STATE BOARD FOR EDUCATOR CERTIFICATION/TEXAS EDUCATION AGENCY
TEXAS EDUCATOR CERTIFICATION
TExES/ExCET TOPT TExMaT TASC/TASC-ASL

TExES | Texas Examinations of Educator Standards

Preparation Manual

140 Chemistry 8–12

PREFACE

The State Board for Educator Certification (SBEC) has developed new standards for Texas educators that delineate what the beginning educator should know and be able to do. These standards, which are based on the state-required curriculum for students—the Texas Essential Knowledge and Skills (TEKS)—form the basis for new Texas Examinations of Educator Standards (TExES™). This initiative will affect all areas of Texas education—from the more than 100 approved Texas educator preparation programs to the more than 7,000 Texas school campuses. This standards-based system reflects the SBEC's commitment to help align Texas education from kindergarten through college. The SBEC's role in this K–16 initiative will ensure that newly certified Texas teachers have the essential knowledge and skills to teach the TEKS to the state's public school students.

This manual is designed to help examinees prepare for the new TExES test in this field. 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 educators.

If you have any questions after reading this preparation manual or you would like additional information about the new TExES tests or the educator standards, please visit the SBEC Web site at **www.sbec.state.tx.us**.

KEY FEATURES OF THE MANUAL

List of competencies that will be tested

Strategies for answering test items

Sample test items and answer key

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SECTION I

THE NEW TExES TESTS FOR TEXAS TEACHERS

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

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

Development of the New TExES Tests

Committees of Texas educators and interested citizens guide the development of the new TExES tests by participating in each stage of the test development process. These working committees comprise 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 TExES tests are described below.

1. **Develop Standards.** Committees are established to recommend what the beginning educator should know and be able to do. Using the Texas Essential Knowledge and Skills (TEKS) as a focal point, draft standards are prepared to define the knowledge and skills required of the beginning educator.
2. **Review Standards.** Committees review and revise the draft standards. The revised draft standards are then placed on the 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. Standards not based specifically on the TEKS, such as those for librarians and counselors, are proposed as rule by the SBEC Board; sent to the SBOE for its 90-day review; and, if not rejected by the SBOE, adopted by the SBEC Board.
3. **Develop Test Frameworks.** Committees review draft test frameworks that are based on the standards. These frameworks outline the specific competencies to be measured on the new TExES tests. The TExES competencies represent the critical components of the standards that can be measured with either a pencil-and-paper-based or 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 an educator certificate has been proposed are surveyed to determine the relative job importance of each competency outlined in the test framework for that content area. Frameworks are revised as needed following an analysis of the survey responses.
5. **Develop and Review New Test Items.** The test contractor develops draft items 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 TExES Tests.** New TExES tests are constructed to reflect the competencies, and the tests are administered to candidates for certification.
9. **Set Passing Standard.** A Standard Setting Committee convenes to review performance data from the initial administration of each new TExES test and to recommend a final passing standard for that test. The SBEC considers this recommendation as it establishes a passing score on the test.

Taking the TExES Test and Receiving Scores

Please refer to the current TExES registration bulletin 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 TExES tests, the score scale is 100–300 with a scaled score of 240 as the minimum passing score. This score represents the minimum level of competency required to be an entry-level educator in this field in Texas public schools.
- your performance in the major content domains of the test and in the specific content competencies of the test.
  - — This information may be useful in identifying strengths and weaknesses in your content preparation and can be used for further study or for preparing to retake the test.
- information to help you understand the score scale and interpret your results.

You will <u>not</u> 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 of each test administration. Information about receiving unofficial scores on the Internet, the score scale, and other score report topics may be found on the SBEC Web site at **www.sbec.state.tx.us**.

Educator Standards

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

SECTION II

USING THE TEST FRAMEWORK

The Texas Examination of Educator Standards (TExES) test measures the content knowledge required of an entry-level educator 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 TExES Test Framework

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

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

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

The educator standards being assessed within each domain are listed for reference at the beginning of the test framework, which begins on page 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

Chemistry 8–12

Competency:

The teacher understands how to select and manage learning activities to ensure the safety of all students and the correct use and care of natural resources, materials, equipment, and technologies.

Descriptive Statements:

The beginning teacher:

- Uses current sources of information about laboratory safety, including safety regulations and guidelines for the use of science facilities, materials, and equipment.
- Recognizes potential safety hazards in the laboratory and in the field and knows how to prevent accidents and apply procedures, including basic first aid, for responding to accidents.
- Employs safe practices in planning and implementing all instructional activities and designs and implements rules and procedures to maintain a safe learning environment.
- Understands procedures for selecting, maintaining, and safely using chemicals, tools, technologies, materials, specimens, and equipment, including procedures for the recycling, reuse, and conservation of laboratory resources.
- Knows how to use appropriate equipment and technology (e.g., Internet, spreadsheet, calculator) for gathering, organizing, displaying, and communicating data in a variety of ways (e.g., charts, tables, graphs, diagrams, written reports, oral presentations).
- Understands how to use a variety of tools, techniques, and technology to gather, organize, and analyze data and how to apply appropriate methods of statistical measures and analysis.
- Knows how to apply techniques to calibrate measuring devices and understands concepts of precision, accuracy, and error with regard to reading and recording numerical data from scientific instruments.
- Uses the International System of Units (i.e., metric system) and performs unit conversions within and across measurement systems.

