TEA Texas Education Agency

TEXAS EDUCATOR CERTIFICATION

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Texas Examinations of Educator Standards™ (TExES™) Program

Preparation Manual

Chemistry 7–12 (240)

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About The Test

Test Name	Chemistry 7–12
Test Code	240
Time	5 hours
Number of Questions	100 multiple-choice questions
Format	Computer-administered test (CAT)

The TExES Chemistry 7–12 (240) test is designed to assess whether a test taker has the requisite knowledge and skills that an entry-level educator in this field in Texas public schools must possess. The 100 multiple-choice questions are based on the Chemistry 7–12 test framework. Questions on this test range from grades 7–12. The test may contain questions that do not count toward the score. Your final scaled score will be based only on scored questions.

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The Domains

Domain	Domain Title	Approx. Percentage of Test	Standards Assessed
I.	Scientific Inquiry and Processes	24%	Physical Science 7–12 I–III, VI–VII, XI
II.	Matter and Energy	41%	Physical Science 7–12 VIII
III.	Chemical Reactions	23%	Physical Science 7–12 VIII
IV.	Science Learning, Instruction and Assessment	12%	Physical Science 7–12 IV–V

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The Standards

Physical Science 7–12 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 7–12 Standard II
The science teacher understands the correct use of tools, materials, equipment and technologies.

Physical Science 7–12 Standard III
The science teacher understands the process of scientific inquiry and its role in science instruction.

Physical Science 7–12 Standard IV
The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.

Physical Science 7–12 Standard V
The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.

Physical Science 7–12 Standard VI
The science teacher understands the history and nature of science.

Physical Science 7–12 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 7–12 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.

Physical Science 7–12 Standard XI
The science teacher knows unifying concepts and processes that are common to all sciences.

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Domains and Competencies

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:

- 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.
- The **descriptive statements**, which describe in greater detail the knowledge and skills eligible for testing.

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; how to perform calculations and how to apply appropriate methods of statistical measures and analysis.

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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 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; understands how to communicate and defend scientific results; and understands the difference between a theory and a hypothesis.

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 relationships, similarities and differences between science and technology.

Competency 003: *The teacher understands the role of mathematics and 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.

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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 in 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., recycling, population growth, disease prevention, resource use, evaluating product claims).

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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 and calculates average atomic mass of an element.

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 properties (e.g., atomic and ionic radii) and chemical properties (e.g., electronegativity, ionization energy) 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 relationships among temperature, number of 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 describe and calculate gas behavior in a variety of systems.

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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 (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 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.

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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) and rate of dissolution (e.g., surface area, agitation).
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 by 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 (e.g., acid precipitation, physiological buffering).

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 (possible career paths) and experiences of all students, including English-language learners and students with special needs.

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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; learning to develop, analyze and evaluate different explanations for a given scientific result; and learning 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.

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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 those assessments to develop effective ways to address the 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.

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Approaches to Answering Multiple-Choice Questions

The purpose of this section is to describe multiple-choice question formats that you will typically see on the Chemistry 7–12 test and to suggest possible ways to approach thinking about and answering them. These approaches are intended to supplement and complement familiar test-taking strategies with which you may already be comfortable and that work for you. Fundamentally, the most important component in assuring your success on the test is knowing the content described in the test framework. This content has been carefully selected to align with the knowledge required to begin a career as a Chemistry 7–12 teacher.

The 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 with 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. Leave no questions unanswered. Questions for which you mark no answer are counted as incorrect. Your score will be determined by the number of questions for which you select the correct answer.

NOTE: The Definitions and Physical Constants, Periodic Table of the Elements and scientific calculator are provided on-screen for this exam. Copies of the reference materials can be found in this preparation manual. Refer to the examination's information page on the Texas Educator Certification Examination Program website for information on how to access and use the on-screen calculator.

The Chemistry 7–12 test is designed to include a total of 100 multiple-choice questions. Your final scaled score will be based only on scored questions. The questions that are not scored are being pilot tested to collect information about how these questions will perform under actual testing conditions. These pilot questions are not identified on the test.

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How to Approach Unfamiliar Question Formats

Some questions include introductory information such as a map, table, graph or reading passage (often called a stimulus) that provides the information the question asks for. New formats for presenting information are developed from time to time. Tests may include audio and video stimulus materials such as a movie clip or some kind of animation, instead of a map or reading passage.

Tests may also include interactive types of questions. These questions take advantage of technology to assess knowledge and skills that go beyond what can be assessed using standard single-selection multiple-choice questions. If you see a format you are not familiar with, **read the directions carefully**. The directions always give clear instructions on how you are expected to respond.

For most questions, you will respond by clicking an oval to choose a single answer choice from a list of options. Other questions may ask you to respond by:

- **Typing in an entry box.** You may be asked to enter a text or numeric answer. Some questions may have more than one place to enter a response.
- **Clicking check boxes.** You may be asked to click check boxes instead of an oval when more than one choice within a set of answers can be selected.
- **Clicking parts of a graphic.** In some questions, you will choose your answer by clicking on location(s) on a graphic such as a map or chart, as opposed to choosing from a list.
- **Clicking on sentences.** In questions with reading passages, you may be asked to choose your answer by clicking on a sentence or sentences within the reading passage.
- **Dragging and dropping answer choices into "targets" on the screen.** You may be asked to choose an answer from a list and drag it into the appropriate location in a table, paragraph of text or graphic.
- **Selecting options from a drop-down menu.** This type of question will ask you to select the appropriate answer or answers by selecting options from a drop-down menu (e.g., to complete a sentence).

Remember that with every question, you will get clear instructions on how to respond.

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Question Formats

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

- Single Questions
- 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.

Single Questions

The single-question format presents a direct question or an incomplete statement. It can also include a reading passage, graphic, table or a combination of these. Four answer options appear below the question.

The following question is an example of the single-question format. It tests knowledge of Chemistry 7–12 Competency 011: *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, $\Delta G = 0$.

Because $\Delta G = 0$, 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.

Clustered Questions

Clustered questions are made up of a stimulus and two or more questions relating to the stimulus. The stimulus material can be a reading passage, description of an experiment, graphic, table or any other information necessary to answer the questions that follow.

You can use several different approaches to respond to clustered 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 questions and refer again to the stimulus material to obtain the specific information you need to answer the questions.

