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

TExES | Texas Examinations of Educator Standards

Preparation Manual

137 Physical Science 8–12

This publication has been produced for Texas Education Agency (TEA) by ETS. ETS is under contract to Texas Education Agency to administer the Texas Examinations of Educator Standards (TExES) program and the Examination for the Certification of Educators in Texas (ExCET) program. The TExES and ExCET programs are administered under the authority of Texas Education Agency; regulations and standards governing the program are subject to change at the discretion of Texas Education Agency. Texas Education Agency and ETS do not discriminate on the basis of race, color, national origin, sex, religion, age or disability in the administration of the testing program or the provision of related services.

Chapter 1

Introduction to the Physical Science 8–12 Test and Suggestions for Using This Test Preparation Manual

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

1

OVERVIEW

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

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

KEY FEATURES OF THE MANUAL

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

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

USING THE TEST FRAMEWORK

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

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

ORGANIZATION OF THE TExES TEST FRAMEWORK

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

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

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

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

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

SAMPLE COMPETENCY

Physical Science 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 ORGANISMS, NATURAL RESOURCES, MATERIALS, EQUIPMENT AND TECHNOLOGIES.

1

SAMPLE DESCRIPTIVE STATEMENTS

The beginning teacher:

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

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

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

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

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

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

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

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

STUDYING FOR THE TExES TEST

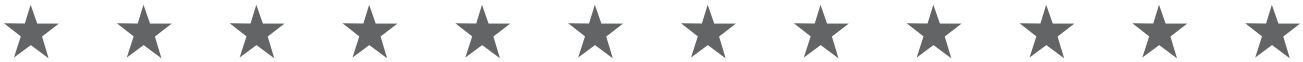
The following steps may be helpful in preparing for the TExES test.

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

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

Chapter 2

Background Information on the TExES Testing Program



THE TExES TESTS FOR TEXAS TEACHERS

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

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

DEVELOPMENT OF THE NEW TExES TESTS

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

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

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

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

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

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

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

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

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

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

TAKING THE TExES TEST AND RECEIVING SCORES

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

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

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

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

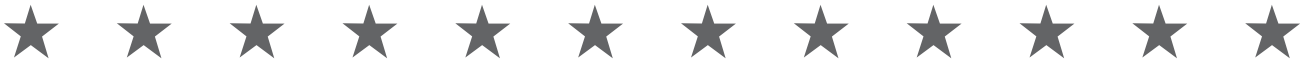
For more information about scores or to access scores online, go to **www.texes.ets.org**.

EDUCATOR STANDARDS

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

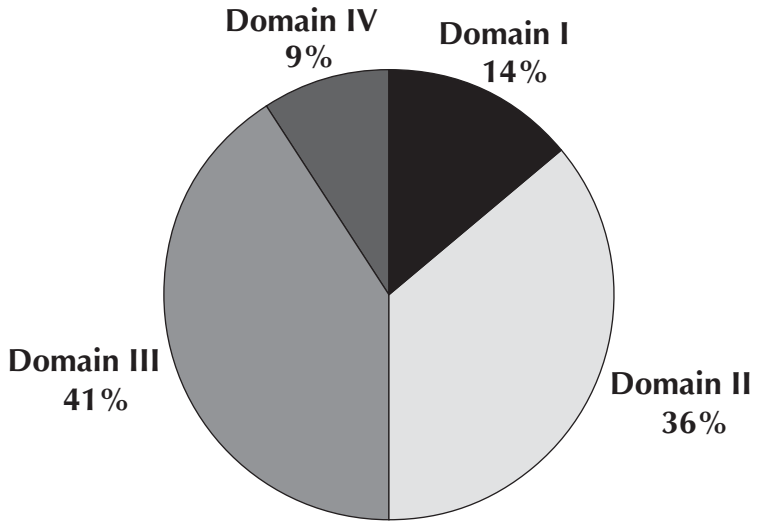
Chapter 3

Study Topics



TEST FRAMEWORK FOR FIELD 137: PHYSICAL SCIENCE 8–12

THE DOMAINS



- **Domain I: Scientific Inquiry and Processes**
  Standards Assessed: Physical Science I–III, VI–VII, XI
- **Domain II: Physics**
  Standard Assessed: Physical Science VIII
- **Domain III: Chemistry**
  Standard Assessed: Physical Science VIII
- **Domain IV: Science Learning, Instruction and Assessment**
  Standards Assessed: Physical Science IV–V

TOTAL TEST BREAKDOWN

- Exam is offered as a paper-based or computer-administered test
- 90 Multiple-Choice Questions (80 Scored Questions*)

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

THE STANDARDS

DOMAIN I — SCIENTIFIC INQUIRY AND PROCESSES (approximately 14% of the test)

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

PHYSICAL SCIENCE STANDARD II:
The science teacher understands the correct use of tools, materials, equipment and technologies.