Studying for the TExES Test

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

1. Identify the information the test will cover by reading through the test competencies (see the following pages in this section). *Within each domain* of this TExES test, each competency will receive approximately equal coverage.

2. Read each competency with its descriptive statements in order to get a more specific idea of the knowledge you will be required to demonstrate on the test. You may wish to use this review of the competencies to set priorities for your study time.

3. Review the "Preparation Resources" section of this manual 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 TExES 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 TExES 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 TExES program.

TEST FRAMEWORK FOR FIELD 140: CHEMISTRY 8–12

Domain I **Scientific Inquiry and Processes (approximately 24% of the test)**

Standards Assessed:

Physical Science Standard I:
The science teacher manages classroom, field, and laboratory activities to ensure the safety of all students and the ethical care and treatment of organisms and specimens.

Physical Science Standard II:
The science teacher understands the correct use of tools, materials, equipment, and technologies.

Physical Science Standard III:
The science teacher understands the process of scientific inquiry and its role in science instruction.

Physical Science Standard VI:
The science teacher understands the history and nature of science.

Physical Science Standard VII:
The science teacher understands how science affects the daily lives of students and how science interacts with and influences personal and societal decisions.

Physical Science Standard XI:
The science teacher knows unifying concepts and processes that are common to all sciences.

Domain II **Matter and Energy (approximately 41% of the test)**

Standards Assessed:

Physical Science Standard VIII:
The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.

Domain III **Chemical Reactions (approximately 23% of the test)**

Standards Assessed:

Physical Science Standard VIII:
The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.

Domain IV **Science Learning, Instruction, and Assessment (approximately 12% of the test)**

Standards Assessed:

Physical Science Standard IV:
The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.

Physical Science Standard V:
The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.

DOMAIN I—SCIENTIFIC INQUIRY AND PROCESSES

Competency 001

The teacher understands how to select and manage learning activities to ensure the safety of all students and the correct use and care of natural resources, materials, equipment, and technologies.

The beginning teacher:

- Uses current sources of information about laboratory safety, including safety regulations and guidelines for the use of science facilities, materials, and equipment.
- Recognizes potential safety hazards in the laboratory and in the field and knows how to prevent accidents and apply procedures, including basic first aid, for responding to accidents.
- Employs safe practices in planning and implementing all instructional activities and designs and implements rules and procedures to maintain a safe learning environment.
- Understands procedures for selecting, maintaining, and safely using chemicals, tools, technologies, materials, specimens, and equipment, including procedures for the recycling, reuse, and conservation of laboratory resources.
- Knows how to use appropriate equipment and technology (e.g., Internet, spreadsheet, calculator) for gathering, organizing, displaying, and communicating data in a variety of ways (e.g., charts, tables, graphs, diagrams, written reports, oral presentations).
- Understands how to use a variety of tools, techniques, and technology to gather, organize, and analyze data and how to apply appropriate methods of statistical measures and analysis.
- Knows how to apply techniques to calibrate measuring devices and understands concepts of precision, accuracy, and error with regard to reading and recording numerical data from scientific instruments.
- Uses the International System of Units (i.e., metric system) and performs unit conversions within and across measurement systems.

Competency 002

The teacher understands the nature of science and the process of scientific inquiry.

The beginning teacher:

- Understands the nature of science, the predictive power of science, and limitations to the scope of science (i.e., the types of questions that science can and cannot answer).
- Knows the characteristics of various types of scientific investigations (e.g., descriptive studies, controlled experiments, comparative data analysis) and how and why scientists use different types of scientific investigations.
- Understands principles and procedures for designing and conducting a variety of scientific investigations, with emphasis on inquiry-based investigations and understands how to communicate and defend scientific results.
- Understands how logical reasoning, verifiable observational and experimental evidence, and peer review are used in the process of generating and evaluating scientific knowledge.
- Understands the relationship, similarities, and differences between science and technology.

Competency 003

The teacher understands the role of mathematics and the unifying concepts common to all sciences.

The beginning teacher:

- Knows the characteristics and general features of systems; how properties and patterns of systems can be described in terms of space, time, energy, and matter; and how system components and different systems interact.
- Understands how to identify potential sources of error in an investigation, evaluate the validity of scientific data, and develop and analyze different explanations for a given scientific result.
- Knows how to apply and analyze the systems model (e.g., interacting parts, boundaries, input, output, feedback, subsystems) across the science disciplines.
- Understands how shared themes and concepts (e.g., systems, order, and organization; evidence, models, and explanation; change, constancy, and measurements; evolution and equilibrium; form and function) provide a unifying framework in science.
- Understands how models are used to represent the natural world and how to evaluate the strengths and limitations of a variety of scientific models (e.g., physical, conceptual, mathematical).
- Understands the importance of mathematics to science and applies scientific conventions and mathematical methods (e.g., significant figures, scientific notation, dimensional analysis, statistical analysis, algebraic manipulation).

