Chemistry: Content Knowledge

5245
Welcome to The Praxis® Study Companion

Prepare to Show What You Know

You have been working to acquire the knowledge and skills you need for your teaching career. Now you are ready to demonstrate your abilities by taking a Praxis® test.

Using the Praxis® Study Companion is a smart way to prepare for the test so you can do your best on test day. This guide can help keep you on track and make the most efficient use of your study time.

The Study Companion contains practical information and helpful tools, including:

- An overview of the Praxis tests
- Specific information on the Praxis test you are taking
- A template study plan
- Study topics
- Practice questions and explanations of correct answers
- Test-taking tips and strategies
- Frequently asked questions
- Links to more detailed information

So where should you start? Begin by reviewing this guide in its entirety and note those sections that you need to revisit. Then you can create your own personalized study plan and schedule based on your individual needs and how much time you have before test day.

Keep in mind that study habits are individual. There are many different ways to successfully prepare for your test. Some people study better on their own, while others prefer a group dynamic. You may have more energy early in the day, but another test taker may concentrate better in the evening. So use this guide to develop the approach that works best for you.

Your teaching career begins with preparation. Good luck!

Know What to Expect

Which tests should I take?

Each state or agency that uses the Praxis tests sets its own requirements for which test or tests you must take for the teaching area you wish to pursue.

Before you register for a test, confirm your state or agency’s testing requirements at www.ets.org/praxis/states.

How are the Praxis tests given?

Praxis tests are given on computer. Other formats are available for test takers approved for accommodations (see page 39).
What should I expect when taking the test on computer?
When taking the test on computer, you can expect to be asked to provide proper identification at the test center. Once admitted, you will be given the opportunity to learn how the computer interface works (how to answer questions, how to skip questions, how to go back to questions you skipped, etc.) before the testing time begins. Watch the What to Expect on Test Day video to see what the experience is like.

Where and when are the Praxis tests offered?
You can select the test center that is most convenient for you. The Praxis tests are administered through an international network of test centers, which includes Prometric® Testing Centers, some universities, and other locations throughout the world.

Testing schedules may differ, so see the Praxis web site for more detailed test registration information at www.ets.org/praxis/register.
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1. Learn About Your Test

Learn about the specific test you will be taking

Chemistry: Content Knowledge (5245)

Test at a Glance

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<thead>
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<th>Test Name</th>
<th>Chemistry: Content Knowledge</th>
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<tbody>
<tr>
<td>Test Code</td>
<td>5245</td>
</tr>
<tr>
<td>Time</td>
<td>2.5 hours</td>
</tr>
<tr>
<td>Number of Questions</td>
<td>125</td>
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<tr>
<td>Format</td>
<td>Selected-response questions</td>
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<tr>
<td>Test Delivery</td>
<td>Computer delivered</td>
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<table>
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<tr>
<th>Content Categories</th>
<th>Approximate Number of Questions</th>
<th>Approximate Percentage of Examination</th>
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<tr>
<td>I. Basic Principles of Matter and Energy; Thermodynamics</td>
<td>17</td>
<td>14%</td>
</tr>
<tr>
<td>II. Atomic and Nuclear Structure</td>
<td>15</td>
<td>12%</td>
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<tr>
<td>III. Nomenclature; Chemical Composition; Bonding and Structure</td>
<td>19</td>
<td>15%</td>
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<tr>
<td>IV. Chemical Reactions; Periodicity</td>
<td>25</td>
<td>20%</td>
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<tr>
<td>V. Solutions and Solubility; Acid-Base Chemistry</td>
<td>19</td>
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<tr>
<td>VI. Scientific Inquiry and Social Perspectives of Science</td>
<td>15</td>
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</tr>
<tr>
<td>VII. Scientific Procedures and Techniques</td>
<td>15</td>
<td>12%</td>
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</tbody>
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About This Test

The Chemistry: Content Knowledge test is designed to measure the knowledge and competencies necessary for a beginning teacher of secondary school Chemistry. Examinees have typically completed or nearly completed a bachelor’s degree program with appropriate coursework in chemistry and education. This test may contain some questions that will not count toward your score.