PHYSICAL SCIENCE STANDARD III:
The science teacher understands the process of scientific inquiry and its role in science instruction.

PHYSICAL SCIENCE STANDARD VI:
The science teacher understands the history and nature of science.

PHYSICAL SCIENCE STANDARD VII:
The science teacher understands how science affects the daily lives of students and how science interacts with and influences personal and societal decisions.

PHYSICAL SCIENCE STANDARD XI:
The science teacher knows unifying concepts and processes that are common to all sciences.

DOMAIN II — PHYSICS (approximately 36% of the test)

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

DOMAIN III — CHEMISTRY (approximately 41% of the test)

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

DOMAIN IV — SCIENCE LEARNING, INSTRUCTION AND ASSESSMENT (approximately 9% of the test)

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

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

COMPETENCIES

DOMAIN I — 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 ORGANISMS, NATURAL RESOURCES, MATERIALS, EQUIPMENT AND TECHNOLOGIES.

The beginning teacher:

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

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

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

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

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

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

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

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

COMPETENCY 002

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

The beginning teacher:

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

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

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

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

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

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

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

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

I. Understands the difference between a theory and a hypothesis, how models are used to represent the natural world and how to evaluate the strengths and limitations of a variety of scientific models (e.g., physical, conceptual, mathematical).

COMPETENCY 003

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

The beginning teacher:

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

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

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

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

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

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

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

DOMAIN II — PHYSICS

COMPETENCY 004
THE TEACHER UNDERSTANDS THE DESCRIPTION OF MOTION IN ONE AND TWO DIMENSIONS.

The beginning teacher:

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

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

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

D. Analyzes and solves problems involving projectile motion.

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

F. Understands motion of fluids.

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

COMPETENCY 005
THE TEACHER UNDERSTANDS THE LAWS OF MOTION.

The beginning teacher:

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

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

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

COMPETENCY 006

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

The beginning teacher:

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

B. Calculates electrostatic forces, fields and potentials.

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

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

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

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

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

COMPETENCY 007

THE TEACHER UNDERSTANDS APPLICATIONS OF ELECTRICITY AND MAGNETISM.

The beginning teacher:

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

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

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

D. Identifies basic components and characteristics of AC circuits.

E. Understands the operation of an electromagnet.

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

COMPETENCY 008

THE TEACHER UNDERSTANDS THE CONSERVATION OF ENERGY AND MOMENTUM.

The beginning teacher:

A. Understands the concept of work.

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

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

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

E. Understands linear and angular momentum.

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

COMPETENCY 009

THE TEACHER UNDERSTANDS THE LAWS OF THERMODYNAMICS.

The beginning teacher:

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

B. Understands the molecular interpretation of temperature and heat.

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

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

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

COMPETENCY 010

THE TEACHER UNDERSTANDS THE CHARACTERISTICS AND BEHAVIOR OF WAVES.

The beginning teacher:

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

B. Compares and contrasts transverse and longitudinal waves.

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

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

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

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

COMPETENCY 011

THE TEACHER UNDERSTANDS THE FUNDAMENTAL CONCEPTS OF QUANTUM PHYSICS.

The beginning teacher:

A. Interprets wave-particle duality.

B. Identifies examples and consequences of the Uncertainty Principle.

C. Understands the photoelectric effect.

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

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

DOMAIN III — CHEMISTRY

COMPETENCY 012

THE TEACHER UNDERSTANDS THE CHARACTERISTICS OF MATTER AND ATOMIC STRUCTURE.

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. Models the atom in terms of protons, neutrons and electron clouds.

E. Identifies elements and isotopes by atomic number and mass number and calculates average atomic mass of an element.

F. Understands atomic orbitals and electron configurations and describes the relationship between electron energy levels and atomic structure.

G. Understands the nature and historical significance of the periodic table.

H. Applies the concept of periodicity to predict the physical (e.g., atomic and ionic radii) and chemical properties (e.g., electronegativity, ionization energy) of an element.

COMPETENCY 013

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) to describe and calculate gas properties in a variety of situations.

D. Applies Dalton's law of partial pressure in various situations (e.g., 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 014

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 (e.g., melting point, crystal structure).

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 chemical bonding and molecular geometry.

COMPETENCY 015

THE TEACHER UNDERSTANDS AND INTERPRETS CHEMICAL EQUATIONS AND CHEMICAL REACTIONS.