Competency 004

The teacher understands the history of science, how science impacts the daily lives of students, and how science interacts with and influences personal and societal decisions.

The beginning teacher:

- Understands the historical development of science, key events in the history of science, and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge.
- Knows how to use examples from the history of science to demonstrate the changing nature of scientific theories and knowledge (i.e., that scientific theories and knowledge are always subject to revision in light of new evidence).
- Knows that science is a human endeavor influenced by societal, cultural, and personal views of the world and knows that decisions about the use and direction of science are based on factors such as ethical standards, economics, and personal and societal biases and needs.
- Understands the application of scientific ethics to the conducting, analyzing, and publishing of scientific investigations.
- Applies scientific principles, probability, and risk/benefit analysis to analyze the advantages of, disadvantages of, or alternatives to a given decision or course of action.
- Understands the role science can play in helping to resolve personal, societal, and global issues (e.g., population growth, disease prevention, resource use).

DOMAIN II—MATTER AND ENERGY

Competency 005

The teacher understands the characteristics of matter.

The beginning teacher:

- Differentiates between physical and chemical properties and changes of matter.
- Explains the structure and properties of solids, liquids, and gases.
- Identifies and analyzes properties of substances (i.e., elements and compounds) and mixtures.
- Identifies elements and isotopes by atomic number and mass number.
- Understands the structure, significance, and history of the periodic table.

Competency 006

The teacher understands the structure and characteristics of atoms.

The beginning teacher:

- Models the atom in terms of protons, neutrons, and electron clouds.
- Understands atomic orbitals and electron configurations and describes the relationship between electron energy levels and atomic structure.
- Analyzes relationships among electron energy levels, photons, and atomic spectra.
- Applies the concept of periodicity to predict the physical and chemical properties of an element.
- Understands the historical development of atomic theory.

Competency 007

The teacher understands the properties of gases.

The beginning teacher:

- Understands interrelationships among temperature, moles, pressure, and volume of gases contained within a closed system.
- Analyzes data obtained from investigations with gases in a closed system and determines whether the data are consistent with the ideal gas law.
- Applies the gas laws (e.g., Charles's law, Boyle's law, combined gas law, Avogadro's law) to predict gas behavior in a variety of systems.
- Applies Dalton's law of partial pressure in various systems, as in collecting a gas over water.
- Understands the relationship between Kinetic Molecular Theory and the ideal gas law.
- Knows how to apply the ideal gas law to analyze mass relationships between reactants and products in chemical reactions involving gases.

Competency 008

The teacher understands properties and characteristics of ionic and covalent bonds.

The beginning teacher:

- Relates the electron configuration of an atom to its chemical reactivity.
- Compares and contrasts characteristics of ionic and covalent bonds.
- Applies the "octet" rule to construct Lewis structures.
- Identifies and describes the arrangement of atoms in molecules, ionic crystals, polymers, and metallic substances.
- Understands the influence of bonding forces on the physical and chemical properties of ionic and covalent substances.
- Identifies and describes intermolecular and intramolecular forces.
- Uses intermolecular forces to explain the physical properties of a given substance.
- Applies the concepts of electronegativity, electron affinity, and oxidation state to analyze chemical bonds.
- Evaluates energy changes in the formation and dissociation of chemical bonds.
- Understands the relationship between covalent bonding, hybridization, and molecular geometry.

Competency 009

The teacher understands and interprets chemical notation and chemical equations.

The beginning teacher:

- Identifies elements, ions, and compounds using scientific nomenclature.
- Uses and interprets symbols, formulas, and equations in describing interactions of matter and energy in chemical reactions.
- Understands mass relationships involving percent composition, empirical formulas, and molecular formulas.
- Interprets and balances chemical equations using conservation of atoms, mass, and charge.
- Understands mass and mole relationships in chemical equations.
- Solves stoichiometric problems including limiting reagents, reaction yield, and percent yield.

Competency 010

The teacher understands types and properties of solutions.

The beginning teacher:

- Analyzes factors that affect solubility (e.g., temperature, pressure, polarity of solvents and solutes).
- Identifies characteristics of saturated, unsaturated, and supersaturated solutions.
- Determines the molarity, molality, and percent composition of aqueous solutions.
- Analyzes precipitation reactions and derives net ionic equations.
- Analyzes the colligative properties of solutions (e.g., vapor-pressure lowering, osmotic pressure changes, boiling-point elevation, freezing-point depression).
- Understands the properties of electrolytes and explains the relationship between concentration and electrical conductivity.
- Analyzes models to explain the structural properties of water and evaluates the significance of water as a solvent in living organisms and the environment.

Competency 011

The teacher understands energy transformations that occur in physical and chemical processes.

The beginning teacher:

- Analyzes the energy transformations that occur in phase transitions.
- Solves problems in calorimetry (e.g., determining the specific heat of a substance, finding the standard enthalpy of formation and reaction of substances).
- Applies the law of conservation of energy to analyze and evaluate energy exchanges that occur in exothermic and endothermic processes.
- Understands thermodynamic relationships among spontaneous reactions, entropy, enthalpy, temperature, and Gibbs free energy.