The development of the test questions and the construction of the test reflect the National Science Education Standards (NSES) and the National Science Teacher Association (NSTA) standards and recognize that there are conceptual and procedural schemes that unify the various scientific disciplines. These fundamental concepts and processes (systems; models; constancy and change; equilibrium; form and function) are useful in understanding the natural world. Insofar as possible, then, the test questions will have the primary objective of evaluating the content areas by using questions that focus on conceptual understanding, critical thinking, and problem solving in science. The test content is developed and reviewed in collaboration with practicing high school chemistry teachers, teacher-educators, and higher education content specialists to keep the test updated and representative of current standards.
The 125 selected-response questions include concepts, terms, phenomena, methods, applications, data analysis, and problem solving in Chemistry, and include an understanding of the impact of science and technology on the environment and human affairs. The topics are typically those covered in introductory college-level chemistry courses, although some questions of a more advanced nature are included, because secondary school teachers must understand the subject matter from a more advanced viewpoint than that presented to their students.

Examinees will not need to use calculators in taking this test. The periodic table of the elements is available as a Help screen, along with a table of information that presents various physical constants and a few conversion factors among SI units. Whenever necessary, additional values of physical constants are included with the text of a question.

Test Specifications

Test specifications describe the knowledge and skills measured by the test. Study topics to help you prepare to answer test questions can be found on page 28.

I. Basic Principles of Matter and Energy; Thermodynamics

A. Matter and Energy

1. Organization of matter
   a. pure substances (elements and compounds)
   b. mixtures (homogeneous, heterogeneous, solutions, suspensions)
   c. states of matter (solid, liquid, gas, plasma)

2. Particulate structure of matter
   a. atoms, ions, molecules

3. Differences between chemical and physical properties and chemical and physical changes
   a. chemical versus physical properties
   b. chemical versus physical changes
   c. intensive versus extensive properties

4. Conservation of energy and the conservation of matter in chemical processes
   a. law of conservation of energy
   b. law of conservation of matter

5. Different forms of energy
   a. kinetic and potential
   b. chemical, electrical, electromagnetic, nuclear, and thermal energy
   c. conversions between different forms of energy within chemical systems

B. Thermodynamics in Chemistry

1. Temperature, thermal energy, and heat capacity, including temperature scales, units of energy, and calculations involving these concepts
   a. temperature and temperature scales
   b. thermal energy and units of energy
   c. heat transfer
   d. heat capacity and specific heat
   e. calorimetry calculations

2. Concepts and calculations involving phase transitions between the various states of matter
   a. phase transitions and diagrams
b. heats of vaporization, fusion, and sublimation  
c. heating curves  

3. Kinetic molecular theory and ideal gas laws  
a. assumptions of the kinetic molecular theory  
b. ideal gases and the ideal gas laws (e.g., applications, calculations)  
c. real gas behavior  

4. Energetics of chemical reactions  
a. exothermic and endothermic reactions  
b. bond energy; Hess’s law  

5. How the laws of thermodynamics relate to chemical reactions and phase changes  
a. laws of thermodynamics  
b. spontaneous/reversible processes  
c. change in enthalpy, entropy, and Gibbs energy in chemical/physical processes  

II. Atomic and Nuclear Structure  
1. Current model of atomic structure  
a. description of atomic model (e.g., subatomic particles, orbitals, quantum numbers)  
b. experimental basis (e.g., cathode ray tube, gold foil experiment, spectral lines)  
c. isotopes (mass number, average atomic mass)  
2. Electron configuration of the elements based on the periodic table  
a. Aufbau principle, Hund’s rule, Pauli exclusion principle  
b. correlation between electron configuration and periodic table  
c. relationship between electron configuration and chemical and physical properties  
3. Radioactivity  
a. characteristics of alpha particles, beta particles, and gamma radiation  
b. radioactive decay processes; half life  
c. fission, fusion, and other nuclear reactions  
d. balancing nuclear reactions and identifying products of nuclear reactions  
4. How the electronic absorption and emission spectra of elements are related to electron energy levels  
a. electronic energy transitions in atoms (e.g., ground state, excited states, emission/absorption of energy)  
b. energy of electronic absorption/emission spectral lines in various regions of the electromagnetic spectrum  
c. relationship between energy, frequency, and wavelength  

III. Nomenclature; Chemical Composition; Bonding and Structure  
A. Nomenclature and Chemical Composition  
1. Systematic names and chemical formulas of simple inorganic compounds  
a. binary compounds  
b. acids, bases, and salts  
c. hydrates  
2. Names of common organic compounds based on their functional groups  
a. alkanes, alkenes, and alkynes  
b. alcohols, ethers, ketones, aldehydes, amines  
3. Mole concept and how it applies to chemical composition  
a. Avogadro’s number, molar mass, and mole conversions  
b. calculation of empirical and molecular formulas  
c. percent composition  
B. Bonding and Structure  
1. Common properties of bonds  
a. relative bond lengths  
b. relative bond strengths  
2. Bond types  
a. ionic bonding  
b. covalent bonding (polar, nonpolar, hybridization)  
c. metallic bonding  
3. Structural formulas and molecular geometry (shape)  
a. Lewis structures including formal charges  
b. resonance structures  
c. molecular geometry (shape and approximate bond angles)  
4. Identify polar and nonpolar molecules  
a. analysis of bonding in the molecule  
b. symmetry of molecular structure
5. Intermolecular interactions
   a. hydrogen bonding
   b. London forces (instantaneous induced dipole-dipole)
   c. dipole-dipole
   d. dipole-induced dipole

