians and community members to attend several school "science nights" at which current classroom projects are displayed and explained.
- C. Ask parents/guardians and community members to serve as volunteers to assist teachers in the school's science classrooms and laboratories.
- D. Suggest that parents/guardians and community members attend curriculum development meetings on a periodic basis.

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Option B is correct because it provides parents/guardians with tangible examples of the end products of the science program's goals and methodology.

Option A is incorrect because it limits the information provided to parents/guardians to descriptions of science program strategies, which may describe methods but may not describe program goals and may not be specific to the goals and methods of the local elementary school.

Option C is incorrect because having parents/guardians and other community members volunteer would only expose a small number of individuals to the goals and methods of the science program.

Option D is incorrect because curriculum development meetings would cover all aspects of the school's curriculum and only allow limited time to familiarize the parents/guardians with the specific goals and methods of the science program.

**Competency 020**

A Master Science Teacher wants to plan science instruction activities for early elementary school students. Which of the following would be most important to incorporate in these plans?

- A. ensuring that each activity takes up about the same amount of time
- B. changing the schedule of activities from day to day
- C. allowing each student to determine how long he or she wishes to engage in a particular activity
- D. alternating activities in which students are active with those in which they are less active

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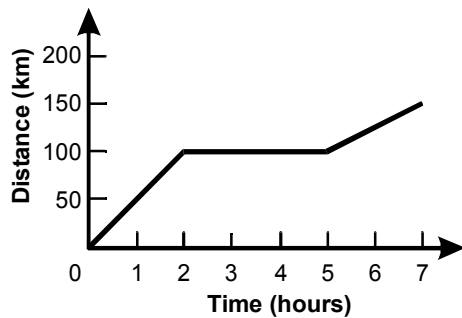
Option D is correct because utilizing a variety of instructional strategies takes into account the developmental characteristics of early elementary school students.

Option A is incorrect because limiting the selection of classroom activities to those that can be completed in the same amount of time is arbitrary and would limit the types of activities that could be effective for early elementary school students.

Option B is incorrect because the content and variety of instructional activities are more important than the timing of these activities. In addition, young elementary school students benefit from a familiar and predictable schedule.

Option C is incorrect because the scheduling of activities based on the moods and motivation of individual students in a classroom is difficult to manage and may encourage some students to quit the activity if they are momentarily frustrated.

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



The time-distance graph above plots the distance a vehicle travels over a certain amount of time.

### Competency 002

Which of the following scenarios would best fit the pattern displayed in the time-distance graph?

- A. The vehicle travels at 25 km/h, then stops while the driver has lunch, and then continues the trip at 50 km/h.
- B. The vehicle travels at 50 km/h, then stops while the driver has lunch, and then continues the trip at 25 km/h.
- C. The vehicle travels at 25 km/h, then stops while the driver has lunch, and then continues on at 25 km/h.
- D. The vehicle travels at 50 km/h, continues at 50 km/h, and then stops while the driver has lunch.

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Option B is correct because the vehicle travels 100 kilometers during the first 2 hours of the trip, remains stationary for the next three hours, and travels 50 kilometers during the final 2 hours of the trip.

Option A is incorrect because it describes a situation in which the speed during the first 2 hours of the trip is less than the speed during the final 2 hours of the trip.

Option C is incorrect because it describes a situation in which the speed during the first 2 hours of the trip is the same as the speed during the last 2 hours of the trip.

Option D is incorrect because it describes a situation in which the vehicle maintains a speed of 50 km/h during the first two portions of the trip and is not moving during the third portion of the trip.

**Competency 002**

During which of the following time intervals shown on the time-distance graph does the vehicle reach its highest speed?

- A. 0–1 hours
- B. 2–3 hours
- C. 4–5 hours
- D. 6–7 hours

---

Option A is correct because the maximum speed of the 50 km/h is maintained during the first hour of the trip.

Options B and C are incorrect because they represent a time period during which the vehicle is not moving.

Option D is incorrect because it represents a time period during which the vehicle is traveling at a velocity of 25 km/h.

## 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. Which of the following characteristics distinguishes an acid from a base?
  - A. An acid is caustic and can cause chemical burns, while a base is less dangerous.
  - B. An acid has a pH level less than seven, while a base has a pH level greater than seven.
  - C. An acid readily reacts with other substances, whereas a base is relatively unreactive.
  - D. An acid can be neutralized by a buffer, whereas a base cannot be neutralized.

### Competency 003

2. Which of the following is the primary cause of a lightning strike that hits the ground?
  - A. A positive charge builds up on the ground from frictional charging of the ground by rapidly moving air molecules.
  - B. A negative charge imbalance develops on the ground as high humidity or moisture induces a negative charge in Earth materials.
  - C. A positive charge imbalance in a cloud equalizes by making electrical contact with the neutral ground surface.
  - D. A negative charge at the bottom of a storm cloud induces a positive charge on the ground surface.

**Competency 003**

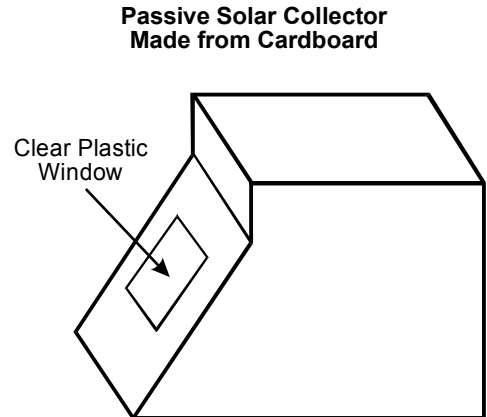
3. Which of the following accurately reflects the relationship between magnetism and electricity?
- A. A stationary magnet induces the flow of electric charge in nearby conductive materials.
  - B. The charge imbalance on the surface of conductive materials creates a magnetic field.
  - C. A magnetic field that fluctuates induces the flow of electric charge in nearby conductive materials.
  - D. The resistance to the flow of charge in a wire produces a magnetic field in adjacent metallic materials.