DOMAIN III—CHEMICAL REACTIONS

Competency 012

The teacher understands chemical kinetics and equilibrium.

The beginning teacher:

- Analyzes factors (e.g., temperature, pressure, concentration, catalysts) that influence the rate of a chemical reaction.
- Solves problems involving rate laws and determines the rate law of a reaction from experimental data.
- Understands principles of chemical equilibrium.
- Solves problems involving principles of chemical equilibrium.
- Identifies the chemical properties of a variety of common household chemicals (e.g., baking soda, bleach, ammonia) in order to predict the potential for chemical reactivity.

Competency 013

The teacher understands acids, bases, and their reactions.

The beginning teacher:

- Identifies the general properties of and relationships among acids, bases, and salts.
- Identifies acids and bases using models of Arrhenius, Brønsted-Lowry, and Lewis.
- Differentiates between strong and weak acids and bases.
- Applies the relationship between hydrogen ion concentration and pH for acids and bases.
- Understands and analyzes acid-base equilibria and buffers.
- Analyzes and applies the principles of acid-base titration.
- Analyzes neutralization reactions based on the principles of solution concentration and stoichiometry.
- Describes the effects of acids and bases in the real world.

Competency 014

The teacher understands oxidation and reduction reactions.

The beginning teacher:

- Determines the oxidation state of ions and atoms in compounds.
- Identifies and balances oxidation and reduction reactions.
- Uses reduction potentials to determine whether a redox reaction will occur spontaneously.
- Explains the operating principles of electrochemical cells and the process of electroplating metals.
- Analyzes applications of oxidation and reduction reactions from everyday life (e.g., combustion, corrosion, electroplating, batteries).

Competency 015

The teacher understands nuclear fission, nuclear fusion, and nuclear reactions.

The beginning teacher:

- Uses models to explain radioactivity and types of radioactive decay (i.e., alpha, beta, gamma).
- Interprets and balances equations for nuclear reactions.
- Compares and contrasts fission and fusion reactions.
- Knows how to use the half-life of radioactive elements to study real-world problems (e.g., carbon dating, radioactive tracers).
- Identifies various issues associated with using nuclear energy (e.g., medical, commercial, environmental).

DOMAIN IV—SCIENCE LEARNING, INSTRUCTION, AND ASSESSMENT

Competency 016

The teacher understands research-based theoretical and practical knowledge about teaching science, how students learn science, and the role of scientific inquiry in science instruction.

The beginning teacher:

- Knows research-based theories about how students develop scientific understanding and how developmental characteristics, prior knowledge, experience, and attitudes of students influence science learning.
- Understands the importance of respecting student diversity by planning activities that are inclusive by selecting and adapting science curricula, content, instructional materials, and activities to meet the interests, knowledge, understanding, abilities, and experiences of all students, including English Language Learners and students with special needs.

- Knows how to plan and implement strategies to encourage student self-motivation and engagement in their own learning (e.g., linking inquiry-based investigations to students' prior knowledge, focusing inquiry-based instruction on issues relevant to students, developing instructional materials using situations from students' daily lives, fostering collaboration among students).
- Knows how to use a variety of instructional strategies to ensure all students comprehend content-related texts, including how to locate, retrieve, and retain information from a range of texts and technologies.
- Understands the science teacher's role in developing the total school program by planning and implementing science instruction that incorporates schoolwide objectives and the statewide curriculum as defined in the Texas Essential Knowledge and Skills (TEKS).
- Knows how to design and manage the learning environment (e.g., individual, small-group, whole-class settings) to focus and support student inquiries and to provide the time, space, and resources for all students to participate in field, laboratory, experimental, and nonexperimental scientific investigation.
- Understands the rationale for using active learning and inquiry methods in science instruction and understands how to model scientific attitudes such as curiosity, openness to new ideas, and skepticism.
- Knows principles and procedures for designing and conducting an inquiry-based scientific investigation (e.g., making observations; generating questions; researching and reviewing current knowledge in light of existing evidence; choosing tools to gather and analyze evidence; proposing answers, explanations, and predictions; communicating and defending results).
- Knows how to assist students with generating, refining, focusing, and testing scientific questions and hypotheses.
- Knows strategies for assisting students in learning to identify, refine, and focus scientific ideas and questions guiding an inquiry-based scientific investigation; to develop, analyze, and evaluate different explanations for a given scientific result; and to identify potential sources of error in an inquiry-based scientific investigation.
- Understands how to implement inquiry strategies designed to promote the use of higher-level thinking skills, logical reasoning, and scientific problem solving in order to move students from concrete to more abstract understanding.
- Knows how to guide students in making systematic observations and measurements.
- Knows how to plan learning activities in a way that uncovers common misconceptions, allows students to build upon their prior knowledge, and challenges them to expand their understanding of science.

Competency 017

The teacher knows how to monitor and assess science learning in laboratory, field, and classroom settings.