6. How bonding and structure correlate with physical properties
   a. boiling points and melting points
   b. solubility
   c. equilibrium vapor pressure

IV. Chemical Reactions; Periodicity

A. Periodicity
   1. Basis of the periodic table and general layout
      a. arranged in groups and periods
      b. atomic number and mass
      c. symbols of the elements
      d. metals, nonmetals, metalloids
      e. transition elements
   2. Periodic trends in physical and chemical properties of the elements
      a. atomic/ionic radius
      b. ionization energy
      c. electron affinity
      d. electronegativity
      e. physical properties (e.g., boiling/melting points, conductivity)
      f. chemical reactivity

B. Chemical Reactions and Basic Principles
   1. Balancing chemical equations
      a. simple chemical equations
      b. chemical equations involving oxidation-reduction
   2. Stoichiometric calculations
      a. simple calculations based on balanced chemical equations involving moles, mass, and volume
      b. limiting reagent calculations and percent yield

3. Identify, write, and predict products of simple reaction types
   a. combustion, neutralization
   b. decomposition, dehydration
   c. single and double replacement
   d. oxidation-reduction

4. Chemical kinetics
   a. rate laws, rate constants, and reaction order
   b. activation energy and reaction mechanisms including catalysts
   c. factors affecting reaction rate such as concentration, surface area, and temperature

5. Chemical reaction equilibrium
   a. equilibrium constants
   b. Le Châtelier’s principle

6. Oxidation-reduction reactions and how to determine oxidation states
   a. oxidation states
   b. identify oxidation-reduction reactions and half reactions
   c. standard reduction potentials
   d. electrochemical reactivity series
   e. electrochemical cells

C. Biochemistry and Organic Chemistry
   1. Important biochemical compounds
      a. carbohydrates, including simple sugars
      b. lipids
      c. proteins and amino acids
      d. DNA and RNA
      e. products of photosynthesis and respiration
   2. Common organic compounds (i.e., identify functional groups)
      a. alcohols
      b. ketones and aldehydes
      c. alkanes, alkenes, and alkynes
      d. ethers
      e. carboxylic acids
      f. amines
      g. benzene
V. Solutions and Solubility; Acid-Base Chemistry

A. Solutions and Solubility

1. Solution terminology and calculations
   a. dilute, concentrated
   b. saturated, unsaturated, supersaturated
   c. solvent, solute
   d. concentration units (e.g., molarity, molality, mole fraction, parts per million (ppm), parts per billion (ppb), percent by mass or volume)
   e. preparation of solutions of varying concentrations

2. Factors affecting solubility and dissolution rate
   a. dissolution rate (i.e., temperature, pressure, surface area, agitation)
   b. solubility and solubility curves (temperature and pressure dependent)

3. Solution phenomena based on colligative properties
   a. freezing point depression
   b. boiling point elevation
   c. vapor pressure effects
   d. osmotic pressure

4. Common applications of equilibrium in ionic solutions
   a. solubility of ionic compounds (e.g., solubility rules, slightly soluble compounds)
   b. $K_{sp}$ calculations including percent dissociation and precipitation
   c. common ion effect
   d. electrolytes, nonelectrolytes, and electrical conductivity

B. Acid-Base Chemistry

1. Define and identify acids and bases and know their properties
   a. Arrhenius acids and bases
   b. Brønsted-Lowry acids and bases
   c. Lewis acids and bases
   d. neutralization and equivalence point

2. The pH scale and calculations involving pH and pOH
   a. pH scale
   b. calculation of pH and pOH
   c. calculation of $[H^+]$ and $[OH^-]$
   d. knows the meaning of $K_w$

3. Concepts and calculations involving acid-base titrations
   a. use and selection of indicators (e.g., phenolphthalein, litmus paper)
   b. endpoint determination
   c. calculations based on titrations