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

Strategy 3 Use a combination of both strategies. Apply the "read the stimulus first" strategy with shorter, more familiar stimuli and the "read the questions 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.

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Whether you read the stimulus before or after you read the questions, you should read it carefully and critically. You may want to note its important points to help you answer the questions.

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 only in terms of the information provided in the stimulus — not in terms of your own experiences or individuals you may have known.

Example

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

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

Now you are prepared to respond to the first of the three questions associated with this stimulus. The first question tests knowledge of Chemistry 7–12 Competency 010: *The teacher understands types and properties of solutions.*

1. A total of 25.0 mL of silver nitrate 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

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.

To determine the mass of silver ions added to the liquid food product, information from both the stimulus and the question must be used. First, the number of moles of silver nitrate added can be calculated by multiplying the molarity of the silver nitrate solution (0.2 M) by the volume added in liters (0.025 L) before the color change occurred. The result of the calculation indicates that 0.005 mole of silver nitrate were added to the liquid food product. The number of moles of silver ions added is equal to the number of moles of silver nitrate added because the

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dissociation of 1 mole of silver nitrate results in 1 mole of silver ions. Multiplying the number of moles of silver ions added (0.005 mole) by the molar mass of the silver ion (107.9 grams/mole) gives the mass of silver ions added to the liquid food product as 0.54 gram. Therefore, **the correct response is option D**.

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

Now you are ready to answer the second question. This question also tests knowledge of Chemistry 7–12 Competency 010: *The teacher understands types and properties of solutions.*

2. 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. $Ag^+(aq) + Cl^-(aq) \rightarrow NaNO_3(aq) + AgCl(s)$

Suggested Approach

Read the question carefully and critically. Eliminate any obviously wrong answers, select the correct answer choice and mark your answer.

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

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

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

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

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

Spectator ions are ions that are not directly involved in the chemical reaction and can be omitted when writing an equation for the net chemical reaction.

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In this case, the sodium and nitrate ions are spectator ions. Omitting spectator ions yields the following equation.

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

Therefore, the correct response is option D.

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

Now you are ready to answer the third question. The question below tests knowledge of Chemistry 7–12 Competency 001: *The teacher understands how to select and manage learning activities to ensure the safety of all students and the correct use and care of natural resources, materials, equipment and technologies*.

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

   A. Titration
   B. Chromatography
   C. Calorimetry
   D. Electrolysis

Suggested Approach

Read the question carefully and critically. Eliminate any obviously wrong answers, select the correct answer choice and mark your answer.

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

Option B is incorrect because chromatography is used to separate components of a mixture. Option C is incorrect because calorimetry is used to measure heat exchanges in chemical reactions. Option D is incorrect because electrolysis uses electrical energy to drive nonspontaneous chemical reactions.

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

Multiple-Choice Practice 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 do not appear on the actual test.

For each sample test question, there is a correct answer and a rationale for each answer option. Please note 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)

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

Physical Constants for Chemistry 7–12

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}.

END OF PHYSICAL CONSTANTS

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 001

1. The volume of a liquid sample can be measured and reported as 18.00 mL by using which of the following pieces of glassware?

   A. 25 mL graduated cylinder
   B. 25 mL beaker
   C. 50 mL buret
   D. 50 mL Erlenmeyer flask

Answer and Rationale

COMPETENCY 001

2. Which of the following is safety equipment that can be found in a high school chemistry lab?

   A. Bunsen burner
   B. Eyewash station
   C. Barometer
   D. Glass mercury thermometer

Answer and Rationale

COMPETENCY 001

3. A shipment of chemicals is delivered to a high school chemistry lab. Of the following, the most appropriate way to store the substances is to organize them by

   A. the alphabetical names of the substances.
   B. the concentrations of the solutions.
   C. solids or liquids.
   D. the chemical properties of the substances.

Answer and Rationale

NOTE: After clicking on a link, right click and select “Previous View” to go back to original text.

COMPETENCY 002

4. Of the following, which is most appropriate to do after forming a hypothesis?

   A. Organize data
   B. Draw conclusions
   C. Propose a theory
   D. Test the hypothesis

Answer and Rationale

COMPETENCY 002

5. Students conducted an activity to determine the acidity of several liquid products commonly used in homes. They added several drops of red cabbage juice to samples of the substances and recorded the resulting colors. The activity is best described as which of the following?

   A. Statistical analysis
   B. Forensic analysis
   C. Descriptive study
   D. Synthesis experiment

Answer and Rationale

COMPETENCY 003

6. Which of the following is an example of a model?

   A. The equation $PV = nRT$.
   B. A liquid has a green color.
   C. Chemistry is a vital part of biology.
   D. When 12 g of carbon completely reacted with oxygen, it formed 44 grams of carbon dioxide.

Answer and Rationale

NOTE: After clicking on a link, right click and select “Previous View” to go back to original text.

COMPETENCY 003

7. A linear measurement of 156.020 mm is made. Which of the following is the best representation in scientific notation that indicates the correct number of significant figures?

   A. 1.56020×10^5 mm
   B. 1.56020×10^2 mm
   C. 1.5602×10^2 mm
   D. 1.56×10^2 mm

Answer and Rationale

COMPETENCY 004

8. Of the following, which contributes the most to water pollution in streams near mountains?

   A. Nuclear power plants
   B. Mine drainage
   C. Carbon dioxide emissions from gas-powered automobiles
   D. Oil-well drilling

Answer and Rationale

COMPETENCY 004

9. Which of the following scientists is particularly noted for his or her contribution to radiochemistry?

   A. Robert Boyle
   B. Marie Curie
   C. Dmitri Mendeleev
   D. John Dalton

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 005

10. Of the following, which is an example of a physical change only?

   A. Snow sublimating in the Arctic
   B. An iron nail rusting
   C. A candle burning
   D. A lead storage battery recharging

Answer and Rationale

COMPETENCY 005

11. Which of the following is true about elements?

   A. When a chemical reaction takes place, the particles in the nucleus of the atoms are rearranged.
   B. Isotopes are different forms of an element in which the atoms have a different number of protons.
   C. All atoms of the element carbon have the same mass.
   D. Compounds consist of two or more different kinds of elements.