**Competency 004**

4. A teacher presenting an introductory lesson on simple electrical circuits gives students a 1.5-volt battery, a light bulb, and two pieces of copper wire and asks them to experiment with various arrangements of connections while recording their results. Which of the following is a safety hazard in this situation?
- A. Most batteries contain flammable chemicals.
  - B. Broken light bulbs can release toxic gases.
  - C. Even small batteries can provide dangerous levels of current.
  - D. Low resistance circuits can become hot.

**Competency 004**

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

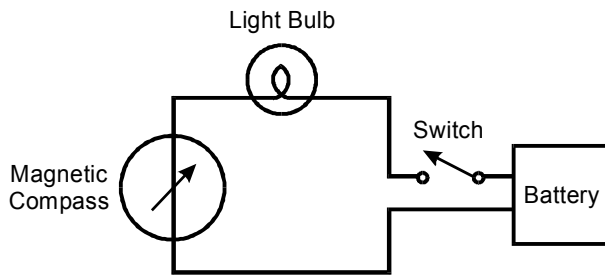


Students have designed and constructed the passive solar collector shown above by modifying the shape of a cardboard box and by adding a window made from clear plastic wrap. Students must now change the design of their solar collector to demonstrate the movement of energy by convection. Which of the following design changes would most effectively achieve this goal?

- A. Add insulation to the roof and walls of the box.
- B. Create additional covered openings in the side of the box.
- C. Add two uncovered openings to the top of the box.
- D. Cover the walls and roof of the box with aluminum foil.

### Competency 004

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



The diagram above shows a simple circuit with a battery, a switch, and a light bulb all connected by a copper wire. A magnetic compass has been placed directly under the wire. Opening and closing this circuit would be most effective for demonstrating which of the following?

- A. the transformation of chemical energy into electrical energy
- B. the principle underlying the operation of an electric motor
- C. the relationship between photons and electrons
- D. the principle involved in electrical resistance

### Competency 005

7. Which of the following types of biological substances are directly involved in regulating animal behavior?
- A. nutrients
  - B. blood cells
  - C. hormones
  - D. lipids

**Competency 005**

8. During the spring, a student notices that a yellow dust is covering the ground surrounding a stand of pine trees. The dusting of the ground with this yellow substance represents which of the following stages in the life cycle of the pine tree?
- A. flower development
  - B. pollen production
  - C. seed dispersal
  - D. embryonic growth

**Competency 005**

9. Certain plant species have thick, fleshy leaves that absorb gases through leaf pores primarily at night. In which of the following habitats would these adaptations typically be encountered?
- A. cloud-forest jungle
  - B. subtropical desert
  - C. high-altitude mountain
  - D. temperate grassland

**Competency 006**

10. Which of the following best describes how mammalian offspring acquire X and Y sex chromosomes?
- A. X chromosomes and Y chromosomes can be inherited from either the male parent or the female parent.
  - B. X chromosomes can be inherited from both males and females, but Y chromosomes are inherited only from the male parent.
  - C. X and Y chromosomes are inherited from the female parent, but only X chromosomes are inherited from the male parent.
  - D. X chromosomes are inherited only from the female parent and Y chromosomes are inherited only from the male parent.

**Competency 007**

11. Which of the following sets of characteristics accounts for the tremendous diversity of species found in the coral reef biome?
- A. regularly changing water conditions and sufficient sunlight
  - B. low turbidity and absence of significant currents
  - C. suitable habitats for a variety of producers and few predators
  - D. abundant nutrients and productive interrelationships between species

**Competency 008**

12. A teacher is conducting a science lesson on aquatic habitats and wants to give students the chance to observe various protozoa in a sample of pond water they collected and to try to identify some of the organisms. To do this, the teacher puts a drop of the pond water in a depression slide and places the slide on a microscope equipped with a video camera. The camera is attached to a television, which allows the teacher to point out different organisms and their characteristics to the class. Which of the following is the best assessment of the teacher's approach to this lesson?
- A. It is inappropriate, because the activity is teacher-centered and does not provide the students with the opportunity to develop hands-on laboratory skills.
  - B. It is appropriate, because students often have difficulty viewing organisms under a microscope and knowing if they are seeing something significant.
  - C. It is inappropriate, because the large images of protozoa on a television screen may inadvertently promote the misconception that protozoa are multicellular organisms.
  - D. It is appropriate, because there is the potential risk of infection by parasites as a result of improper handling of the pond water samples by students as they prepare slides.

**Competency 009**

13. The Ogallala Aquifer is a large ground-water deposit that lies under the Great Plains from South Dakota to Texas. The water level of the aquifer has dropped significantly over the past 20 years primarily because:
- A. the surface water recharge to the aquifer has been decreased due to climate changes.
  - B. the water pumped from the aquifer for irrigation and drinking water exceeds recharge from precipitation.
  - C. the water withdrawal has compacted the aquifer sediments, reducing the total volume of porous rock.
  - D. the amount of rainfall that has fallen over the area has decreased substantially during the period.

**Competency 009**

14. Chemical weathering proceeds most rapidly in which of the following environments?
- A. a mountainous zone that receives heavy snow during the winter
  - B. a rain forest that is consistently warm and wet
  - C. a semiarid zone with seasonally heavy rainfall
  - D. an extremely arid region that has a large range in daily temperature

**Competency 011**

15. Supernovae are enormous explosions in space that occur when:
- A. the intense spinning of a pulsating neutron star tears the star apart, generating a nuclear reaction.
  - B. two stars collide, setting off a chain reaction that involves several nearby stars.
  - C. a massive star exhausts almost all of its nuclear fuel and rapidly collapses.
  - D. a mass of antimatter left over from the big bang contacts a similar-sized mass of normal matter.