The beginning teacher:

- Knows how to use formal and informal assessments (e.g., projects, laboratory reports and field journals, rubrics, portfolios, student profiles, checklists) of student performance and products to evaluate student participation in and understanding of inquiry-based scientific investigations.
- Connects assessment to instruction in the science curriculum (e.g., designing assessments to match learning objectives, using assessment results to inform instructional practice).
- Knows the importance of monitoring and assessing students' understanding of science concepts and skills on an ongoing basis by using a variety of appropriate assessment methods (e.g., performance assessment, self-assessment, peer assessment, formal/informal assessment).
- Understands the purposes and characteristics of and uses various types of assessment in science, including formative and summative assessments, and the importance of limiting the use of an assessment to its intended purpose.
- Understands strategies for assessing students' prior knowledge and misconceptions about science and how to use these assessments to develop effective ways to address these misconceptions.
- Understands characteristics of assessments, such as reliability, validity, and the absence of bias in order to evaluate assessment instruments and their results.
- Understands the role of assessment as a learning experience for students and strategies for engaging students in meaningful self-assessment and peer assessment.
- Recognizes the importance of selecting assessment instruments and methods that provide all students with adequate opportunities to demonstrate their achievements.
- Recognizes the importance of clarifying teacher expectations and student achievement by sharing evaluation criteria and assessment results with students and other appropriate educational stakeholders.

SECTION III

APPROACHES TO ANSWERING MULTIPLE-CHOICE ITEMS

The purpose of this section is to describe multiple-choice item formats that you will see on the TExES test in this field and to suggest possible ways to approach thinking about and answering the multiple-choice items. However, these approaches are not intended to replace familiar test-taking strategies with which you are already comfortable and that work for you.

The Chemistry 8–12 test is designed to include 80 scorable multiple-choice items and approximately 10 nonscorable items. Your final scaled score will be based only on scorable items. The nonscorable multiple-choice items are pilot tested by including them in the test in order to collect information about how these items 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 respond to 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.

Calculators. Scientific calculators will be provided at the test administration site. See the TExES registration bulletin for the brand and model of the calculator that will be available.

Physical Constants. A set of physical constants will be provided in your test booklet. A copy of those physical constants is also provided in Section IV of this preparation manual.

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 in Section IV of this preparation manual.

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 one 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 cluster, 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.

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

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. The following item is an example of this type. It tests knowledge of Chemistry 8–12 competency 011: *The teacher understands energy transformations that occur in physical and chemical processes*.

For a given reaction, $\Delta H = 13.6$ kJ and $\Delta S = 145$ J/K. Assuming these values are independent of temperature, at what temperature will the reaction become spontaneous?

A. 94 K

B. 94°C

C. 11 K

D. 11°C

Suggested Approach

Read the 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.

The first step in this problem is to consider the information given and the question being asked. In this case, the change in enthalpy (ΔH) and change in disorder or entropy (ΔS) are given for a chemical reaction, and you are asked for the temperature at which the reaction occurs spontaneously. The spontaneity of a reaction can be determined by calculating the Gibbs free energy of a system (ΔG). The free energy of a system is the maximum useful energy obtainable in the form of work from a given reaction at constant temperature and pressure. If $\Delta G > 0$, then the reaction is nonspontaneous. If $\Delta G < 0$, then the reaction is spontaneous. The system is at equilibrium when there is no net gain or loss of free energy within the system ($\Delta G = 0$). Equilibrium is also the threshold at which the reaction becomes spontaneous. The expression for the free energy is $\Delta G = \Delta H - T\Delta S$, where T, the temperature, is expressed using the Kelvin scale.

Thus, the question requires that you determine at what temperature the reaction will become spontaneous, $\Delta G = 0$.

If $\Delta G = 0$, then $T\Delta S = \Delta H$, and $T = \Delta H/\Delta S$.

Inserting the given values gives $T = \frac{13.6 \text{ kJ}}{145 \text{ J/K}}$. Converting kilojoules to joules, 13.6 kJ = 13,600 J, and simplifying results in $T = \frac{13{,}600 \text{ J}}{145 \text{ J/K}} = 93.8$ K. This answer is closest to the value given in option A.

Option B results from confusing the Celsius and Kelvin temperature scales. Option C results from incorrectly solving the expression for $\Delta G = 0$ and obtaining $T = \Delta S/\Delta H$. Option D results from both incorrectly solving the equation and using the incorrect temperature scale. Therefore, the correct response is option A.

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 respond to 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 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.

Suggested Approach

First read the stimulus (a description of a chemistry laboratory procedure).

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

To determine the amount of table salt in a salty liquid food product, 0.2 M silver nitrate solution is slowly added to 50 mL of the food product. A small amount of sodium chromate is also added to the solution as an indicator. The chromate ions react with the excess silver ions to produce an orange/red color.

Now you are ready to respond to the item or items associated with this stimulus. The item below tests knowledge of Chemistry 8–12 competency 010: *The teacher understands types and properties of solutions*.

A total of 25.0 mL of silver nitrate solution is added to the liquid food product before a color change is observed. What is the mass of the silver ions added to the food product?