Answer and Rationale

COMPETENCY 006

12. Based on the periodic table, which of the following atoms has the highest first-ionization energy?

   A. Ca
   B. Ni
   C. Br
   D. I

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 006

13. Which of the following is the ground-state electron configuration for Se?

A. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2 4p^4$
B. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2 4p^6\ 5s^2 5p^6$
C. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^2 4p^4$
D. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2 4p^4 4d^{10}$

Answer and Rationale

COMPETENCY 006

14. When hydrogen atoms in excited electronic states undergo transitions to lower electronic states, they emit specific wavelengths of infrared, visible, or ultraviolet light. Ultraviolet light will be emitted when which of the following electronic energy level transitions occur? (n is the principle quantum number for an electronic energy level.)

A. $n = 3$ to $n = 2$
B. $n = 4$ to $n = 1$
C. $n = 4$ to $n = 3$
D. $n = 5$ to $n = 4$

Answer and Rationale

COMPETENCY 007

15. When the temperature increases in a sample of gas molecules in a closed container of fixed volume, which of the following changes takes place?

A. A decrease in the frequency of collisions between molecules
B. An increase in the volume of each molecule
C. An increase in the average attractive forces between molecules
D. An increase in the average speed of the molecules

Answer and Rationale

NOTE: After clicking on a link, right click and select “Previous View” to go back to original text.

COMPETENCY 007

16. A gas sample at 300.0 K and 1.0 atm is allowed to expand into an adjoining vessel until the volume is doubled. The gas is then heated, causing the temperature to increase to 900.0 K. What is the final pressure of the gas sample?

A. 1.0 atm 1.0 atmosphere
B. 1.5 atm 1.5 atmospheres
C. 2.0 atm 2.0 atmospheres
D. 6.0 atm 6.0 atmospheres

Answer and Rationale

COMPETENCY 008

17. Which of the following compounds has predominately covalent bonding?

A. $CaCl_2$
B. $AlCl_3$
C. CH_2Cl_2
D. Na_2O

Answer and Rationale

COMPETENCY 008

18. Which of the following molecules has trigonal planar geometry?

A. NH_3
B. H_2O
C. BH_3
D. CO_2

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 009

19. How many oxygen atoms are in 2.0 mol of $NaNO_3$?

    A. 3
    B. 6
    C. 1.8×10^{24}
    D. 3.6×10^{24}

Answer and Rationale

COMPETENCY 009

20. Which of the following is the balanced equation for the displacement reaction of potassium with aluminum nitrate?

    A. $3\ K + Al(NO_3)_3 \rightarrow 3\ KNO_3 + Al$
    B. $K + AlNO_3 \rightarrow KNO_3 + Al$
    C. $3\ K + AlNO_3 \rightarrow K_3N + AlO_3$
    D. $K + AlN \rightarrow KN + Al$

Answer and Rationale

COMPETENCY 009

$$2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(g)$$

21. According to the balanced equation above, what is the maximum mass of CO_2 that can be produced if 3.00 mol of $C_2H_6(g)$ and 160.0 g of oxygen are available?

    A. 2.86 g
    B. 6.00 g
    C. 126 g
    D. 264 g

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 010

22. If 23.8 g of $MgCl_2$ is completely dissolved in water, forming a 500.0 mL solution, which of the following is the concentration of Cl^- in the solution? (Assume molar mass of $MgCl_2$ is 95.2 g.)

    A. 0.050 M
    B. 0.250 M
    C. 0.500 M
    D. 1.00 M

Answer and Rationale

COMPETENCY 010

23. Of the following solutions, which has the lowest freezing point?

    A. 0.5 m $CaCl_2$(*aq*)
    B. 0.5 m NaCl(*aq*)
    C. 0.5 m $NaNO_3$(*aq*)
    D. 0.5 m HCl(*aq*)

Answer and Rationale

COMPETENCY 010

24. Which of the following actions will change the solubility of a solid compound in water?

    A. Stirring the water vigorously
    B. Using a powder solid rather than a chunk solid
    C. Adding more water
    D. Changing the temperature of the water

Answer and Rationale

NOTE: After clicking on a link, right click and select “Previous View” to go back to original text.

COMPETENCY 011

25. Which of the following is an exothermic process?

A. Bonds breaking in a chemical reaction: $H_3C{-}CH_3 \rightarrow 2\ {\cdot}CH_3$
B. Water evaporating from a puddle: $H_2O(l) \rightarrow H_2O(g)$
C. Frost forming on the ground from water vapor in the air: $H_2O(g) \rightarrow H_2O(s)$
D. Ionization of gaseous sodium atoms: $Na(g) \rightarrow Na^+(g)$

Answer and Rationale

COMPETENCY 011

26. A 50.0 gram sample of a metal at 100.0°C is dropped into a beaker of 25.0°C water. The water warms up and the metal cools down. After thermal equilibrium was reached at 30.0°C, it was determined that 4,000.0 J of energy was absorbed by the water. What is the specific heat capacity of the metal?

A. 1.75 J g^{-1} $°C^{-1}$
B. 1.14 J g^{-1} $°C^{-1}$
C. 0.875 J g^{-1} $°C^{-1}$
D. 0.570 J g^{-1} $°C^{-1}$

Answer and Rationale

NOTE: After clicking on a link, right click and select “Previous View” to go back to original text.

COMPETENCY 012

$$A + 2B \rightarrow 2C$$

27. For the reaction represented above, the initial reaction rate is determined using initial concentrations: [A] = 1 M, [B] = 1 M, and [C] = 0. When the reaction is run again using initial concentrations: [A] = 1 M, [B] = 2 M, and [C] = 0, the initial reaction rate was found to have doubled. Based on the data, which of the following could be the initial rate law?

    A. Rate = [A][B]
    B. Rate = $[A][B]^2$
    C. Rate = $[A]^2[B]^2$
    D. $\text{Rate} = \frac{[A][B]^2}{[C]^2}$

Answer and Rationale

COMPETENCY 012

$$k = Ae^{-\frac{E_a}{RT}}$$

28. For some chemical reactions, the rate constant follows the Arrhenius expression, given above. What does the E_a term represent in the Arrhenius expression?

    A. The change in enthalpy for the reaction
    B. The change in Gibbs energy for the reaction
    C. The change in entropy for the reaction
    D. The activation energy for the reaction

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 012

$$A_2(g) \ + \ 2\ B_2(g) \ \rightleftharpoons \ 2\ B_2A(g)$$

29. Which of the following is the expression for the equilibrium constant, in terms of concentration, for the equilibrium represented above?