**Competency 011**

16. Venus is located almost twice as far from the sun as is the planet Mercury. Given this fact, which of the following best explains why Venus is significantly hotter than Mercury?
- A. Mercury's slow axial rotation allows much of the heat from the sun to be dissipated on its dark side.
  - B. Venus's widespread volcanism releases large amounts of internal heat to its atmosphere.
  - C. Mercury's low gravity prevents compressional heating of its cold, solid interior.
  - D. Venus's thick atmosphere contains high levels of the heat-trapping gas, carbon dioxide.

**Competency 013**

17. Research conducted by Marie Curie during the early part of the twentieth century led most directly to which of the following advances in medicine?
- A. the widespread adoption of sanitary procedures to prevent infection
  - B. the identification of genetic diseases through genealogical research
  - C. the use of anesthetics such as ether during surgical procedures
  - D. the development of X-ray technology as a diagnostic tool

**Competency 015**

18. A second-grade class is studying a population of birds and their food preferences. Some of the birds prefer worms, some prefer insects, and some prefer berries. A subset of each group occasionally eats from one of the other food categories and another subset occasionally eats from any of the three food categories. Which of the following graphs or diagrams would be most effective for illustrating the overlapping food preferences of the entire population of birds?
- A. pie graph
  - B. bar graph
  - C. tree diagram
  - D. Venn diagram

**Competency 016**

19. In an elementary school, a Master Science Teacher wants to establish a policy for safety checks in all classrooms, including checks of fire extinguishers, access to exits, and stored chemicals and materials. Which of the following strategies is most appropriate to assure that these checks are performed regularly and thoroughly?
- A. Conduct all safety inspections personally, using a rotating weekly schedule for carrying out classroom inspections.
  - B. Issue periodic notifications to teachers, reminding them to perform the safety checks and report the results.
  - C. Collaborate with teachers to create consistent procedures, an inspection schedule, and a checklist for safety inspections.
  - D. Ask teachers to regularly inspect the safety of their classrooms and report safety concerns at staff meetings.

**Competency 016**

20. A Master Science Teacher can best use the Professional Development Profile in the *Texas Safety Standards for Kindergarten through Grade 12* to:
- A. evaluate teachers on their knowledge of safety protocols.
  - B. work with teachers to identify safety topics appropriate for further training.
  - C. develop safety standards at the schoolwide level.
  - D. improve personal knowledge of safety procedures in response to emergencies.

**Competency 017**

21. A novice teacher asks a Master Science Teacher for guidance in preparing a lesson on the structure and function of organisms. In which of the following areas is it most important for the Master Science Teacher to offer guidance?
- A. suitable application of technological resources
  - B. adequate use and development of critical-thinking skills
  - C. appropriate use of cooperative-learning activities
  - D. proper alignment and effective integration of content

**Competency 017**

22. The Master Science Teacher is working with a vertical team of science teachers to develop plans for the next school year. Both the third-grade and fifth-grade team members want to teach a unit on geology. To determine the most appropriate place for the unit within the overall science curriculum, the Master Science Teacher should recommend that the team *first* consult which of the following resources?
- A. Texas Essential Knowledge and Skills (TEKS) for Science
  - B. state-adopted science textbooks for each grade level
  - C. *National Science Education Standards*
  - D. the school district's science scope and sequence for each grade

**Competency 018**

23. At the end of an introductory lesson on magnets, a teacher asks the class some questions about the lesson. She finds that several students think that magnets will attract and attach to any metal object. Which of the following would be an appropriate extension activity for the teacher to introduce at this point?
- A. Provide the students with different types of metals to experiment with magnets.
  - B. Ask the students to research magnetic and nonmagnetic materials on the Internet.
  - C. Give the students a chart that lists all magnetic and nonmagnetic materials.
  - D. Have the students form small groups and discuss the reason that magnets attach to metals.

**Competency 019**

24. A Master Science Teacher uses an observation checklist to assess her third-grade students' understanding of lab procedures. She then wants to provide feedback to the students on their performance on each of the designated procedures. Which of the following would be the most appropriate way for the Master Science Teacher to share the observation results with her students?
- A. Discuss results with small groups of students who are assembled according to the observation results.
  - B. Meet briefly with individual students to review the results of the observation.
  - C. Post the observation results in the classroom for students to check during their free time.
  - D. Send a copy of the observation results home with each student to be reviewed by his or her parents/guardians.

**Competency 019**

25. The Master Science Teacher is helping a group of teachers select the most effective way to assess students' understanding of concepts related to energy. The group identifies three types of assessments that might work, but is having difficulty choosing among them. Which of the following guiding questions by the Master Science Teacher would be most likely to help the teachers select an effective assessment type?
- A. Can my students' responses to this type of assessment be easily translated into a graph?
  - B. Can I provide an appropriate level of feedback to my students based on their responses to this type of assessment?
  - C. Will I be able to score my students' responses to this type of assessment efficiently?
  - D. Will my students' responses to this type of assessment provide the information I need to make instructional decisions?

**Competency 019**

26. A teacher administers a test to a class after they have completed a unit on earth science. After examining the test scores, the teacher feels concerned about the reliability of the test instrument and tells the Master Science Teacher that she plans to give the students the test again. In explaining the primary concern with determining the reliability of a test by giving it to the same group of students twice, the Master Science Teacher should state that:
- A. students will have prior knowledge of the test and may answer the questions differently.
  - B. students from another class should be used as a control in determining reliability.
  - C. test administrations will not likely be the same and so results cannot be compared.
  - D. test validity can be assessed effectively using this approach but not test reliability.