A. 0.005 g

B. 0.20 g

C. 0.24 g

D. 0.54 g

To determine the mass of silver ions added to the liquid food product, information from both the stimulus and the item must be used. First, the number of moles of silver nitrate added can be calculated by multiplying the molarity of the silver nitrate solution (0.2 M) by the volume added in liters (0.025 L) before the color change occurred. The result of the calculation indicates that 0.005 moles of silver nitrate were added to the liquid food product. The number of moles of silver ions added is equal to the number of moles of silver nitrate added because the dissociation of 1 mole of silver nitrate results in 1 mole of silver ions. Multiplying the number of moles of silver ions added (0.005 moles) by the molar mass of the silver ion (107.9 grams/mole) gives the mass of silver ions added to the liquid food product as 0.54 grams. Therefore, the correct response is option D.

Option A is incorrect because it represents the number of moles of silver ions added but uses a unit of mass (grams). Option B is incorrect because it represents the molarity of the silver nitrate used in the reaction, but again uses a unit of mass (grams). Option C represents a correct calculation of the number of moles of silver ions added, but it then shows that this number is incorrectly multiplied by the atomic number of silver (47).

Now you are ready to respond to the next item. The item below tests knowledge of Chemistry 8–12 competency 010: *The teacher understands types and properties of solutions*.

Which of the following equations could be used to represent the reaction occurring between the silver nitrate and the ions in the salty solution?

A. $AgNO_3(aq) + Na^+(aq) \longrightarrow NaNO_3(aq) + Ag(s)$

B. $AgNO_3(aq) + Na^+(aq) \longrightarrow Ag(s) + Na^+(aq) + NO_3^-(aq)$

C. $AgNO_3(aq) + Cl^-(aq) \longrightarrow ClNO_3(aq) + Ag(s)$

D. $AgNO_3(aq) + Cl^-(aq) \longrightarrow AgCl(s) + NO_3^-(aq)$

This item asks which of four equations can be used to represent the reaction described in the stimulus.

The silver nitrate and the sodium chloride in the food product react according to the balanced molecular equation shown below.

$$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$$

Since $AgNO_3$, NaCl, and $NaNO_3$ are all soluble ionic compounds, the equation can be written in ionic form, which shows ions in solution.

$$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \longrightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$$

Spectator ions are ions that are not directly involved in the chemical reaction and can be omitted when writing an equation for the net chemical reaction. In this case, the sodium and nitrate ions are spectator ions. Omitting only the sodium ion as a spectator yields the following equation.

$$Ag^+(aq) + NO_3^-(aq) + Cl^-(aq) \longrightarrow AgCl(s) + NO_3^-(aq)$$

Representing silver nitrate as an aqueous compound on the left side of the equation above leads to the equation shown in option D. Therefore, the correct response is option D.

Options A and B both incorrectly drop the chloride ion as a spectator ion. Chloride ions combine with silver ions to form the solid precipitate silver chloride. The equations in both options A and B erroneously identify elemental silver as the solid product of the reaction. Option C incorrectly brings two negatively charged ions together in the compound $ClNO_3$. Option C, like options A and B, also shows the production of solid silver.

Now you are ready to respond to the next item. The item below tests knowledge of Chemistry 8–12 competency 001: *The teacher understands how to select and manage learning activities to ensure the safety of all students and the correct use and care of natural resources, materials, equipment, and technologies.*

Which of the following analytic techniques is used in this analysis?

A. titration

B. gravimetric

C. calorimetry

D. electrolysis

This item asks for identification of the analytic technique that is described in the stimulus. Option A gives the technique called "titration." Titration involves the gradual addition of a solution of known concentration to a known quantity of another solution just to the point of complete reaction, which is often determined by a sudden color change in the presence of an indicator solution. This technique matches the one described in the stimulus, in which silver nitrate solution of known concentration is slowly added to 50 mL of a salty liquid food product until the reaction between the silver ions and available chloride ions is complete, as indicated by the appearance of an orange/red color. Therefore, the correct response is Option A.

Option B is incorrect because gravimetric analysis involves determining mass as the key measurement. A gravimetric analysis of this reaction would involve separating, drying, and measuring the mass of silver chloride precipitate that formed. Option C is incorrect because calorimetry is used to measure heat exchanges in chemical reactions. Option D is incorrect because electrolysis uses electrical energy to drive nonspontaneous chemical reactions.

SECTION IV

SAMPLE ITEMS

This section presents some sample test items for you to review as part of your preparation for the test. 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 answer key follows the sample items. The answer key lists the item number and 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 test.

PERIODIC TABLE OF THE ELEMENTS

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

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

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

Physical Constants for Use on Chemistry Items

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

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

Avogadro's number is 6.022×10^{23}.