The beginning teacher:

A. Identifies elements, common 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 mass and charge.

E. Understands mass relationships in chemical equations and solves problems using calculations involving moles, limiting reagents and reaction yield.

F. Identifies factors (e.g., temperature, pressure, concentration, catalysts) that influence the rate of a chemical reaction and describes their effects.

G. Understands principles of chemical equilibrium and solves problems involving equilibrium constants.

H. 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 016

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) and rate of dissolution (e.g., surface area, agitation).

B. Identifies characteristics of saturated, unsaturated and supersaturated solutions.

C. Determines the molarity, molality, normality and percent composition of aqueous solutions.

D. Analyzes precipitation reactions and derives net ionic equations.

E. Understands 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. Understands methods for measuring and comparing the rates of reaction in solutions of varying concentration.

H. 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 017

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 reactions.

D. Understands thermodynamic relationships among spontaneous reactions, entropy, enthalpy, temperature and Gibbs free energy.

COMPETENCY 018

THE TEACHER UNDERSTANDS NUCLEAR FISSION, NUCLEAR FUSION AND NUCLEAR REACTIONS.

The beginning teacher:

A. Uses models to explain radioactivity and radioactive decay (i.e., alpha, beta, gamma).

B. Interprets and balances equations for nuclear reactions.

C. Compares and contrasts fission and fusion reactions (e.g., relative energy released in the reactions, mass distribution of products).

D. Knows how to use the half-life of radioactive elements to solve real-world problems (e.g., carbon dating, radioactive tracers).

E. Understands stable and unstable isotopes.

F. Knows various issues associated with using nuclear energy (e.g., medical, commercial, environmental).

COMPETENCY 019

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 operation and applications of electrochemical cells.

E. Analyzes applications of oxidation and reduction reactions from everyday life (e.g., combustion, rusting, electroplating, batteries).

COMPETENCY 020

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 hydronium 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 (e.g., acid precipitation, physiological buffering).

DOMAIN IV — SCIENCE LEARNING, INSTRUCTION AND ASSESSMENT

COMPETENCY 021

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

The beginning teacher:

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

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

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

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

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

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

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

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

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

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

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

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

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

COMPETENCY 022

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

The beginning teacher:

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

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

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

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

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

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

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

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

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

Chapter 4

Succeeding on Multiple-Choice Questions

APPROACHES TO ANSWERING MULTIPLE-CHOICE QUESTIONS

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

The Physical Science 8–12 test is designed to include a total of 90 multiple-choice questions, out of which 80 are scored. The number of scored questions will not vary; however, the number of questions that are not scored may vary in the actual test. Your final scaled score will be based only on scored questions. The questions that are not scored are being pilot tested in order to collect information about how these questions will perform under actual testing conditions. These questions are not identified on the test.

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

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

Calculators. Scientific calculators will be provided at the test center. See the TExES *Registration Bulletin* for the brand and model of the calculator that will be available.

Periodic Table of the Elements. A Periodic Table of the Elements will be provided as part of the test for use on science questions. A copy of this periodic table is provided in Chapter 5.

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

QUESTION FORMATS

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

— Single Questions
— Questions with Stimulus Material
— Clustered Questions

On the following pages, you will find descriptions of these commonly used question formats, along with suggested approaches for responding to each type of question. In the actual testing situation, if you are taking the paper-based version of the test, you may mark the test questions and/or write in the margins of your test booklet. **Your final response must be indicated on the answer sheet provided.** If you are taking the test via computer, you may write on the scratch paper provided at the testing center. **Your final response must be selected on the computer.**

SINGLE QUESTIONS

In the single-question format, a problem is presented as a direct question or an incomplete statement, and four answer options appear below the question. The following question is an example of this type. It tests knowledge of Physical Science 8–12 Competency 017: *The teacher understands energy transformations that occur in physical and chemical processes*.

EXAMPLE

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

A. 94 K

B. 94ºC

C. 11 K

D. 11ºC

SUGGESTED APPROACH

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

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, $\Delta G = 0$.

Since $\Delta G = 0$, 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 $T = \frac{13{,}600\,\text{J}}{145\,\text{J/K}} = 93.8\,\text{K}$. **This answer is closest to response option A.**

Option B comes 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 comes from both incorrectly solving the equation and using the incorrect temperature scale.

QUESTIONS WITH STIMULUS MATERIAL

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

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

Strategy 1 Skim the stimulus material to understand its purpose, its arrangement and/or its content. Then read the question and refer again to the stimulus material to verify the correct answer.

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

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

Whether you read the stimulus before or after you read the question, you should read it carefully and critically. If you are taking the paper-based version of the test, you may want to underline its important parts to help you answer the question.