**Competency 021**

27. A novice third-grade teacher plans to teach a lesson on the relationship between force and motion. Since she is concerned about her skill at delivering this lesson, she asks the Master Science Teacher to observe her teaching and provide feedback. Which of the following is the most constructive way for the Master Science Teacher to respond after observing the lesson?
- A. Ask the teacher to discuss areas that she feels need improvement and supplement her responses with weaknesses that she did not notice.
  - B. Offer to teach a lesson on the relationship between force and motion that the teacher can observe and ask her to compare the presentation of the lesson with that of her own.
  - C. Provide a written observation report on the presentation and ask the teacher to review it before they go over it together.
  - D. Suggest that the teacher give an assignment on force and motion and offer to go over the students' work to pinpoint misunderstandings resulting from the teacher's presentation.

**Competency 021**

28. A teacher has moved into the newly created position of Master Science Teacher at her school. She is concerned that the other teachers will misunderstand her new role. Which of the following would be the most appropriate way for the Master Science Teacher to communicate her role to the other teachers?
- A. Visit with teachers individually to encourage them to self-reflect on their instructional needs and to contact her if they want assistance.
  - B. Send each of the teachers a letter describing her position as one of instructional support.
  - C. Meet with groups of teachers to explain how she can help with their instructional needs and support their teaching of science.
  - D. Ask the principal to outline her responsibilities for instructional support at a staff meeting.

**Competency 022**

29. Elementary school teachers are working with the school's Master Science Teacher to improve the overall effectiveness of science instruction. As part of the process, the Master Science Teacher plans to observe classes and conduct a follow-up conference with each teacher. The Master Science Teacher can most effectively use the observations and conferences to support this project by focusing on:
- A. the sophistication of the resources available to students during the lessons.
  - B. the teacher's ability to integrate the lessons with the science textbook.
  - C. the amount and scope of material that the teacher covers during the lessons.
  - D. the students' engagement with and understanding of the lesson.

**Competency 022**

30. The most effective way for a Master Science Teacher to assist a colleague in reflecting on her teaching would be to:
- A. provide the colleague with research-based articles she can use to develop a checklist for self-evaluation.
  - B. suggest that the colleague make a list of her most successful teaching methods and discuss the list with another teacher.
  - C. ask the colleague guiding questions to help her analyze how learning takes place in her classroom.
  - D. have the colleague compare her teaching approach to the approaches of other teachers of the same grade level.

<b>Answer Key</b>		
<b>Item Number</b>	<b>Correct Answer</b>	<b>Competency</b>
1	<b>B</b>	001
2	<b>D</b>	003
3	<b>C</b>	003
4	<b>D</b>	004
5	<b>C</b>	004
6	<b>B</b>	004
7	<b>C</b>	005
8	<b>B</b>	005
9	<b>B</b>	005
10	<b>B</b>	006
11	<b>D</b>	007
12	<b>B</b>	008
13	<b>B</b>	009
14	<b>B</b>	009
15	<b>C</b>	011
16	<b>D</b>	011
17	<b>D</b>	013
18	<b>D</b>	015
19	<b>C</b>	016
20	<b>B</b>	016
21	<b>D</b>	017
22	<b>A</b>	017
23	<b>A</b>	018
24	<b>B</b>	019
25	<b>D</b>	019
26	<b>A</b>	019
27	<b>A</b>	021
28	<b>C</b>	021
29	<b>D</b>	022
30	<b>C</b>	022



## 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

<b>PURPOSE</b>	The extent to which the candidate responds to the components of the assignment in relation to relevant competencies in the Master Science Teacher EC–4 test framework.
<b>APPLICATION OF KNOWLEDGE</b>	Accuracy and effectiveness in the application of knowledge as described in relevant competencies in the Master Science Teacher EC–4 test framework.
<b>SUPPORT</b>	Quality and relevance of supporting details in relation to relevant competencies in the Master Science Teacher EC–4 test framework.
<b>RATIONALE</b>	Soundness of reasoning and depth of understanding of the assigned task in relation to relevant competencies in the Master Science Teacher EC–4 test framework.
<b>SYNTHESIS</b>	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 EC–4 in an applied context.

## SCORE SCALE

Score	Score Point Description
4	<p><b>The "4" response reflects thorough knowledge and understanding of relevant competencies in the Master Science Teacher EC–4 test framework.</b></p> <ul style="list-style-type: none"> <li>• The response addresses all components of the assignment and fully completes the assigned task.</li> <li>• The response demonstrates an accurate and very effective application of relevant knowledge.</li> <li>• The response provides strong supporting evidence with specific and relevant examples.</li> <li>• The response demonstrates clear, logical reasoning and a comprehensive understanding of the assigned task.</li> <li>• The response demonstrates strong ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher EC–4.</li> </ul>
3	<p><b>The "3" response reflects sufficient knowledge and understanding of relevant competencies in the Master Science Teacher EC–4 test framework.</b></p> <ul style="list-style-type: none"> <li>• The response addresses most or all components of the assignment and sufficiently completes the assigned task.</li> <li>• The response demonstrates a generally accurate and effective application of relevant knowledge; minor problems in accuracy or effectiveness may be evident.</li> <li>• The response provides sufficient supporting evidence with mostly specific and relevant examples.</li> <li>• The response demonstrates sufficient reasoning and an overall understanding of the assigned task.</li> <li>• The response demonstrates sufficient ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher EC–4.</li> </ul>
2	<p><b>The "2" response reflects partial knowledge and understanding of relevant competencies in the Master Science Teacher EC–4 test framework.</b></p> <ul style="list-style-type: none"> <li>• The response addresses at least some components of the assignment and/or partially completes the assigned task.</li> <li>• The response demonstrates a partial and/or ineffective application of relevant knowledge; significant inaccuracies may be evident.</li> <li>• The response provides minimal supporting evidence with few relevant examples; some extraneous or unrelated information may be evident.</li> <li>• The response demonstrates limited reasoning and understanding of the assigned task.</li> <li>• The response demonstrates partial ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher EC–4.</li> </ul>
1	<p><b>The "1" response reflects little or no knowledge or understanding of relevant competencies in the Master Science Teacher EC–4 test framework.</b></p> <ul style="list-style-type: none"> <li>• The response addresses few components of the assignment and/or fails to complete the assigned task.</li> <li>• The response demonstrates a largely inaccurate and/or ineffective application of relevant knowledge.</li> <li>• The response provides little or no supporting evidence, few or no relevant examples, or many examples of extraneous or unrelated information.</li> <li>• The response demonstrates little or no reasoning or understanding of the assigned task.</li> <li>• The response demonstrates little or no ability to synthesize the knowledge and skills required to perform the multifaceted role of the Master Science Teacher EC–4.</li> </ul>
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 EC–4