END OF PHYSICAL CONSTANTS

Competency 002

1. A descriptive study differs from a controlled experiment primarily in that a descriptive study involves:

   A. measurement and interpretation of data but not quantitative analysis of data.

   B. quantitative and qualitative data collection related to phenomena but not interpretation of data.

   C. inferential conclusions related to observed phenomena but not deductive reasoning.

   D. observation and analysis of phenomena but not manipulation of a variable.

Competency 003

2. The value of a mathematical equation such as $PV = nRT$ to the endeavor of science is that it:

   A. may be readily understood by all scientists, irrespective of language and training.

   B. quantifies the relationship among variables precisely and without ambiguity.

   C. specifies the types of inquiry that will be most fruitful with regard to a variable of interest.

   D. may be applied to understand patterns in a variety of scientific contexts.

Competency 004

3. The practice of stoichiometry is most directly related to which of the following historical events in chemistry?

   A. Rutherford's development of the nuclear model of the atom

   B. Curie's discovery of radioactive transmutation

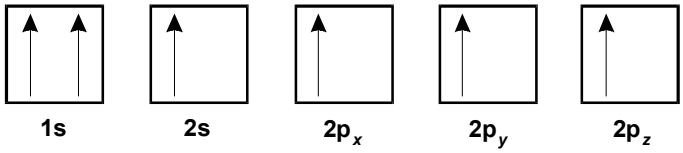
   C. Einstein's discovery of general relativity

   D. Lavoisier's development of the law of conservation of matter

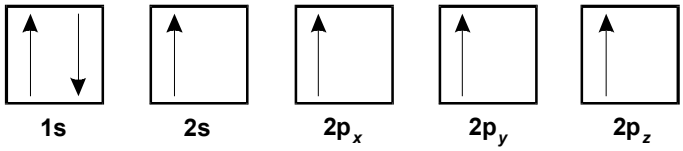
Competency 006

4. Which of the following orbital notations shows the correct electron arrangement of a neutral carbon atom in its ground state?

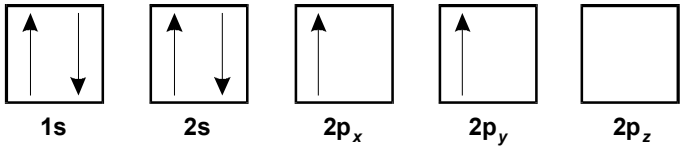
A.



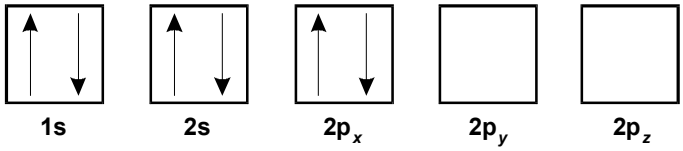
B.



C.



D.



Competency 007

5. A gas-filled balloon with a volume of 3.0 L at 300 K and 1.0 atm rises into the stratosphere where the pressure is 3.0×10^{-3} atm and the temperature is 250 K. What is the volume of the balloon?

   A. 250 L

   B. 750 L

   C. 830 L

   D. 1200 L

Competency 008

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

Bond	Bond Energy (kJ/mol)
A—A	336
B—B	363
A—B	358

The table gives the amount of energy required to break a particular bond. Which of the following equations correctly calculates the energy change, in kilojoules per mole, for a reaction with the formula $A_2 + B_2 \longrightarrow 2\ AB$?

A. 336 + 363 + 358 = 1057

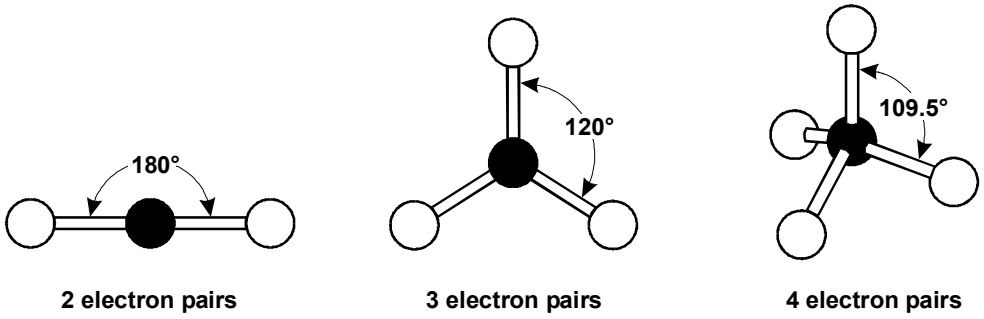
B. 336 + 363 – 358 = 341

C. 336 + 363 – 716 = –17

D. 672 – 726 – 716 = –770

Competency 008

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



The diagram shows the predicted molecular geometry for molecules with 2, 3, and 4 electron pairs arranged about a central atom. Which of the following is the basic rule used in predicting the geometry of these molecules?

A. The electron pairs are arranged so electrons can easily move among orbitals.

B. The electron pairs are arranged to minimize the electrostatic repulsion between them.

C. The electron pairs are arranged so the net electron spin of the molecule is zero.

D. The electron pairs are arranged so the molecule has a net dipole moment.

Competency 009

8. Which of the following is the correct IUPAC name for the ion $Ca_3(PO_4)_2$?

A. tricalcium phosphate

B. calcium diphosphate

C. calcium phosphate

D. tricalcium diphosphate

Competency 012

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

Reaction	Equilibrium Concentrations	
$2\ NO(g) + O_2(g) \rightleftharpoons 2\ NO_2$	NO	0.0813 M
	O_2	0.1905 M
	NO_2	28.47 M

The table gives the equilibrium concentrations for the reaction. What is the equilibrium constant for the reaction?