A. $K_c = \dfrac{[B_2A]^2}{[A_2][B_2]^2}$

B. $K_c = \dfrac{[A_2][B_2]^2}{[B_2A]^2}$

C. $K_c = \dfrac{[2\ B_2A]^2}{[A_2][2\ B_2]^2}$

D. $K_c = \dfrac{[A_2][2\ B_2]^2}{[2\ B_2A]^2}$

Answer and Rationale

COMPETENCY 013

30. Which of the following mixtures will form a buffer solution?

A. 50 mL of 0.01 M $KCl(aq)$ and 50 mL of 0.01 M $KOH(aq)$
B. 50 mL of 0.01 M $KCl(aq)$ and 50 mL of 0.01 M $HCl(aq)$
C. 50 mL of 0.01 M $KOH(aq)$ and 50 mL of 0.01 M $HCl(aq)$l
D. 50 mL of 0.01 M $CH_3COOH(aq)$ and 50 mL of 0.01 M $CH_3COOK(aq)$

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 013

31. What is the pH of 0.001 M $NaOH(aq)$ at 298 K ?

A. 1.0
B. 3.0
C. 8.0
D. 11.0

Answer and Rationale

COMPETENCY 013

32. A 1 M aqueous solution of an acid HA with pH = 6.0 is titrated with a 0.1 M NaOH solution. If the pH = 10.0 at the equivalence point, which of the following is most likely true about the acid HA?

A. HA is a strong acid
B. HA is a weak acid
C. HA is a strong electrolyte
D. HA is chemically inert

Answer and Rationale

COMPETENCY 014

$$AgNO_3(aq) + NaCl(s) \rightleftharpoons AgCl(s) + Na^+(aq) + NO_3^-(aq)$$

33. Which of the following is true about the reaction represented above?

A. Silver is reduced.
B. Sodium is oxidized.
C. Chlorine is reduced.
D. No oxidation or reduction is taking place in the reaction.

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 014

34. If 5.00 amperes are provided for 10.0 hours in an electroplating experiment, which of the following is the maximum amount of Cu^{2+} that can be plated out of 3.00 L of a 2.00 M $CuSO_4$ solution? (Assume F = 96,500 C/mol.)

A. 0.933 mol Cu
B. 1.87 mol Cu
C. 3.73 mol Cu
D. 6.00 mol Cu

Answer and Rationale

COMPETENCY 015

35. Which of the following nuclear processes is an example of an alpha emission?

A. $^{215}Bi \rightarrow {}^{215}Po$
B. $^{240}U \rightarrow {}^{240}Np$
C. $^{222}Rn \rightarrow {}^{218}Po$
D. $^{40}K \rightarrow {}^{40}Ar$

Answer and Rationale

COMPETENCY 015

36. The half-life of a radioactive isotope of hydrogen is 12.3 years. If the original sample of the isotope is 16 micrograms, which TWO of the following statements are true after 25 years elapse?

A. A little more than 8.0 micrograms of the isotope will remain.
B. A little less than 4.0 micrograms of the isotope will remain.
C. More than two half-lives have elapsed.
D. Although radioactive decay occurred, the mass of the isotope will still be 16 micrograms.

Answer and Rationale

NOTE: After clicking on a link, right click and select “Previous View” to go back to original text.

COMPETENCY 016

37. Which of the following activities is most appropriate after a short lesson on the significance of oxidation numbers?

   A. The students attempt to balance a simple redox reaction
   B. The teacher presents a demonstration involving a combustion reaction
   C. The students perform an acid-base titration in the lab
   D. The students determine the number of neutrons in one atom of iodine-131 based on information from the periodic table

Answer and Rationale

COMPETENCY 016

38. Which of the following is an element of inquiry-based science instruction?

   A. A teacher-led question and answer session
   B. A video presentation of science principles to be included in a unit of study
   C. A student forming a hypothesis prior to a lab activity
   D. A student writing a report after researching information on the Internet

Answer and Rationale

COMPETENCY 017

39. Of the following, which is the most appropriate way to assess a student's understanding of preparing a 1 M HCl solution from a 6 M HCl solution?

   A. Short quiz
   B. Lab report
   C. Summative assessment
   D. Performance assessment

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

COMPETENCY 017

40. When teaching a complex unit it is important to frequently monitor and assess the students' understanding of the concepts throughout the unit by doing which of the following?

    A. Facilitating a class discussion while monitoring responses and questions
    B. Having students conduct frequent lab exercises with full lab reports
    C. Administering a series of short quizzes periodically throughout the unit
    D. Assigning a multistep research project that is due at the end of the unit

Answer and Rationale

NOTE: After clicking on a link, right click and select "Previous View" to go back to original text.