#### 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 EC–4. 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 EC–4 test framework.
- **APPLICATION OF KNOWLEDGE:** Accuracy and effectiveness in the application of knowledge as described in relevant competencies in the Master Science Teacher EC–4 test framework.
- **SUPPORT:** Quality and relevance of supporting details in relation to relevant competencies in the Master Science Teacher EC–4 test framework.
- **RATIONALE:** Soundness of reasoning and depth of understanding of the assigned task in relation to relevant competencies in the Master Science Teacher EC–4 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 EC–4 in an applied context.

The assignment is intended to assess knowledge and skills required to perform the roles of the Master Science Teacher EC–4, 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 EC–4.

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 fourth-grade teacher, Mr. Jong, who is teaching a lesson on the water cycle and the role of evaporation in the water cycle. The science instruction time is 50 minutes a day. The class is composed of students who achieve at various levels.

**Master Science Teacher Task:** Mr. Jong has asked the Master Science Teacher (MST) to observe his lesson on the water cycle and to provide him with feedback. The MST has agreed to observe his lesson. Mr. Jong shows the MST information about the lesson he plans to teach. On the following pages, you will find:

- information from Mr. Jong regarding previous instruction for this class;
- information about the lesson;
- an assignment given by Mr. Jong to his class;
- excerpts of notes taken by the MST while observing Mr. Jong'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. Jong 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. Jong's instruction.
4. A full description of a plan of action you would develop as a mentor-teacher specifically to guide Mr. Jong in implementing the strategies you have described.

**Information from Mr. Jong regarding previous instruction:** The students in this class have learned about the weather in different parts of the country and how the seasons affect weather. Students have also discussed the water cycle and how weather in Texas can be affected by moist air from the Gulf of Mexico and dry air from north and west. Mr. Jong thinks the students are ready to examine the process of evaporation and its role in the water cycle. Students have been provided with a description of the procedure for the lesson's activity.

### INFORMATION ABOUT THE LESSON

**Student expectations:**

- Investigate the role of evaporation in the water cycle.
- Collect and analyze information.

<b>Introduction</b>	<ul style="list-style-type: none"> <li>• Write "Oceans," "Rivers," "Rain and Snow," "Clouds," and "Land" across the top of the board with a large circle drawn under the list that has an arrow showing a clockwise motion for the cycle. Above the circle, write "The Sun's Energy."</li> <li>• Ask the students how these terms can be connected in the water cycle and which term should be placed at the top of the circle.</li> <li>• Once the components of the water cycle are listed on the circle, write the processes that connect each component of the cycle in their correct places.</li> <li>• Ask students what they think "evaporation" means. After discussion, introduce the evaporation activity.</li> <li>• Explain to students that they will be examining the role of heat in evaporation.</li> </ul>
<b>Materials</b>	<ul style="list-style-type: none"> <li>• metric rulers, one per team</li> <li>• table lamps with 40-watt bulbs, one per team</li> <li>• black heavy construction paper, three pieces per team</li> <li>• eye droppers, one per team, for measuring five drops of water</li> <li>• clock that all students can see or stop watches, for timing evaporation</li> </ul>
<b>Activity</b>	<ol style="list-style-type: none"> <li>1. Working in teams, students dampen a small area of the construction paper with five drops of water.</li> <li>2. Teams will use the lamps to evaporate water from the dampened paper.</li> <li>3. Each team will repeat the experiment three times, placing the lamp 2 cm, 4 cm, and 8 cm directly over the dampened circle on the paper.</li> <li>4. Students record the time it takes to evaporate the water from the paper, and then they use the data to complete their assignment.</li> </ol>
<b>Discussion</b>	Discuss the activity and the general conclusions that can be made about the role of the sun's energy on the water cycle.
<b>Assignment</b>	Complete the assignment "The Water Cycle and the Sun's Energy."*

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

## ASSIGNMENT

### The Water Cycle and the Sun's Energy

Complete the table below with data from the class activity.

	Lamp Distance	Time	Observations
<b>Trial 1</b>	2 cm		
<b>Trial 2</b>	4 cm		
<b>Trial 3</b>	8 cm		

1. What do you think happened to the water on the paper?
2. How was the experiment we did in class similar to the sun's effect on the water cycle?
3. Why do you think it took longer to evaporate the water when the lamp was farther away?
4. What causes the invisible water drops in the air to come together and form clouds?
5. Do you think blowing on the paper would have helped evaporate the water? Explain.
6. What roles do lakes, streams, and the land play in the water cycle?