4. Equilibrium relationships in acid-base chemistry
   a. strong/weak acids and bases, including common examples
   b. monoprotic and polyprotic acids
   c. $K_a$, $K_b$, and percent dissociation
   d. hydrolysis (acidic and basic salts)
   e. buffer solutions

VI. Scientific Inquiry and Social Perspectives of Science

A. History and Nature of Scientific Inquiry

1. Processes involved in scientific inquiry
   a. formulating problems
   b. forming and testing hypotheses
   c. development of theories, models, and laws (postulates, assumptions)
   d. process skills including observing, concluding, comparing, inferring, categorizing, and generalizing

2. Experimental design
   a. testing hypotheses
   b. significance of controls
   c. use and identification of variables
   d. data collection planning
Step 1: Learn About Your Test

3. Nature of scientific knowledge
   a. subject to change
   b. consistent with experimental evidence
   c. reproducibility
   d. unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)

4. Major historical developments in chemistry and the contributions of major historical figures
   a. how current chemical principles and models developed over time
   b. major developments in chemistry (e.g., atomic model, ideal gas behavior) including major historical figures

B. Science, Technology, Society, and the Environment

1. Impact of chemistry and technology on society and the environment
   a. pharmaceuticals
   b. acid rain
   c. medical imaging
   d. air and water pollution
   e. greenhouse gases
   f. ozone layer depletion
   g. waste disposal and recycling
   h. nanotechnology

2. Applications of chemistry in daily life
   a. plastics, soap, batteries, fuel cells, and other consumer products
   b. water purification
   c. chemical properties of household products

3. Advantages and disadvantages associated with various types of energy production
   a. renewable and nonrenewable energy resources
   b. conservation and recycling
   c. pros and cons of power generation based on various sources such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power

VII. Scientific Procedures and Techniques

1. Collect, evaluate, manipulate, interpret, and report data
   a. significant figures in collected data and calculations
   b. organization and presentation of data
   c. knows how to interpret and draw conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variables, predictions and conclusions based on data)

2. Units of measurement, notation systems, conversions, and mathematics used in chemistry
   a. standard units of measurement
   b. unit conversion
   c. scientific notation
   d. measurement equipment

3. Basic error analysis
   a. determining mean
   b. accuracy and precision
   c. identifying sources and effects of error
   d. percent error

4. Appropriate preparation, use, storage, and disposal of materials in the laboratory
   a. appropriate use and storage
   b. safe disposal
   c. preparation for classroom use
   d. safe procedures and safety precautions

5. Appropriate use, maintenance, and calibration of laboratory equipment
   a. appropriate use and storage
   b. maintenance and calibration
   c. preparation for classroom use
   d. safety procedures and precautions when using equipment

6. Safety procedures and precautions for the high school chemistry laboratory
   a. location and use of standard safety equipment such as eyewash and shower
   b. laboratory safety rules for students
   c. appropriate apparel and conduct in the laboratory, such as wearing goggles
   d. emergency procedures
2. Familiarize Yourself with Test Questions

Become comfortable with the types of questions you’ll find on the Praxis tests

The Praxis assessments include a variety of question types: constructed response (for which you write a response of your own); selected response, for which you select one or more answers from a list of choices or make another kind of selection (e.g., by clicking on a sentence in a text or by clicking on part of a graphic); and numeric entry, for which you enter a numeric value in an answer field. You may be familiar with these question formats from taking other standardized tests. If not, familiarize yourself with them so you don’t spend time during the test figuring out how to answer them.

Understanding Computer-Delivered Questions

Questions on computer-delivered tests are interactive in the sense that you answer by selecting an option or entering text on the screen. 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 respond by clicking an oval to select a single answer from a list of answer choices.

However, interactive question types may also ask you to respond by:

- **Clicking more than one oval** to select answers from a list of choices.
- **Typing in an entry box.** When the answer is a number, you may be asked to enter a numerical 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 select your answers by clicking on a location (or locations) on a graphic such as a map or chart, as opposed to choosing your answer from a list.
- **Clicking on sentences.** In questions with reading passages, you may be asked to choose your answers 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 select answers from a list of choices and drag your answers to the appropriate location in a table, paragraph of text or graphic.
- **Selecting answer choices from a drop-down menu.** You may be asked to choose answers by selecting choices from a drop-down menu (e.g., to complete a sentence).

Remember that with every question you will get clear instructions.

Perhaps the best way to understand computer-delivered questions is to view the Computer-delivered Testing Demonstration on the Praxis web site to learn how a computer-delivered test works and see examples of some types of questions you may encounter.
Understanding Selected-Response Questions

Many selected-response questions begin with the phrase “which of the following.” Take a look at this example:

Which of the following is a flavor made from beans?
(A) Strawberry  
(B) Cherry  
(C) Vanilla  
(D) Mint

How would you answer this question?
All of the answer choices are flavors. Your job is to decide which of the flavors is the one made from beans.