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

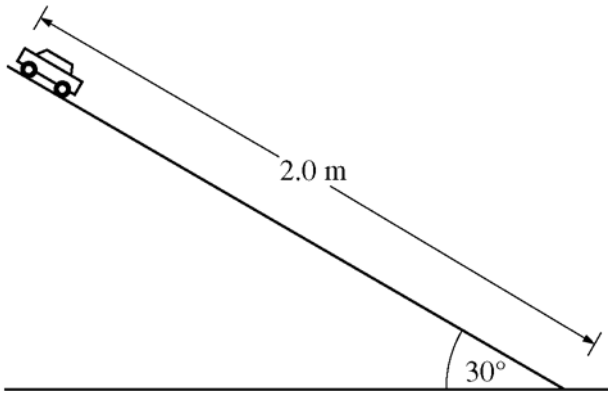
EXAMPLE 1

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

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

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

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



Now you are prepared to address the first of the two questions associated with this stimulus. The first question measures Physical Science 8–12 Competency 005: *The teacher understands the laws of motion.*

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

   A. 0.10 N

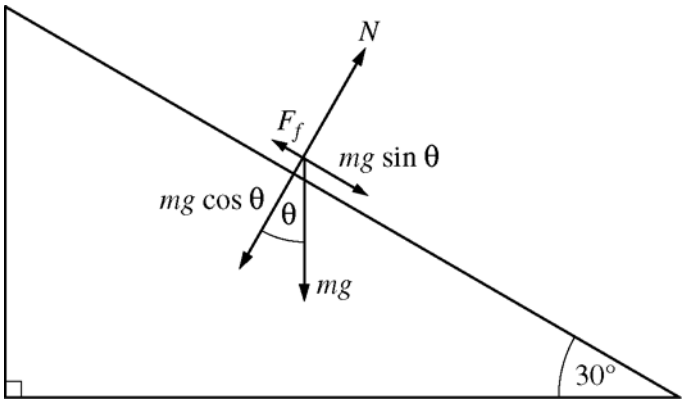
   B. 0.49 N

   C. 0.85 N

   D. 0.98 N

SUGGESTED APPROACH

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



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

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

Now you are ready to answer the next question. The second question also measures Physical Science 8–12 Competency 005: *The teacher understands the laws of motion.*

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

   A. 0.21 N

   B. 0.28 N

   C. 0.56 N

   D. 0.98 N

SUGGESTED APPROACH

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

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

CLUSTERED QUESTIONS

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

Chapter 5

Multiple-Choice Practice Questions

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

SAMPLE MULTIPLE-CHOICE QUESTIONS

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

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

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

PERIODIC TABLE OF THE ELEMENTS

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.179
11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.938	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.91	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.02	89 **†Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (271)	111 **Rg** (272)	112 **§** (277)						

§Not yet named

*Lanthanide Series	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
†Actinide Series	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	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)

Definitions and Physical Constants for Physical Science 8–12

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

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

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

Avogadro's number is 6.022×10^{23}.

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

END OF DEFINITIONS AND PHYSICAL CONSTANTS

COMPETENCY 001

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

	Gun A	Gun B
Mean Distance	141.3 cm	138.5 cm
Standard Deviation	2.4 cm	3.1 cm

The table gives data on the horizontal distance traveled by a ball fired from two different spring guns under identical conditions. Which of the following statements best describes the data?

A. The data collected for Gun A are more precise than the data collected for Gun B

B. The data collected for Gun A are more accurate than the data collected for Gun B

C. The data collected for Gun A show a greater random error than the data collected for Gun B

D. The data collected for Gun A show a greater amount of experimental design error than the data collected for Gun B

COMPETENCY 002

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

In an experiment designed to test the effects of solutes on temperature, students label four beakers A, B, C and D and add 50 mL of distilled water at room temperature to each. They then add 5 g of table sugar to beaker B, 10 g to beaker C and 15 g to beaker D. No sugar is added to beaker A. The students measure the temperature of the contents of each beaker. After heating each beaker for the same amount of time on a hot plate at the same setting, the students measure the temperature again. The change in temperature is recorded.

Beaker A is included in this investigation for which of the following reasons?

A. To determine the expected average temperature of beakers B, C and D to compare to the average of the actual observed results

B. As a trial run to confirm the proper functioning of the apparatus and calibration of the thermometer

C. To be certain that the specified amount of heating time will not be enough to bring the water to the boiling point

D. As a control to establish the standard against which to compare the temperature changes in the other beakers

COMPETENCY 002

3. **Use the description of an experiment below to answer the question that follows.**

   Tape a pencil to the edge of a table so that half of the pencil is hanging over the edge. Hang a rubber band on the pencil and attach a paper clip to the bottom of the rubber band. Measure the initial length of the rubber band. Attach a washer to the paper clip and measure the length of the band. Repeat with 2, 3, 4 and 5 identical washers. Graph your results.