## SELECTED EXCERPTS FROM THE MST'S OBSERVATION NOTES

- Class begins as Mr. Jong writes the various components of the water cycle across the top of the board with a large circle underneath that has an arrow showing a clockwise motion. Over the circle he writes "The Sun's Energy." As he writes, he tells the class that they will be examining the driving force that moves the water cycle and asks, "Why do you think I am using a circle to represent the water cycle?"
  - One student responds, "Isn't cycle just another word for circle, like in the word bicycle?" Mr. J responds, "Yes, that's true, and like a bicycle wheel, a cycle repeats itself, so as we go around the circle, it eventually comes back to the beginning of the cycle. Which of the terms at the top of the board would be a good starting point for the water cycle?" Another student responds, "'The Sun's Energy' is written at the top, wouldn't that be a good place to start?"
- Mr. J responds, "In a way, that is what starts and runs the water cycle and that's what you will be examining in your experiment today, but the sun's energy is outside the water cycle. Of the words at the very top of the board, which one would be a good place to begin the water cycle and would also be a good place to end it?"
  - One student says, "What about the ocean? It has the most water." Mr. J agrees that the ocean is a good starting point. As Mr. J writes "oceans," he asks, "What should come next in the water cycle?"
  - One student suggests clouds, but another disagrees, saying that rain and snow are water and that only big storm clouds have rain in them. Mr. J says, "I think clouds would fit better, and since rain and snow come from clouds, they can go next." Another student then asks where land fits in, because land is dirt and rock, not water. Mr. J asks, "What do rain and snow fall on?" A student responds that rain and snow fall on the ground and that it should be next.
- Mr. J writes "land" next and then asks the class, "How does water that falls on the land end up back in the oceans?"
  - One student replies that not all rain and snow end up in the ocean, some goes into lakes and some into plants and dirt. Mr. J responds, "Those are important things that I wanted to talk about. Some rain soaks into the ground and ends up being used by plants, but where does it go from there?" A student answers, "Plants need water to grow. That's how they make food. We learned that last year when we grew bean plants." "Yes," says Mr. J, "that is correct. Plants do need water to grow, but that water ends up going up into the air to help make clouds by the process of evaporation that we will study today." Finishing up the water cycle diagram, Mr. J writes "rivers" on the water cycle and asks, "Where do rivers end up going to?" A student says, "They go into lakes and ponds, and the big rivers go back into the oceans." Mr. J says, "That's correct. Some of the rain and snow that falls ends up being stored in lakes and ponds. The water in those lakes slowly drains into the oceans, starting the water cycle over again. So ponds, swamps, plants, and even rocks and soil all store some of the rain and snow that falls on the earth. Eventually, that water ends up joining the water cycle again. Some evaporates to make clouds, and some flows back to the oceans in big rivers."
- Mr. J says, "Without the sun's energy, the water in the oceans would not be able to become clouds, because the water in oceans evaporates when it is heated by the sun's energy. You've all seen evaporation happen after a rainstorm. The water on pavement disappears because it is heated by the sun's energy. You can make water evaporate from your hands if you blow on them when they are damp. Even if you don't blow on your hands, eventually the water evaporates. Does anyone know what happens when water evaporates?" A student says, "Well, when the water evaporates from your hand, it disappears."

## SELECTED EXCERPTS FROM THE MST'S OBSERVATION NOTES (*continued*)

- Mr. J responds, "It does look like it disappears, but what happens is that it breaks into tiny drops of water called water vapor. These drops of water vapor are so small we can't even see them. They float away and mix with the air. Eventually, this invisible water vapor joins together to make clouds." As Mr. J writes "water vapor" on the board, he asks the class, "On a very hot and sticky day, what happens to the outside of a glass of ice water?"
  - A student responds, "A glass of water sweats just like we do on a hot day." Mr. J responds, "That's a good way to look at it. The cold glass is causing thousands of invisible water vapor drops in the air to join together on the outside of the glass and that is just what happens in clouds." One student asks, "Does that mean that clouds are cold?" Mr. J responds, "It is the air that is cold that high up and that causes the clouds to form. Now we better get started on the experiment."
- The students break into their teams and go to their previously set up workstations. Mr. J makes sure the students know how to proceed with the experiment, repeating the directions several times, as he walks from team to team. After five minutes, teams start to record the time as the paper has dried rapidly with the lamp at the closest setting. One team has already started taking notes on the second trial at the 4 cm setting, and Mr. J walks over and asks, "How quickly did the paper dry on the 4 cm setting?" One of the students on the team responds, "It was even faster than the first because we were blowing on the paper at the same time." Mr. J points out that it is an important observation they have made.
- Toward the end of the period, Mr. J asks students to finish writing down their results and observations. After the teams have finished up, Mr. J says, "You can see how the lamps helped dry out the damp paper, but can anyone tell me how this is similar to the way in which energy from the sun helps to drive the water cycle?"
  - A student responds, "When the water in the oceans is heated up by the sun, some of it turns into tiny water vapor drops that end up as clouds." Mr. J responds, "Yes, that's correct. Remember that we call that process 'evaporation.' Notice that the word 'vapor' is in the word 'evaporation.' The evaporation of water from oceans, lakes, and anywhere that water exists on the earth's surface is what gives clouds the water they need to make it rain or snow." Another student says, "I thought the ocean was the beginning and end of the water cycle." Mr. J adds, "In a way it is, but water anywhere on the earth's surface can evaporate and turn into clouds."
- Mr. J then asks, "When you doubled the distance between the lamp and the paper, how did it change how quickly the paper dried out?"
  - A student says, "Our results showed that when the lamp was closest to the paper, the paper wrinkled up a little, but it didn't dry any faster than at the 4 cm distance." Mr. J asks, "Why do you think that is?" The same student continues, "I'm not sure, but I thought the closer the lamp was to the paper, the faster it would dry out." Mr. J adds, "That would probably be true if everything else in the experiment was kept constant. If there was more air movement over the paper in the second trial, then that might have helped dry the paper out."
- Mr. J then instructs the class to use their results and what they have learned during the activity to complete the questions on the assignment sheet.

**TEAM A**  
**COMPLETED ASSIGNMENT**

**The Water Cycle and the Sun's Energy**

Complete the table below with data from the class activity.