Answer Key and Rationales

Question Number	Competency Number	Correct Answer	Rationales
1	001	C	**Option C is correct** because the smallest divisions on a scale of a 50 mL buret are typically 0.1 mL. Thus, the volume of the sample can be estimated to two decimal places: 18.00 ± 0.01 mL. **Option A is incorrect** because the smallest divisions on a scale of a 25 mL graduated cylinder are typically 1 mL. Thus, the volume of the sample can be estimated to one decimal place only: 18.0 ± 0.1 mL. **Option B is incorrect** because the smallest divisions on a scale of a 25 mL beaker are 5 mL or greater. Thus, the volume of the sample can be estimated to be between 15 and 20 mL. **Option D is incorrect** because the smallest divisions on a scale of a 50 mL Erlenmeyer flask are typically 10 mL. Thus, the volume of the sample can be estimated to be between 10 and 20 mL. Back to Question
2	001	B	**Option B is correct** because an eyewash station is used to flush the eyes when liquids have been splashed or sprayed into a person's eyes. **Option A is incorrect** because a Bunsen burner is used to heat some materials in the lab and must be used with care. **Option C is incorrect** because a barometer is used to measure atmospheric pressure. **Option D is incorrect** because a glass mercury thermometer can pose a significant hazard due to possible broken glass and mercury exposure. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
3	001	D	**Option D is correct** because substances that are stored near each other might react chemically with each other and create safety concerns. **Options A, B, and C are incorrect** because they are organizational concepts that are not as important as the possibility of chemical reactions between the various substances. Back to Question
4	002	D	**Option D is correct** because a hypothesis must be tested in order to support or disprove it. **Option A is incorrect** because the testing data have not yet been produced, and any preliminary observational data available should have been organized and analyzed in the process of developing a hypothesis. **Option B is incorrect** because the hypothesis has not yet been tested, so there are not sufficient data for analyzing and drawing conclusions. **Option C is incorrect** because a theory cannot be developed until enough testing has been done to produce data that support the hypothesis. Back to Question
5	002	C	**Option C is correct** because a descriptive study indicates characteristics, not causes. **Option A is incorrect** because no numerical data were collected. **Option B is incorrect** because only observations were recorded and no analysis was done. **Option D is incorrect** because no synthesis reactions took place. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
6	003	A	**Option A is correct** because the equation represents a mathematical model of the behavior of an ideal gas in which intermolecular attractions and gas particle volume are accounted for. **Option B is incorrect** because the color of the liquid is an observation. **Option C is incorrect** because although chemistry is very much a part of biology, this fact does not represent a model. **Option D is incorrect** because the quantitative analysis of the carbon reaction is an observation based on analysis of data and does not represent a model. Back to Question
7	003	B	**Option B is correct** because the number 156.020 is represented by two powers of ten (10^2) and indicates six significant figures. **Option A is incorrect** because it incorrectly indicates five powers of ten (10^5), even though it does include all six significant figures. **Option C is incorrect** because although it correctly indicates two powers of ten (10^2), it does not include all six significant figures; it includes only five. **Option D is incorrect** because although it correctly indicates two powers of ten (10^2), it does not include all six significant figures; it includes only three. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
8	004	B	**Option B is correct** because acid and metal ion mine-drainage from abandoned coal mines has a significant impact on many streams in mountainous coal-mining regions. **Option A is incorrect** because although nuclear power plants can contribute to thermal pollution, plants are typically located near rivers or oceans, not in mountain regions near streams. Radioactive emissions are not common and are not the major source of water pollution in mountain streams. **Option C is incorrect** because carbon dioxide emissions can lead to a minor amount of dissolved carbon dioxide (carbonic acid), but the level is not considered significant. **Option D is incorrect** because oil-well drilling is not typically done in areas that could affect streams in mountainous regions. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
9	004	B	**Option B is correct** because Marie Curie did extensive work in isolating radioactive isotopes, and she discovered two radioactive elements. **Option A is incorrect** because Robert Boyle is most known for his discovery, Boyle's law, which indicates that the volume of a gas is inversely proportional to the absolute pressure of the gas if the temperature is kept constant in a closed system. **Option C is incorrect** because Dmitri Mendeleev is most known for the development of a periodic table. **Option D is incorrect** because John Dalton is most known for his atomic theory, which describes some basic principles of atoms and how they combine to form compounds, but it does not involve radioactivity. Back to Question
10	005	A	**Option A is correct** because snow (H_2O) changes state from solid to gas, which is a physical change, and no chemical changes occur. **Option B is incorrect** because Fe in the iron nail reacts with O_2 to form FeO_2, which is a chemical change. **Option C is incorrect** because a candlewick reacts with oxygen in the flame, and a combustion reaction occurs, which is a chemical change. **Option D is incorrect** because recharging a lead storage battery involves an electrochemical reaction. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
11	005	D	**Option D is correct** because compounds are composed of two or more elements. **Option A is incorrect** because chemical reactions do not involve changes in the nucleus. **Option B is incorrect** because isotopes of an element have the same number of protons but a different number of neutrons. **Option C is incorrect** because carbon has isotopes that have atoms with a different number of neutrons and hence a different mass even though they have the same number of protons and electrons. For example, all carbon atoms have 6 protons and 6 electrons, but carbon-12 has 6 neutrons and carbon-13 has 7 neutrons. Back to Question
12	006	C	**Option C is correct** because, based on periodic trends, the first-ionization energy increases from left to right in a row on the periodic table and decreases from top to bottom of a column. Br is farther to the right than Ni and Ca in a row and is above I in a column. **Option A is incorrect** because on the periodic table Ca is farther to the left on a row than Br. **Option B is incorrect** because on the periodic table Ni is farther to the left on a row than Br. **Option D is incorrect** because on the periodic table I is below Br in a column. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
13	006	C	**Option C is correct** because it contains the correct number of electrons and correctly indicates the electron configuration according to the Aufbau principle. **Option A is incorrect** because it contains 24 electrons, whereas Se has 34 electrons. **Option B is incorrect** because it contains the correct number of electrons, but it is missing the 3*d* electrons. **Option D is incorrect** because it contains the correct number of electrons, but it has 4*d* electrons, not 3*d* electrons. Back to Question
14	006	B	**Option B is correct** because ultraviolet light has a shorter wavelength and a higher energy than visible or infrared light. Ultraviolet emissions occur for transitions from higher energy levels to the $n = 1$ level. Visible emissions occur from transitions from higher energy levels to the $n = 2$ level. Infrared emissions occur for transitions from higher energy levels to the $n = 3$ level. The electronic energy levels get closer together as n increases as can be seen from the following equation. $\Delta E = R_H \left(\frac{1}{n_{initial}^2} - \frac{1}{n_{final}^2} \right)$ **Options A, C, and D are incorrect** because the energies involved in those transitions are smaller than for $n = 4$ to $n = 1$. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
15	007	D	**Option D is correct** because as temperature increases, the average speed of the molecules in the sample will increase. **Option A is incorrect** because the frequency of collisions will increase, not decrease. **Option B is incorrect** because the actual volume of each molecule does not change with temperature. **Option C is incorrect** because the attractive forces are dependent on the electrostatic nature of the molecules and the distance between the molecules. As temperature increases, the electrostatic properties of each molecule do not change, and the sample is in a fixed-volume container, so the average distance between molecules will not change. Hence, there is no change in the average attractive forces between molecules. Back to Question
16	007	B	**Option B is correct** because pressure of a fixed number of moles of gas is inversely proportional to volume and directly proportional to temperature. $\left(P_2 = P_1 \times \frac{V_1}{V_2} \times \frac{T_2}{T_1}\right)$. Hence, $P_2 = 1.5 \text{ atm}$, calculated as follows: $\left(P_2 = 1 \text{ atm} \times \frac{1}{2} \times \frac{900 \text{ K}}{300 \text{ K}}\right) = 1.5 \text{ atm}$. **Option A is incorrect** because pressure is not 1.0 atm. **Option C is incorrect** because pressure is not 2.0 atm. **Option D is incorrect** because pressure is not 6.0 atm. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
17	008	C	**Option C is correct** because in CH_2Cl_2 molecules both the C-H and the C-Cl bonds are covalent. **Option A is incorrect** because the compound $CaCl_2$ has ionic bonding between metallic Ca^{2+} ions and nonmetallic Cl^- ions. **Option B is incorrect** because the compound $AlCl_3$ has ionic bonding between metallic Al^{3+} ions and nonmetallic Cl^- ions. **Option D is incorrect** because the compound Na_2O has ionic bonding between metallic Na^+ ions and nonmetallic O^{2-} ions. Back to Question
18	008	C	**Option C is correct** because the molecule BH_3 has trigonal planar geometry due to having three bonding pairs but no electron pairs around the central atom (boron). Based on valence-shell-electron-pair-repulsion (VSEPR) theory, this configuration has the minimum repulsion. **Option A is incorrect** because the NH_3 molecule has trigonal pyramidal geometry. **Option B is incorrect** because the molecule H_2O has bent geometry. **Option D is incorrect** because the molecule CO_2 has linear geometry. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
19	009	D	**Option D is correct** because there are three oxygen atoms in the formula, there are 2 moles of the compound, and there is a total of $2 \times 3 \times 6.02 \times 10^{23} = 3.6 \times 10^{24}$ oxygen atoms. **Option A is incorrect** because there are three oxygen atoms in the formula but many more in 2.0 mol of $NaNO_3$. **Option B is incorrect** because there are six oxygen atoms in two units of the formula but many more in 2.0 mol of $NaNO_3$. **Option C is incorrect** because there are 1.8×10^{24} oxygen atoms in 1.0 mol of $NaNO_3$, but there is twice that amount in 2.0 mol of $NaNO_3$. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
20	009	A	**Option A is correct** because the reaction of potassium with aluminum nitrate forms KNO_3 and Al, the formula for aluminum nitrate is $Al(NO_3)_3$, the formula for potassium nitrate is KNO_3 and the equation is balanced with an equal number of each type of atom on the right and left sides of the equation (i.e., three K atoms, one Al atom, three N atoms, and nine O atoms). **Option B is incorrect** because the formula for aluminum nitrate is not correctly represented. **Option C is incorrect** because the incorrect products are formed, and the formula for aluminum nitrate is not correctly represented. **Option D is incorrect** because the incorrect products are formed, and the compound formulas are not correctly represented. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
21	009	C	**Option C is correct** because the mass that is produced is 126 g. The oxygen is the limiting reagent. 160 g oxygen is 5 moles of O_2. Based on the balanced equation, 5 moles of O_2 can completely react with 1.42 moles of C_2H_6. $\left(5\ O_2 \times \frac{2\ C_2H_6}{7\ O_2} = 1.42\ \text{mol}\ C_2H_6\right)$. So the 3 moles of C_2H_6 is in excess. Hence, the maximum mass of CO_2 that can be produced is 126 g (to three significant figures), calculated as follows: $5\ \text{mol}\ O_2 \times \frac{4\ \text{mol}\ CO_2}{7\ \text{mol}\ O_2} \times \frac{44\ \text{g}\ CO_2}{1\ \text{mol}\ CO_2} = 126\ \text{g}\ CO_2$. **Option A is incorrect** because 2.86 is the number of moles of CO_2 produced, not the mass produced. **Option B is incorrect** because 6.0 is neither the number of moles nor the mass of the product produced. **Option D is incorrect** because 264 is the mass of CO_2 that would be produced if all the C_2H_6 was consumed, but there is insufficient oxygen to do that. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
22	010	D	**Option D is correct** because concentration of Cl^- is 1.0 M, calculated as follows: Since 500 mL = 0.5 L, then $\frac{23.8\text{ g } MgCl_2}{0.5\text{ L}} \times \frac{1\text{ mol } MgCl_2}{95.2\text{ g } MgCl_2} \times \frac{2\ Cl^-}{1\ MgCl_2} = 1.0\text{ M}$ the fraction. **Option A is incorrect** because 0.050 does not correctly give the concentration of Cl^- expressed in mol/L; it is the approximate concentration of $MgCl_2$ expressed in g/mL. **Option B is incorrect** because 0.250 does not correctly give the concentration of Cl^- expressed in mol/L; it is the total number of moles of $MgCl_2$ dissolved. **Option C is incorrect** because 0.500 does not correctly give the concentration of Cl^- expressed in mol/L; it is the number of moles of $MgCl_2$ per liter. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
23	010	A	**Option A is correct** because 0.50 m $CaCl_2$ dissociates into 3 ions in solution ($CaCl_2 \rightarrow Ca^{2+} + 2\ Cl^-$), and the number of particles in solution is proportional to the freezing point depression. **Option B is incorrect** because 0.50 m NaCl dissociates into 2 ions in solution ($NaCl \rightarrow Na^+ + Cl^-$) and has fewer particles in solution than 0.50 m $CaCl_2$. Hence, its freezing point depression is less than that of 0.50 m $CaCl_2$. **Option C is incorrect** because 0.50 m $NaNO_3$ dissociates into 2 ions in solution ($NaNO_3 \rightarrow Na^+ + NO_3^-$) and has fewer particles in solution than does 0.50 m $CaCl_2$. Hence, its freezing point depression is less than that of 0.50 m $CaCl_2$. **Option D is incorrect** because 0.50 m HCl dissociates into 2 ions in solution ($HCl \rightarrow H^+ + Cl^-$) and has fewer particles in solution than does 0.50 m $CaCl_2$. Hence, its freezing point depression is less than that of 0.50 m $CaCl_2$. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
24	010	D	**Option D is correct** because solubility is defined as the maximum mass of a solid that can dissolve in 100 mL of a solution at a particular temperature. Changing the temperature will increase or decrease the solubility (maximum mass that can dissolve in 100 mL). **Option A is incorrect** because stirring only increases the rate of dissolving and has no effect on the solubility (maximum mass that can dissolve in 100 mL). **Option B is incorrect** because using powder instead of chunks only increases the rate of dissolving and has no effect on the solubility (maximum mass that can dissolve in 100 mL). **Option C is incorrect** because adding water can increase the total mass that dissolves, but it has no effect on the solubility (maximum mass that can dissolve in 100 mL). The maximum possible concentration of the solution is the same. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
25	011	C	**Option C is correct** because energy is released (exothermic) when the gaseous water molecules come together to form solid H_2O in a crystal structure (frost). The potential energy is higher when the molecules are far apart in the gaseous state, and the potential energy is reduced when the molecules are close together in the solid state. **Option A is incorrect** because the input of energy is required (endothermic) to break a bond between carbon atoms. **Option B is incorrect** because the input of energy is required (endothermic) to change liquid water to gaseous water in which the molecules are much farther apart (higher potential energy). **Option D is incorrect** because the removal of an electron from sodium to form an ion requires the input of energy (endothermic). Back to Question
26	011	B	**Option B is correct** because the specific heat capacity of the metal is 1.14 J g^{-1} °C^{-1}. The heat lost by the cooling metal is equal to the heat absorbed by the water and is found from $\frac{4000\ \text{J}}{(50.0\ \text{g})(70.0°\text{C})} = 1.14\ \text{J g}^{-1}\ °\text{C}^{-1}$. **Options A, B, and C are incorrect.** Back to Question