   Which of the following is the independent variable in the experiment above?

   A. The initial length of the rubber band

   B. The length of the rubber band after each washer is added

   C. The number of washers attached to the paper clip

   D. The mass of a single washer

COMPETENCY 003

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

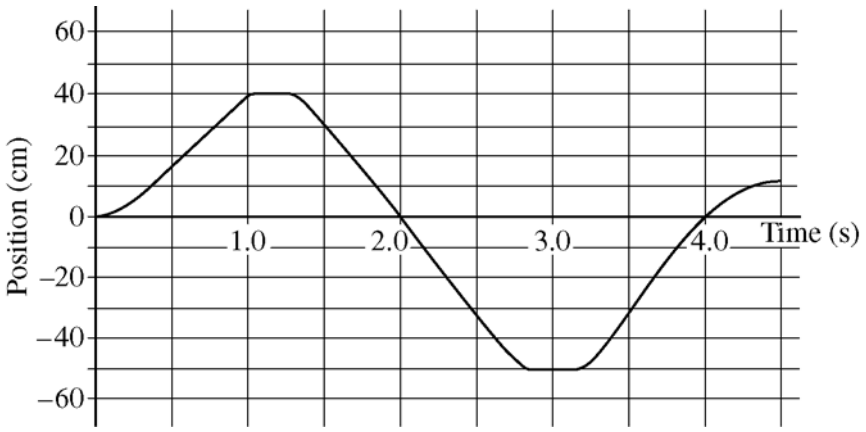
   A. It demonstrates how the direction of scientific research is influenced by cultural biases

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

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

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

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



The graph shows the position of an object traveling in a straight line with respect to time.

COMPETENCY 004

5. What is the velocity of the object at $t = 2.5$ s?

   A. –7.5 cm/s

   B. –25 cm/s

   C. –45 cm/s

   D. –60 cm/s

COMPETENCY 004

6. Which of the following describes the motion of the particle at $t = 4$ s?

   A. The particle is stationary

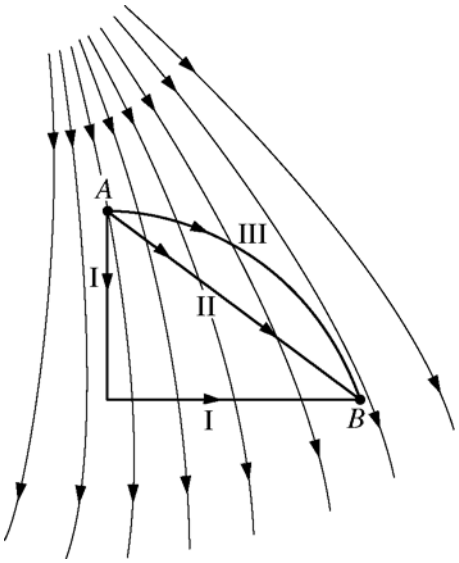
   B. The particle is decelerating

   C. The particle is traveling to the right at a constant speed

   D. The particle is moving backward

COMPETENCY 006

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



The diagram shows the lines of force for an electric field, and three different paths linking points *A* and *B*. The work required to move a positive charge from point *A* to point *B* is evaluated over the three different paths. Which of the following statements about the work required to move the charge from *A* to *B* is true?

A. The amount of work will be the same for all of the paths

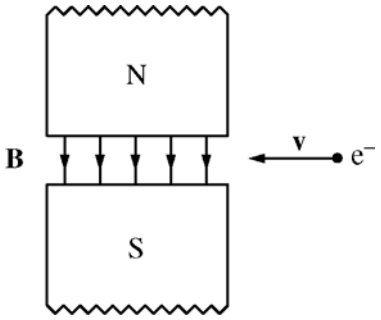
B. The amount of work will be equal to zero for path I

C. The amount of work will be greater for path II than for path III

D. The amount of work will be greater for path III than for path II

COMPETENCY 006

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



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

A. Into the page

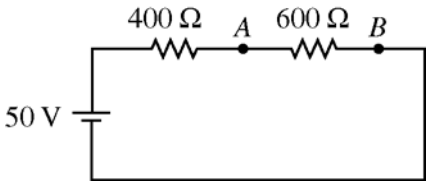
B. Out of the page

C. Toward the north pole of the magnet

D. Toward the south pole of the magnet

COMPETENCY 007

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



What is the potential difference across *AB*?