	<b>Lamp Distance</b>	<b>Time</b>	<b>Observations</b>
<b>Trial 1</b>	2 cm	3 min	<i>The water spread out beyond the edge of the circle as it dried.</i>
<b>Trial 2</b>	4 cm	10 min	<i>The damp paper did not get as warm and it took much longer to dry.</i>
<b>Trial 3</b>	8 cm	Over 20 min	<i>We ran out of time and the paper was still damp.</i>

1. What do you think happened to the water on the paper?  
*It evaporated.*
2. How was the experiment we did in class similar to the sun's effect on the water cycle?  
*The light we used was like the sun and it dries up water like the sun does on a hot day. The sun makes the water cycle possible, because it causes water to break up into little bits that float in the air and make clouds.*
3. Why do you think it took longer to evaporate the water when the lamp was farther away?  
*It took much longer to dry each time because the air moving around kept the water cooler so it couldn't heat up.*
4. What causes the invisible water drops in the air to come together and form clouds?  
*The tiny drops of water bump into one another and stick together making clouds. When there are a lot of them, the clouds sweat sort of like people do creating rain.*
5. Do you think blowing on the paper would have helped evaporate the water? Explain.  
*Blowing on the paper might have cooled it off and kept it from heating up so much so it would not dry the water up as fast.*
6. What roles do lakes, streams, and the land play in the water cycle?  
*The tiny water drops that make clouds can come from any water that is heated by the sun, except from plants that turn the water into food.*

**TEAM B**  
**COMPLETED ASSIGNMENT**

**The Water Cycle and the Sun's Energy**

Complete the table below with data from the class activity.

	<b>Lamp Distance</b>	<b>Time</b>	<b>Observations</b>
<b>Trial 1</b>	2 cm	3 min	<i>It was hard to keep the lamp at 2 cm and still see if the paper was drying out, so we lifted it a few times.</i>
<b>Trial 2</b>	4 cm	3 min	<i>We blew on the paper and it helped evaporate the water from the paper faster.</i>
<b>Trial 3</b>	8 cm	12 min	<i>The lamp didn't seem to be heating the paper much at this height, so we both blew hard on the paper.</i>

1. What do you think happened to the water on the paper?  
*It boiled away into the air.*
2. How was the experiment we did in class similar to the sun's effect on the water cycle?  
*It heated the paper the way the sun heats the ocean, causing water on the paper to evaporate into the air.*
3. Why do you think it took longer to evaporate the water when the lamp was farther away?  
*Our second test took almost the same time as our first test. I think it was because we blew on it.*
4. What causes the invisible water drops in the air to come together and form clouds?  
*Clouds are high in the sky and cold so little drops of water collect on them until there are enough for it to rain.*
5. Do you think blowing on the paper would have helped evaporate the water? Explain.  
*When we blew on the paper I think it helped dry it up because it blew some of the water away.*
6. What roles do lakes, streams, and the land play in the water cycle?  
*They collect water that can be used by plants and animals so that all the water doesn't end up going back to the ocean.*

## Sample Case Study Responses

### MST EC–4 Strong Response

A real strength of this lesson is that Mr. Jong uses good questioning strategies to diagram and discuss the water cycle. He asks "why," "which," "what," "where," and "how" questions that students answer using prior knowledge and everyday experiences. He uses student answers to complete a diagram of the water cycle on the board.

A weakness of the lesson is that, in doing the experiment, students introduce several variables. Some groups blew on the paper while another group "lifted it a few times." These added procedures were not followed for each trial. One group lifted the paper in Trial 1 and blew hard on it in Trial 3. Having more than one variable in an experiment gives invalid data.

The instructional strategy that Mr. Jong should use to make this part of the lesson effective is to discuss experimental design with students prior to completing the activity. He should then help students define variables that will be held constant and variables that will vary. He should guide students to see that all factors except the distance from the light must be constant.

Making sure that students understand that it is important to only change one variable in an experiment would give students a better understanding of the scientific method. They can see that the validity of an experiment depends on getting good data and that you cannot compare results or make accurate conclusions if you change a factor from one trial to the next.

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A second weakness of this lesson is that students have not studied a phase diagram and have not learned about phase changes of water. They need an understanding of condensation and evaporation. A student comments that "a glass of water sweats just like we do on a hot day." In answering question four of the assignment, team A combines the process of condensation with sweating and team B is confused over the role cold air plays in cloud formation.

An instructional strategy that Mr. Jong should use is to introduce phase changes of water prior to the discussion of the water cycle. Students should study a phase change diagram and discuss the meaning of condensation and evaporation. They should relate energy and temperature to the phase change diagram. They would then be able to apply this knowledge to the experiment.

This strategy would be effective because it would give students the basic concepts that they need to construct a complete picture of the physical changes involved in the water cycle. It would clarify the misconceptions related to water condensation on a glass and sweating on a hot day.

To guide Mr. Jong in implementing these strategies, I would meet with him and ask him to identify what he sees as the strengths and weaknesses of the lesson. Where were students most engaged? Confused? I would also ask him to look at the experimental design and the students' completed

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assignments to assess the effectiveness of this part of the lesson. I would work with him to suggest ways to revise this experiment and ways to design future activities so that students learn to follow good scientific procedures.

I would encourage Mr. Jong to continue to use good questioning strategies and to continue to develop concepts using students' prior knowledge.

Using the observations made during this lesson, I would analyze with Mr. Jong areas in which students needed additional knowledge. I would plan to meet with Mr. Jong after he has planned another lesson to help him make sure that all necessary information and skills were developed in the lesson.

## MST EC-4 Weak Response

One strength of Mr. Jong's lesson is his use of a hands-on activity to involve the students in the learning process. By having them do their own experiments with evaporation, he enables them to participate in their own learning and increases the chance they will understand the concept.

Children learn much better by doing rather than just listening.