Question Number	Competency Number	Correct Answer	Rationales
27	012	A	**Option A is correct** because for the initial rate law Rate = [A][B], the initial reaction rate doubles when [B] doubles, calculated as follows: $\frac{\text{Rate 2}}{\text{Rate 1}} = \frac{[A]_2}{[A]_1} \times \frac{[B]_2}{[B]_1} = \frac{(1\text{ M})}{(1\text{ M})} \times \frac{(2\text{ M})}{(1\text{ M})} = 2$. **Option B is incorrect** because for the initial rate law Rate = $[A][B]^2$, the initial reaction rate increases fourfold when [B] doubles, calculated as follows: $\frac{\text{Rate 2}}{\text{Rate 1}} = \frac{[A]_2}{[A]_1} \times \frac{[B]_2^2}{[B]_1^2} = \frac{(1\text{ M})}{(1\text{ M})} \times \frac{(2\text{ M})^2}{(1\text{ M})^2} = 4$. **Option C is incorrect** because for the initial rate law Rate = $[A]^2[B]^2$, the initial reaction rate increases fourfold when [B] doubles, calculated as follows: $\frac{\text{Rate 2}}{\text{Rate 1}} = \frac{[A]_2^2}{[A]_1^2} \times \frac{[B]_2^2}{[B]_1^2} = \frac{(1\text{ M})^2}{(1\text{ M})^2} \times \frac{(2\text{ M})^2}{(1\text{ M})^2} = 4$. **Option D is incorrect** because for the initial rate law Rate = $\frac{[A][B]^2}{[C]^2}$, again the initial reaction rate increases fourfold when [B] doubles, due to the $[B]^2$ term in the rate law. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
28	012	D	**Option D is correct** because E_a represents the activation energy. **Option A is incorrect** because E_a does not represent the change in enthalpy for the reaction (ΔH_{rxn}). **Option B is incorrect** because E_a does not represent the change in Gibbs energy for the reaction (ΔG_{rxn}). **Option C is incorrect** because E_a does not represent the change in entropy for the reaction (ΔS_{rxn}). Back to Question
29	012	A	**Option A is correct** because the equilibrium constant expression should have the concentration of the product in the numerator, raised to the power that corresponds to the coefficient for the product in the balanced equation (in this case the coefficient is 2). And the concentrations of the reactants should be in the denominator, each raised to the power that corresponds to the coefficient for that reactant in the balanced equation (in this case the coefficients are 1 for A_2 and 2 for B_2. **Options B, C, and D are incorrect.** Back to Question

