



STATE BOARD FOR EDUCATOR CERTIFICATION/TEXAS EDUCATION AGENCY

TEXAS EDUCATOR CERTIFICATION

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## Texas Examinations of Educator Standards™ (TEXES™) Chemistry 8–12 (140)

### Purpose

The purpose of the TEXES™ Chemistry 8–12 test is to measure the requisite knowledge and skills that an entry-level educator in this field in Texas public schools must possess. The test is a requirement for candidates seeking a Chemistry 8–12 certificate.

### Test Characteristics

**Number of items:** 90 multiple-choice questions. Typically, 80 multiple-choice questions are scored and 10 multiple-choice questions are used for pilot-testing purposes and do not contribute to the examinee's score.

**Score Scale:** The Chemistry 8–12 test is scored on a 100-300 scale, with a passing score of 240.

### Test Structure

The Chemistry 8–12 test contains the following domain and test item structure:

Domain No.	Domain Title	Approx. Percentage of Test
I.	Scientific Inquiry and Processes	24%
II.	Matter and Energy	41%
III.	Chemical Reactions	23%
IV.	Science Learning, Instruction and Assessment	12%

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## Test Administration

On each test date, the Chemistry 8–12 test is administered as a full-session test during the afternoon session only. Each session is five hours long.

## Scoring

Results are reported as scaled scores in a range from 100 to 300, with a passing score of 240. The total test score is based on an examinee's performance on the entire test. Domain and competency performance information, which is provided on the examinee's score report, is based on an examinee's performance on each domain and each competency.

Please note:

- Domain and competency performance information presents the number of questions answered correctly out of the total number of scorable questions appearing on the test.
- Domain and competency performance information is included to help assess an examinee's areas of relative strength and need.
- Domain and competency performance information may be based on comparatively few test questions and may be less reliable than total test information.

## Test Framework

The complete test framework for this field, containing the competencies and descriptive statements for each domain, appears on the following pages.

## Score Report Instructions

See *Understanding Your Texas Educator Certification Program Test Scores* on the ETS TExES website at [www.texas.ets.org](http://www.texas.ets.org).

## Preparation Manual

The preparation manual for this field may be viewed or downloaded from Preparation Materials section of the ETS TExES website at [www.texas.ets.org](http://www.texas.ets.org).

# TEST FRAMEWORK FOR FIELD 140: CHEMISTRY 8–12

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## 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:

- A. Uses current sources of information about laboratory safety, including safety regulations and guidelines for the use of science facilities, materials and equipment.
- B. 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.
- C. Employs safe practices in planning and implementing all instructional activities and designs and implements rules and procedures to maintain a safe learning environment.
- D. Understands procedures for selecting, maintaining and safely using chemicals, tools, technologies, materials, specimens and equipment, including procedures for the recycling, reuse and conservation of laboratory resources.
- E. Knows how to use appropriate equipment and technology (e.g., Internet, spreadsheet, calculator) for gathering, organizing, displaying and communicating data in a variety of ways (e.g., charts, tables, graphs, diagrams, written reports, oral presentations).
- F. 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.
- G. Knows how to apply techniques to calibrate measuring devices and understands concepts of precision, accuracy and error with regard to reading and recording numerical data from scientific instruments.
- H. 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:

- A. 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).
- B. Knows the characteristics of various types of scientific investigations (e.g., descriptive studies, controlled experiments, comparative data analysis) and how and why scientists use different types of scientific investigations.
- C. Understands principles and procedures for designing and conducting a variety of scientific investigations, with emphasis on inquiry-based investigations and understands how to communicate and defend scientific results.
- D. Understands how logical reasoning, verifiable observational and experimental evidence and peer review are used in the process of generating and evaluating scientific knowledge.
- E. Understands 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:

- A. 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.
- B. 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.
- C. Knows how to apply and analyze the systems model (e.g., interacting parts, boundaries, input, output, feedback, subsystems) across the science disciplines.
- D. 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.
- E. 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).
- F. 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:

- A. Understands the historical development of science, key events in the history of science and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge.
- B. Knows how to use examples from the history of science to demonstrate the changing nature of scientific theories and knowledge (i.e., that scientific theories and knowledge are always subject to revision in light of new evidence).
- C. Knows that science is a human endeavor influenced by societal, cultural and personal views of the world and 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.
- D. Understands the application of scientific ethics to the conducting, analyzing and publishing of scientific investigations.
- E. 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.
- F. 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:

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

### **Competency 006**

**The teacher understands the structure and characteristics of atoms.**

The beginning teacher:

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

**Competency 007****The teacher understands the properties of gases.**

The beginning teacher:

- A. Understands interrelationships among temperature, moles, pressure and volume of gases contained within a closed system.
- B. Analyzes data obtained from investigations with gases in a closed system and determines whether the data are consistent with the ideal gas law.
- C. 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.
- D. Applies Dalton's law of partial pressure in various systems, as in collecting a gas over water.
- E. Understands the relationship between Kinetic Molecular Theory and the ideal gas law.
- F. 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:

- A. Relates the electron configuration of an atom to its chemical reactivity.
- B. Compares and contrasts characteristics of ionic and covalent bonds.
- C. Applies the "octet" rule to construct Lewis structures.
- D. Identifies and describes the arrangement of atoms in molecules, ionic crystals, polymers and metallic substances.
- E. Understands the influence of bonding forces on the physical and chemical properties of ionic and covalent substances.
- F. Identifies and describes intermolecular and intramolecular forces.
- G. Uses intermolecular forces to explain the physical properties of a given substance.
- H. Applies the concepts of electronegativity, electron affinity, and oxidation state to analyze chemical bonds.
- I. Evaluates energy changes in the formation and dissociation of chemical bonds.
- J. 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:

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

**Competency 010**

**The teacher understands types and properties of solutions.**

The beginning teacher:

- A. Analyzes factors that affect solubility (e.g., temperature, pressure, polarity of solvents and solutes).
- B. Identifies characteristics of saturated, unsaturated and supersaturated solutions.
- C. Determines the molarity, molality and percent composition of aqueous solutions.
- D. Analyzes precipitation reactions and derives net ionic equations.
- E. Analyzes the colligative properties of solutions (e.g., vapor-pressure lowering, osmotic pressure changes, boiling-point elevation, freezing-point depression).
- F. Understands the properties of electrolytes and explains the relationship between concentration and electrical conductivity.
- G. 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:

- A. Analyzes the energy transformations that occur in phase transitions.
- B. Solves problems in calorimetry (e.g., determining the specific heat of a substance, finding the standard enthalpy of formation and reaction of substances).
- C. Applies the law of conservation of energy to analyze and evaluate energy exchanges that occur in exothermic and endothermic processes.
- D. 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:

- A. Analyzes factors (e.g., temperature, pressure, concentration, catalysts) that influence the rate of a chemical reaction.
- B. Solves problems involving rate laws and determines the rate law of a reaction from experimental data.
- C. Understands principles of chemical equilibrium.
- D. Solves problems involving principles of chemical equilibrium.
- E. 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:

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

### Competency 014

**The teacher understands oxidation and reduction reactions.**

The beginning teacher:

- A. Determines the oxidation state of ions and atoms in compounds.
- B. Identifies and balances oxidation and reduction reactions.
- C. Uses reduction potentials to determine whether a redox reaction will occur spontaneously.
- D. Explains the operating principles of electrochemical cells and the process of electroplating metals.
- E. 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:

- A. Uses models to explain radioactivity and types of radioactive decay (i.e., alpha, beta, gamma).
- B. Interprets and balances equations for nuclear reactions.
- C. Compares and contrasts fission and fusion reactions.
- D. Knows how to use the half-life of radioactive elements to study real-world problems (e.g., carbon dating, radioactive tracers).
- E. 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:

- A. Knows research-based theories about how students develop scientific understanding and how developmental characteristics, prior knowledge, experience and attitudes of students influence science learning.
- B. Understands the importance of respecting student diversity by planning activities that are inclusive 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.
- C. Knows how to plan and implement strategies to encourage student self motivation and engagement in their own learning (e.g., linking inquiry-based investigations to students' prior knowledge, focusing inquiry-based instruction on issues relevant to students, developing instructional materials using situations from students' daily lives, fostering collaboration among students).
- D. Knows how to use a variety of instructional strategies to ensure all students comprehend content-related texts, including how to locate, retrieve and retain information from a range of texts and technologies.
- E. Understands the science teacher's role in developing the total school program by planning and implementing science instruction that incorporates school wide objectives and the statewide curriculum as defined in the Texas Essential Knowledge and Skills (TEKS).
- F. Knows how to design and manage the learning environment (e.g., individual, small-group, whole-class settings) to focus and support student inquiries and to provide the time, space, and resources for all students to participate in field, laboratory, experimental and nonexperimental scientific investigation.

- G. Understands the rationale for using active learning and inquiry methods in science instruction and understands how to model scientific attitudes such as curiosity, openness to new ideas and skepticism.
- H. Knows principles and procedures for designing and conducting an inquiry based scientific investigation (e.g., making observations; generating questions; researching and reviewing current knowledge in light of existing evidence; choosing tools to gather and analyze evidence; proposing answers, explanations and predictions; communicating and defending results).
- I. Knows how to assist students with generating, refining, focusing and testing scientific questions and hypotheses.
- J. Knows strategies for assisting students in learning to identify, refine and focus scientific ideas and questions guiding an inquiry-based scientific investigation; to develop, analyze and evaluate different explanations for a given scientific result; and to identify potential sources of error in an inquiry-based scientific investigation.
- K. Understands how to implement inquiry strategies designed to promote the use of higher-level thinking skills, logical reasoning and scientific problem solving in order to move students from concrete to more abstract understanding.
- L. Knows how to guide students in making systematic observations and measurements.
- M. Knows how to 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:

- A. 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.
- B. Connects assessment to instruction in the science curriculum (e.g., designing assessments to match learning objectives, using assessment results to inform instructional practice).
- C. Knows the importance of monitoring and assessing students' understanding of science concepts and skills on an ongoing basis by using a variety of appropriate assessment methods (e.g., performance assessment, self-assessment, peer assessment, formal/informal assessment).
- D. Understands the purposes 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.
- E. Understands strategies for assessing students' prior knowledge and misconceptions about science and how to use these assessments to develop effective ways to address these misconceptions.
- F. Understands characteristics of assessments, such as reliability, validity and the absence of bias in order to evaluate assessment instruments and their results.

- G. Understands the role of assessment as a learning experience for students and strategies for engaging students in meaningful self-assessment and peer assessment.
- H. Recognizes the importance of selecting assessment instruments and methods that provide all students with adequate opportunities to demonstrate their achievements.
- I. Recognizes the importance of clarifying teacher expectations and student achievement by sharing evaluation criteria and assessment results with students and other appropriate educational stakeholders.