Two weaknesses are that Mr. Jong did not answer all the questions the students had about the water cycle before starting the experiment and he did not provide lamps with strong enough bulbs to complete the experiment. The students had a lot of questions about the water cycle and evaporation. Although the teacher explained some of the ideas, he left some vague, like how the water vapor forms clouds. The students seemed confused about the difference between condensation and evaporation. Mr. Jong needed to spend more time on the introduction and give more examples rather than hurry on to the experiment.

Although the experiment with the lamps was good, the teacher should have made sure the bulbs were strong enough to actually evaporate the water in a reasonable amount of time. The students ran out of time or had to do other things (blowing on the paper) to get the water to evaporate. The students showed good creativity in how they overcame the problem, but the main point of the experiment was lost.

(continued)

Mr. Jong needs to spend more time on the introduction to this lesson. He should provide more explanation about the water cycle in general and answer students' questions in more detail. By lengthening the question and answer portion, the teacher can create many more "teachable moments" and give the students important background information that they will need to conduct their experiments. This would be effective because the more the students know about the concept being taught, the better they will be able to learn from the hands-on portion of the lesson.

Proper preparation is a very important part of planning a lesson in science. Mr. Jong needs to be sure the experiments he uses in class will actually work before letting the students try them. He should have used stronger bulbs in the lamps so the water would evaporate in a shorter time. This would certainly have contributed to a more effective demonstration of evaporation. Because of the distraction from the low-power lamps, students did not get the results the teacher hoped for.

As a mentor to Mr. Jong, I would first review the lesson with him, guiding him to see what he did wrong. I could model a lesson for him and point out how I plan for a particular experiment by preparing ahead of time. I would also recommend that he attend a class or seminar on questioning techniques so he can get more out of his classroom discussions.

## SECTION V

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### 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

*Science and Children*, National Science Teachers Association

*Teaching Pre K–8*, Early Years, Inc.

*The Earth Scientist*, National Earth Science Teachers Association

*The Elementary School Journal*, University of Chicago Press

*The Science Teacher*, National Science Teachers Association

*The Texas Science Teacher*, Science Teachers Association of Texas

*Young Children*, Journal of the National Association for the Education of Young People

#### Web Sites

TEKS with teaching suggestions: "Vistas" and "Snapshots"  
**[www.utdanacenter.org/sciencetoolkit](http://www.utdanacenter.org/sciencetoolkit)**

Science facilities handbook  
**[www.utdanacenter.org/sciencetoolkit](http://www.utdanacenter.org/sciencetoolkit)**

American Association for the Advancement of Science  
**[www.aaas.org](http://www.aaas.org)**

Publications: Science for ALL Americans, Science benchmarks for science literacy; Spanish—*Ciencia: Conocimientos Para Todos; Avances en Conocimientos*  
**[www.project2061.org/esp/tools/default.htm](http://www.project2061.org/esp/tools/default.htm)**

National Science Teachers Association (NSTA)  
**[www.nsta.org](http://www.nsta.org)**

National Science Standards  
**[www.nap.edu/readingroom/books/nses.html](http://www.nap.edu/readingroom/books/nses.html)**

TEA Web site for information on curriculum, textbooks, and assessment  
**[www.tea.state.tx.us](http://www.tea.state.tx.us)**

Resources for Certification Requirements and PD Provider Number  
[www.sbec.state.tx.us](http://www.sbec.state.tx.us)

Resources for Teaching Science: Science Center at Region IV  
[www.texassciencecenter.org](http://www.texassciencecenter.org)

Teacher Toolkit; Safety; Facilities; TEXTeams; Charles A. Dana Center  
[www.utdanacenter.org/sciencetoolkit](http://www.utdanacenter.org/sciencetoolkit)

Texas Regional Collaboratives for Excellence in Science Teaching  
[www.thetrc.org](http://www.thetrc.org)

TEA Science Teacher Toolbag  
[www.TEA.state.tx.us/tchrtoolbag/curres\\_science.html](http://www.TEA.state.tx.us/tchrtoolbag/curres_science.html)  
[www.tea.state.tx.us/tchrtoolbag/prodev\\_sci.html](http://www.tea.state.tx.us/tchrtoolbag/prodev_sci.html)

Texas Earth Science Teachers Association  
[www.statweb.org/testa](http://www.statweb.org/testa)

Texas Marine Education Association  
[www.statweb.org/tmea](http://www.statweb.org/tmea)

National Earth Science Teachers Association  
[www.nestanet.org](http://www.nestanet.org)

National Science Teacher Convention: Anaheim, CA April 6-8, 2006  
[www.NSTA.org](http://www.NSTA.org)

What Works Clearinghouse  
[www.w-w-c.org](http://www.w-w-c.org)

UTOPIA: UT Web site for Educators  
[www.utopia.utexas.edu](http://www.utopia.utexas.edu)

Eisenhower National Clearinhouse (ENC) Archives  
[www.mathsciencenetwork.org](http://www.mathsciencenetwork.org)

Girlstart: Nonprofit program to empower girls in science, mathematics, and technology  
[www.girlstart.org](http://www.girlstart.org)

Southwest Educational Development Laboratory  
[www.sedl.org](http://www.sedl.org)

IBM science resource  
[www.tryscience.org](http://www.tryscience.org)

NASA's The Space Place  
[www.spaceplace.nasa.gov](http://www.spaceplace.nasa.gov)

Earth Science Week Materials; October 9–15, 2005  
[www.earthscienceworld.org/week](http://www.earthscienceworld.org/week)

NCLB: A Teacher Toolkit  
[www.ed.gov/teachers/nclbguide/nclb-teachers-toolkit.pdf](http://www.ed.gov/teachers/nclbguide/nclb-teachers-toolkit.pdf)

US Department of Education publications: "Helping Your Child Learn Science"  
[www.ed.pubs@inet.ed.gov](http://www.ed.pubs@inet.ed.gov)

Rice University/Learn Web site  
[www.learn.rice.edu/wdominey@rice.edu](http://www.learn.rice.edu/wdominey@rice.edu)

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