Question Number	Competency Number	Correct Answer	Rationales
30	013	D	**Option D is correct** because a 1:1 mixture of a weak acid (CH_3COOH) and the salt of a weak acid (CH_3COOK) will form a buffer solution. There is an equilibrium involving the CH_3COOH and the CH_3COO^-. Small additions of either acid or base will not result in a pH change based on the equilibrium. **Option A is incorrect** because a mixture of a neutral salt (KCl) and a strong base (KOH) will not form a buffer solution. **Option B is incorrect** because a mixture of a neutral salt (KCl) and a strong acid (HCl) will not form a buffer solution. **Option C is incorrect** because a mixture of a strong base (KOH) and a strong acid (HCl) will not form a buffer solution. Back to Question
31	013	D	**Option D is correct** because pH = 11.0 for 0.001 M NaOH solution. For an aqueous solution, the pH is equal to $-\log[H^+]$. And at 298 K, $[H^+] = \frac{1 \times 10^{-14}}{[OH^-]} = \frac{1 \times 10^{-14}}{(0.001)} = 1 \times 10^{-11}\,M$. So pH = 11.0, based on the following calculation: since pH = $-\log[H^+]$, then $pH = -\log(1 \times 10^{-11}) = -(-11) = 11.0$. **Options A, B and C are incorrect**. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
32	013	B	**Option B is correct** because when a weak acid is titrated by a strong base such as NaOH, the equivalence point is not at pH = 7.0, but instead will be in the basic range (in this case, pH = 10.0). This is explained by the hydrolysis of the salt that forms, NaA. Because A^- is a conjugate base of a weak acid, it will react with water to form some HA and OH^- ($A^- + H_2O \rightleftharpoons HA + OH^-$). The pH at the equivalence point will be related to the K_a of the acid. **Option A is incorrect** because HA is not a strong acid, as indicated by the pH at the equivalence point. **Option C is incorrect** because HA is a weak acid, as indicated by the pH at the equivalence point. Hence, it cannot be a strong electrolyte because weak acids are those that do not dissociate completely in water. Strong electrolytes are compounds that completely dissociate into ions in solution. **Option D is incorrect** because HA is reacting with the NaOH during the titration, as evidenced by the change in pH from 6.0 to 10.0. Hence, it is not chemically inert. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
33	014	D	**Option D is correct** because none of the species have a change in oxidation state during the reaction; no oxidation or reduction is taking place. **Option A is incorrect** because silver has an oxidation state of +1 in both reactants and products; hence, is not being reduced. **Option B is incorrect** because sodium has an oxidation state of +1 in both reactants and products; hence, is not being oxidized. **Option C is incorrect** because chlorine has an oxidation state of −1 in both reactants and products; hence, is not being reduced. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
34	014	A	**Option A is correct** because the maximum amount of copper that can be plated out, based on the current provided, is 0.933 mol Cu, calculated as follows: 5 amperes = 5 Coulombs/second = 5 C/s and $\frac{5\text{ C}}{\text{s}} \times 10\text{ hr} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{60\text{ s}}{1\text{ min}} = 180{,}000\text{ C}$ and $180{,}000\text{ C} \times \frac{1\text{ mol e}^-}{96{,}500\text{ C}} = 1.865\text{ mol e}^-$ and $1.865\text{ mol e}^- \times \frac{1\text{ mol Cu}^{2+}}{2\text{ mol e}^-} = 0.933\text{ mol Cu}$. **Option B is incorrect** because 1.87 mol of Cu is twice the amount that is produced and does not account for the fact that 2 moles of electrons are needed to plate out 1 mole of Cu. **Option C is incorrect** because 3.73 mol is four times the amount that is produced. **Option D is incorrect** because 6.00 mol of Cu is far larger than the amount that can be produced and is equal to all of the Cu that is contained in the 3.00 L solution. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
35	015	C	**Option C is correct** because an alpha particle is emitted in the process: $^{222}\text{Rn} \rightarrow {}^{218}\text{Po}$. $\left({}^{222}_{86}\text{Rn} \rightarrow {}^{218}_{84}\text{Po} + {}^{4}_{2}\text{He}\right)$ **Option A is incorrect** because a negative beta emission is taking place in which an electron is emitted in the process: $^{215}\text{Bi} \rightarrow {}^{215}\text{Po}$. $\left({}^{215}_{83}\text{Bi} \rightarrow {}^{215}_{84}\text{Po} + {}^{0}_{-1}e\right)$ **Option B is incorrect** because a negative beta emission is taking place in which an electron is emitted in the process: $^{240}\text{U} \rightarrow {}^{240}\text{Np}$. $\left({}^{240}_{92}\text{U} \rightarrow {}^{240}_{93}\text{Np} + {}^{0}_{-1}e\right)$ **Option D is incorrect** because a positive beta emission is taking place in which a positron is emitted in the process: $^{40}\text{K} \rightarrow {}^{40}\text{Ar}$. $\left({}^{40}_{19}\text{K} \rightarrow {}^{40}_{18}\text{Ar} + {}^{0}_{+1}e\right)$ Back to Question