A. $\dfrac{(0.0813)^2(0.1905)}{(28.47)^2}$

B. $\dfrac{(0.0813)^2(0.1905)^2}{(28.47)}$

C. $\dfrac{(28.47)^2}{(0.0813)^2(0.1905)}$

D. $\dfrac{(28.47)}{(0.0813)^2(0.1905)^2}$

Competency 013

10. **Use the equation below to answer the question that follows.**

$H^+(aq) + NH_3(aq) \longrightarrow NH_4^+(aq)$

In this reaction, the $NH_3(aq)$ can be considered a Brønsted base because it:

A. has an oxidation number equal to 0.

B. contains a metal and a nonmetal.

C. reacts with hydroxide ions.

D. acts as a proton acceptor.

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

To remove tarnish from a silver bracelet, a jeweler loosely wraps the bracelet in aluminum foil and submerges the system in a beaker of water. The jeweler next adds baking soda to the water and gently heats the water. The tarnish is removed by the following equation.

$$2\ Al(s) + 3\ Ag_2S(aq) + 6\ H_2O(\ell) \longrightarrow 6\ Ag(s) + 2\ Al(OH)_3(aq) + 3\ H_2S(g)$$

Competency 014

11. In this reaction, which of the following pairs of numbers represents the oxidation number of silver in the reactant and product, respectively?

    A. 0, +1

    B. 0, +6

    C. +1, 0

    D. +1, +6

Competency 014

12. In this reaction, which of the following species acts as the reducing agent?

    A. Al

    B. H_2O

    C. S^{2-}

    D. OH^-

◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆

Competency 015

13. The isotope $^{14}_{6}C$ undergoes beta decay.

    What is the product of this decay process?

    A. $^{13}_{5}B$

    B. $^{14}_{5}B$

    C. $^{14}_{7}N$

    D. $^{15}_{7}N$

Competency 016

14. A teacher has prepared several electrochemical cells using different pairs of electrodes and asks students to predict which cell they believe will give the highest reading on a voltmeter and explain their reasoning. Which of the following is a primary rationale for asking students to make predictions and listening to their responses and explanations before actually measuring the current?

    A. to provide practice in forming opinions free from external influence

    B. to test students on their knowledge of the principles of electrochemistry

    C. to correct students' misconceptions prior to performing the demonstration

    D. to encourage students to consider what they already know or think they know about a topic

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

In an introductory unit on solubility, an eighth-grade science teacher gives the students the following materials and asks them
to determine whether the materials are soluble in water. The students work in teams of two.

- table salt
- baking powder
- zinc powder
- sugar

Competency 017

15. The teacher would like to use this investigation as a starting point for an extended inquiry-based unit on solubility. Which of the following assignments would be most appropriate for meeting the teacher's goal?

    A. Carefully describe what you observed and pose at least one scientific question related to solubility that could be investigated by empirical methods.

    B. Write a brief essay in which you explain what happens at the molecular level as a substance is dissolved in water.

    C. Repeat the experiment using the same materials and procedures as were used in the original experiment.

    D. Use the Internet to research the properties of saturated and supersaturated solutions and be prepared to present your research to the class.

Competency 017

16. As the inquiry unit progresses, the students perform an experiment in which they are asked to predict whether adding a solute to water will affect the boiling point of water. The students then design and carry out an experiment to test their predictions. The students are asked to communicate the results of their experiment in a written lab report. Which of the following should be the primary criterion used by the teacher in assessing the section of each team's report where the students state the conclusion of their experiment?

    A. Is the conclusion consistent with accepted scientific knowledge?

    B. Is the conclusion supported by the data collected during the experiment?

    C. Is the conclusion in agreement with the students' predictions?

    D. Is the conclusion in agreement with those of the other teams in the class?

◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆

Item Number	Correct Answer	Competency
1	**D**	002
2	**B**	003
3	**D**	004
4	**C**	006
5	**C**	007
6	**C**	008
7	**B**	008
8	**C**	009
9	**C**	012
10	**D**	013
11	**C**	014
12	**A**	014
13	**C**	015
14	**D**	016
15	**A**	017
16	**B**	017

SECTION V

PREPARATION RESOURCES

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

Journals

ChemMatters, American Chemical Society.

The Science Teacher, National Science Teachers Association.

Texas Science Teacher, Science Teachers Association of Texas.

Other Sources

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

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Joyce, B. R., Weil, M., and Calhoun, E. (2000). *Models of Teaching* (6th ed.). Boston, MA: Allyn & Bacon.

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

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Texas Education Agency. (1997). *Texas Essential Knowledge and Skills* (TEKS). Austin, TX.

Texas Education Agency. (2000). *Texas Safety Standards: Kindergarten Through Grade 12* (2nd Ed.). Austin, TX.

Whitten, K. W., Davis, R. E., Peck, L. M., Stanley, G. G. (2003). *General Chemistry* (7th ed.). Florence, KY: Brooks/Cole.

Online Resources

American Chemical Society, www.chemistry.org

National Science Teachers Association, www.nsta.org

The Associated Chemistry Teachers of Texas, www.statweb.org/ACT2/

00624-55075 • WEBPDF106