A. 20 V

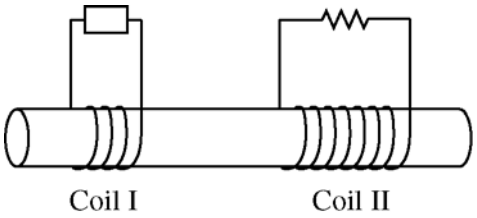
B. 30 V

C. 33 V

D. 50 V

COMPETENCY 007

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



Two coils of wire are wrapped around an iron bar. A current from an external power source flows through Coil I. Coil II is attached to a resistor. Which of the following statements must be true for this apparatus to function as a transformer?

A. The capacitance of Coil II must be negligible

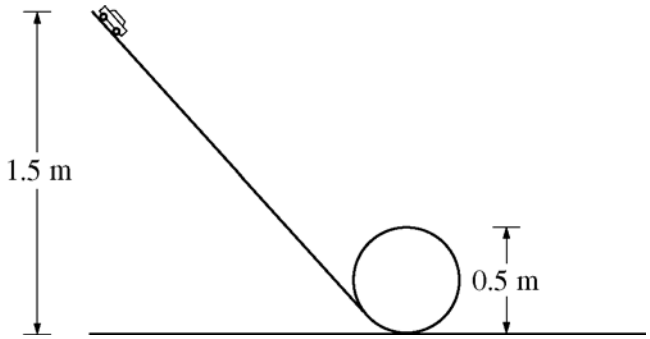
B. The iron core must be a permanent magnet

C. The number of turns in Coil II must be greater than the number in Coil I

D. The current through Coil I must vary with time

COMPETENCY 008

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



A toy car is released from rest at the top of the track shown above. The car goes down the slope and through the loop-de-loop. If friction is neglected, what is the speed of the car at the top of the loop?

A. 4.4 m/s

B. 4.9 m/s

C. 14.7 m/s

D. 19.6 m/s

COMPETENCY 009

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

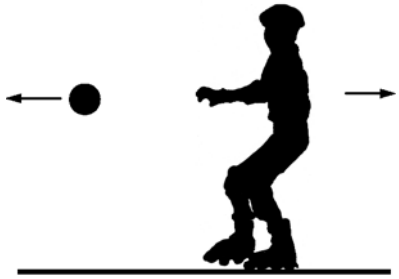
A. The heat capacity of the gas increases

B. The average momentum of the gas molecules increases

C. The entropy of the gas increases

D. The average kinetic energy of the gas molecules increases

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



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

COMPETENCY 008

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

    A. 0.02 m/s

    B. 0.10 m/s

    C. 2.50 m/s

    D. 12.00 m/s

COMPETENCY 021

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

    A. Automobile

    B. Submarine

    C. Helicopter

    D. Rocket

COMPETENCY 010

15. Which of the following waves always transmit momentum to the particles of the wave medium at right angles to the direction of wave propagation?

A. Longitudinal waves

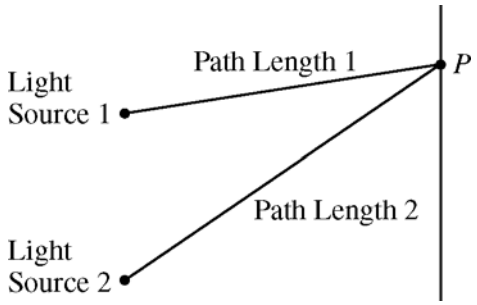
B. Transverse waves

C. Standing waves

D. Matter waves

COMPETENCY 010

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



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

A. 0

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

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

D. λ

COMPETENCY 011

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

A. $20hf$

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

C. $500hf$

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

COMPETENCY 011

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

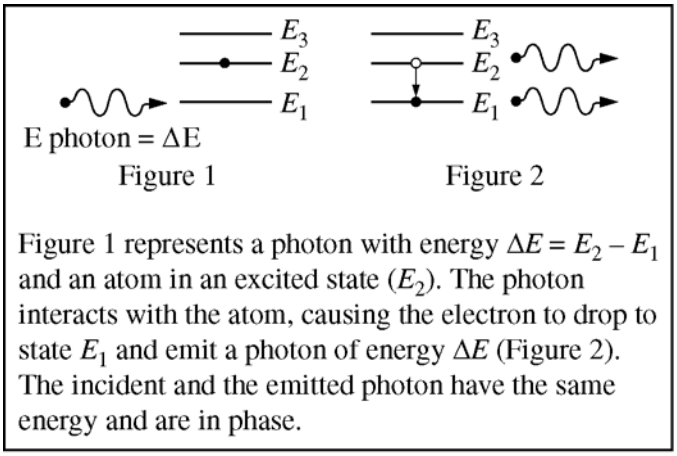


Figure 1 represents a photon with energy $\Delta E = E_2 - E_1$ and an atom in an excited state (E_2). The photon interacts with the atom, causing the electron to drop to state E_1 and emit a photon of energy ΔE (Figure 2). The incident and the emitted photon have the same energy and are in phase.