Question Number	Competency Number	Correct Answer	Rationales
36	015	B, C	**Options B and C are correct** because after 25 years, the mass of the isotope that will remain is 3.9 micrograms, which is a little less than 4.0 micrograms. Since the half-life is 12.3 years, 25 years is more than two half-lives. If only two half-lives had elapsed (24.6 years), then the mass of isotope remaining would have been 4.0 micrograms: $\frac{1}{2} \times \frac{1}{2} \times 16 \text{ micrograms} = 4 \text{ micrograms.}$ The actual mass remaining after 25 years elapse can be calculated using the following steps. Based on the half-life, the decay rate constant can be found from $-kt = \frac{0.693}{12.3 \text{ years}}.$ Based on first-order decay kinetics, the amount of isotope remaining (x) is found from $\frac{\ln x}{\ln 16 \text{ micrograms}} = -kt = \frac{0.693}{12.3 \text{ years}} \times 25 \text{ years.}$ Solving this equation for x yields 3.9 micrograms of isotope remaining. **Options A and D are incorrect**. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
37	016	A	**Option A is correct** because the oxidation number of the elements in the various species in the reaction must be known in order to correctly balance a redox (oxidation-reduction) reaction. In addition to trying to balance the number of atoms on both sides of the equation, the students must also balance the increase and decrease in oxidation numbers that take place, and various species gain or lose electrons. **Option B is incorrect** because although a combustion reaction may involve an oxidation and reduction, the demonstration would not illustrate the use of oxidation numbers. **Option C is incorrect** because an acid-base titration may or may not involve an oxidation-reduction, but the titration would not illustrate the use of oxidation numbers. **Option D is incorrect** because the number of neutrons in iodine-131 can be deduced by finding the atomic number of iodine on the periodic table. The oxidation state of iodine is not related to this determination. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
38	016	C	**Option C is correct** because inquiry-based learning does involve students proposing a hypothesis prior to designing an experiment to test the hypothesis. **Option A is incorrect** because a teacher asking questions is important, but it is not an element of inquiry-based science instruction. **Option B is incorrect** because videos can be helpful, but they are not elements of inquiry-based learning. **Option D is incorrect** because writing reports can have value, but it is not an element of inquiry-based learning. Back to Question

Question Number	Competency Number	Correct Answer	Rationales
39	017	D	**Option D is correct** because an assessment of the students preparing the solution in the lab is the best way to assess their understanding of the theory, their implementation of the theory and their technique. This approach is called a performance assessment. **Option A is incorrect** because a short quiz would assess only some theoretical understanding of how to prepare solutions by dilution, but it will not assess the students' ability to implement the theory or their technique. **Option B is incorrect** because a report can assess only how well students explain what should be done, but it will not assess their ability to implement the theory or their technique. **Option C is incorrect** because a summative assessment will assess only some theoretical understanding of how to prepare solutions by dilution, but it will not assess students' ability to implement the theory or their technique. Back to Question
40	017	A,C	**Options A and C are correct** because they will effectively assess the students' understanding of the concepts throughout the unit. **Option B is incorrect** because frequent full lab reports will be time-consuming and will assess much more than what is needed. **Option D is incorrect** because the feedback to the teacher will not be available until the end of the unit and will not provide the frequent monitoring of understanding that was desired. Back to Question

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**

Preparation Resources

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

JOURNALS

ChemMatters, American Chemical Society.

The Science Teacher, National Science Teachers Association.

Texas Science Teacher, Science Teachers Association of Texas.

OTHER RESOURCES

American Chemical Society (2011). *ChemCom: Chemistry in the Community*, Fifth Edition. W. H. Freeman and Company.

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Zumdahl, S. S., and Zumdahl, S. A., DeCoste, D.J. (2014). *Chemistry*, Tenth Edition. Cengage Learning.

Online Resources

American Chemical Society — www.acs.org

National Science Teachers Association — www.nsta.org

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