The passage above describes the operation of which of the following?

A. Laser

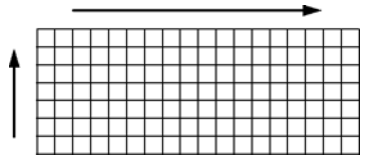
B. Photodetector

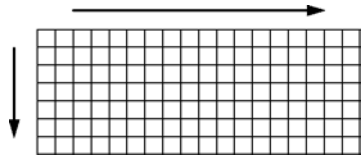
C. Superconductor

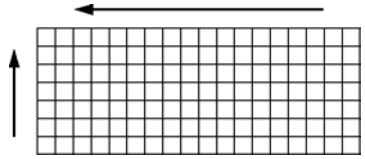
D. Spectrograph

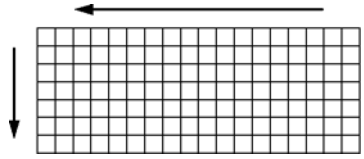
COMPETENCY 012

19. Which of the following diagrams shows the general trend of increasing atomic radius in the periodic table?

A. 

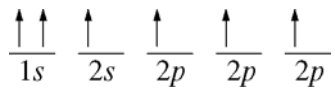
C. 

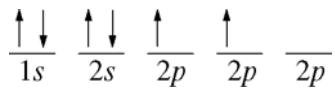
B. 

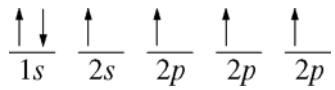
D. 

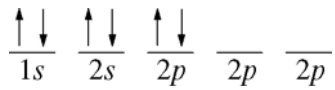
COMPETENCY 012

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

A. 

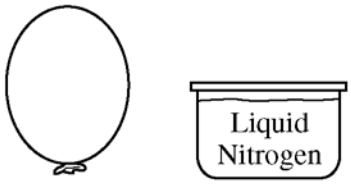
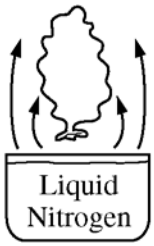
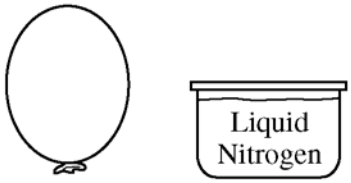
C. 

B. 

D. 

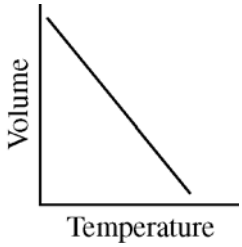
COMPETENCY 013

21. **Use the demonstration below to answer the question that follows.**

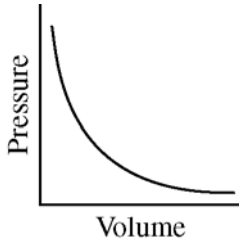
Step 1	A balloon is inflated at room temperature.	
Step 2	The balloon is cooled by placing it over liquid nitrogen.	
Step 3	The balloon is moved away from the liquid nitrogen and allowed to return to room temperature.	

Which of the following graphs best shows the behavior of the gas in the balloon in this demonstration?

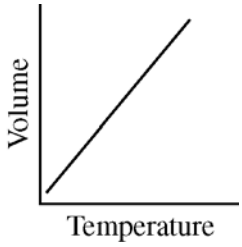
A.



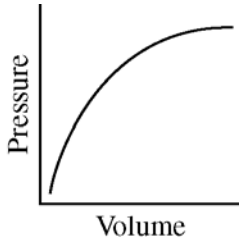
C.



B.



D.



COMPETENCY 013

22. A gas-filled balloon with a volume of 3.00 L at 300.0 K and 1.00 atm rises into the stratosphere where the pressure is 3.00×10^{-3} atm and the temperature is 250.0 K. What is the volume of the balloon?

    A. 250 L

    B. 750 L

    C. 833 L

    D. 1200 L

COMPETENCY 014

23. **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 average amount of energy required to break a particular bond. Which of the following equations correctly calculates the energy change, in kJ/mol, for a reaction with the formula $A_2 + B_2 \rightarrow 2\,AB$?

A. 336 + 363 + 358 = 1057

B. 336 + 363 – 358 = 341

C. 336 + 363 – 2(358) = –17

D. 2(336) – 2(363) – 2(358) = –770

COMPETENCY 014

24. Which of the following is the molecular geometry of the NH_3 molecule?

    A. Tetrahedral

    B. Trigonal pyramidal

    C. Trigonal planar

    D. Octahedral

COMPETENCY 015

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

    A. Tricalcium phosphate

    B. Calcium diphosphate

    C. Tricalcium bis(phosphate)

    D. Tricalcium diphosphate

COMPETENCY 015

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

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.

COMPETENCY 016

27. 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

COMPETENCY 016

28. Which of the following is the net ionic equation that represents the reaction occurring between the silver nitrate and the dissolved table salt in the solution?

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

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

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

    D. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

COMPETENCY 001

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

    A. Titration

    B. Chromatography

    C. Calorimetry

    D. Electrolysis

COMPETENCY 018

30. 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 018

31. Which of the following characteristics of nuclear fission makes a chain reaction possible?

A. The nuclear disintegration series of uranium-235

B. The large amount of energy released

C. The release of neutrons as fission products

D. The creation of strontium-90 and xenon-143 radioisotopes

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 reaction represented below.

$$2\,Al(s) + 3\,Ag_2S(aq) + 6\,H_2O(l) \rightarrow 6\,Ag(s) + 2\,Al(OH)_3(aq) + 3\,H_2S(g)$$

COMPETENCY 019

32. Which of the following is the change in the oxidation state of Ag in the reaction?

A. $0 \rightarrow +1$

B. $0 \rightarrow +6$

C. $+1 \rightarrow 0$

D. $+1 \rightarrow +6$

COMPETENCY 019

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

A. A1

B. H_2O

C. S^{2-}

D. OH^-

COMPETENCY 020

34. The pH of several solutions with the same molar concentration is measured and recorded in the table below.

Solution	pH
I	2.3
II	4.5
III	9.8
IV	11.6

Which solution is the most basic?

A. Solution I

B. Solution II

C. Solution III

D. Solution IV

COMPETENCY 020

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

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

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.

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 022

36. 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 022

37. 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?

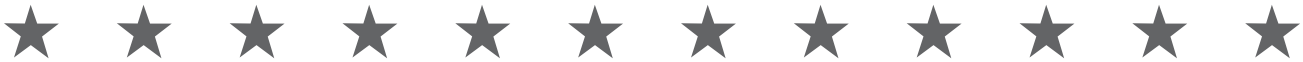
    D. Is the conclusion in agreement with those of the other teams in the class?

ANSWER KEY

Question Number	Correct Answer	Competency
1	A	001
2	D	002
3	C	002
4	D	003
5	D	004
6	B	004
7	A	006
8	A	006
9	B	007
10	D	007
11	A	008
12	C	009
13	B	008
14	D	021
15	B	010
16	C	010
17	D	011
18	A	011
19	D	012
20	C	012
21	B	013
22	C	013
23	C	014
24	B	014
25	C	015
26	C	015
27	D	016
28	D	016
29	A	001
30	C	018
31	C	018
32	C	019
33	A	019
34	D	020
35	D	020
36	A	022
37	B	022

Chapter 6

Are You Ready? – Last-Minute Tips



PREPARING TO TAKE THE TEST

CHECKLIST

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

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

THE DAY OF THE TEST

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

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

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

Appendix A

Study Plan Sheet

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

Appendix B

Preparation Resources

PREPARATION RESOURCES

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

JOURNALS

American Scientist, Sigma XI, the Scientific Research Society.

ChemMatters, American Chemical Society.

Nature, The Nature Publishing Group.

Texas Science Teacher, Science Teachers Association of Texas.

The Physics Teacher, American Association of Physics Teachers.

The Science Teacher, National Science Teachers Association.

OTHER RESOURCES

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

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

Chang, R. (2010). *Chemistry*, Tenth Edition. McGraw-Hill.

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

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

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

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

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

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

Herron, J. D., and Eubanks, I. D. (1995). *The Chemistry Classroom: Formulas for Successful Teaching*. Washington, District of Columbia. American Chemical Society.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Whitten, K. W., Davis, R. E., Peck, L., and Stanley, G. G. (2006). *General Chemistry*, Eighth Edition. Brooks Cole.

Zumdahl, S. S., and Zumdahl, S. A. (2007). *Chemistry*, Seventh Edition. Houghton Mifflin.

ONLINE RESOURCES

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

American Association of Physics Teachers — www.aapt.org

American Chemical Society — www.acs.org

American Physical Society — www.aps.org

National Science Teachers Association — www.nsta.org

86632-86632 • S211E.1 • Printed in U.S.A.
760290