Try following these steps to select the correct answer.

1) **Limit your answer to the choices given.** You may know that chocolate and coffee are also flavors made from beans, but they are not listed. Rather than thinking of other possible answers, focus only on the choices given (“which of the following”).

2) **Eliminate incorrect answers.** You may know that strawberry and cherry flavors are made from fruit and that mint flavor is made from a plant. That leaves vanilla as the only possible answer.

3) **Verify your answer.** You can substitute “vanilla” for the phrase “which of the following” and turn the question into this statement: “Vanilla is a flavor made from beans.” This will help you be sure that your answer is correct. If you’re still uncertain, try substituting the other choices to see if they make sense. You may want to use this technique as you answer selected-response questions on the practice tests.

Try a more challenging example
The vanilla bean question is pretty straightforward, but you’ll find that more challenging questions have a similar structure. For example:

Entries in outlines are generally arranged according to which of the following relationships of ideas?
(A) Literal and inferential  
(B) Concrete and abstract  
(C) Linear and recursive  
(D) Main and subordinate

You’ll notice that this example also contains the phrase “which of the following.” This phrase helps you determine that your answer will be a “relationship of ideas” from the choices provided. You are supposed to find the choice that describes how entries, or ideas, in outlines are related.

Sometimes it helps to put the question in your own words. Here, you could paraphrase the question in this way: “How are outlines usually organized?” Since the ideas in outlines usually appear as main ideas and subordinate ideas, the answer is (D).
QUICK TIP: Don’t be intimidated by words you may not understand. It might be easy to be thrown by words like “recursive” or “inferential.” Read carefully to understand the question and look for an answer that fits. An outline is something you are probably familiar with and expect to teach to your students. So slow down, and use what you know.

Watch out for selected-response questions containing “NOT,” “LEAST,” and “EXCEPT”
This type of question asks you to select the choice that does not fit. You must be very careful because it is easy to forget that you are selecting the negative. This question type is used in situations in which there are several good solutions or ways to approach something, but also a clearly wrong way.

How to approach questions about graphs, tables, or reading passages
When answering questions about graphs, tables, or reading passages, provide only the information that the questions ask for. In the case of a map or graph, you might want to read the questions first, and then look at the map or graph. In the case of a long reading passage, you might want to go ahead and read the passage first, noting places you think are important, and then answer the questions. Again, the important thing is to be sure you answer the questions as they refer to the material presented. So read the questions carefully.

How to approach unfamiliar formats
New question formats are developed from time to time to find new ways of assessing knowledge. Tests may include audio and video components, such as a movie clip or animation, instead of a map or reading passage. Other tests may allow you to zoom in on details in a graphic or picture.

Tests may also include interactive questions. These questions take advantage of technology to assess knowledge and skills in ways that standard selected-response questions cannot. 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.

QUICK TIP: Don’t make the questions more difficult than they are. Don’t read for hidden meanings or tricks. There are no trick questions on Praxis tests. They are intended to be serious, straightforward tests of your knowledge.

Understanding Constructed-Response Questions
Constructed-response questions require you to demonstrate your knowledge in a subject area by creating your own response to particular topics. Essays and short-answer questions are types of constructed-response questions.

For example, an essay question might present you with a topic and ask you to discuss the extent to which you agree or disagree with the opinion stated. You must support your position with specific reasons and examples from your own experience, observations, or reading.

Take a look at a few sample essay topics:

- “Celebrities have a tremendous influence on the young, and for that reason, they have a responsibility to act as role models.”
- “We are constantly bombarded by advertisements—on television and radio, in newspapers and magazines, on highway signs, and the sides of buses. They have become too pervasive. It’s time to put limits on advertising.”
- “Advances in computer technology have made the classroom unnecessary, since students and teachers are able to communicate with one another from computer terminals at home or at work.”
Keep these things in mind when you respond to a constructed-response question

1) **Answer the question accurately.** Analyze what each part of the question is asking you to do. If the question asks you to describe or discuss, you should provide more than just a list.

2) **Answer the question completely.** If a question asks you to do three distinct things in your response, you should cover all three things for the best score. Otherwise, no matter how well you write, you will not be awarded full credit.

3) **Answer the question that is asked.** Do not change the question or challenge the basis of the question. You will receive no credit or a low score if you answer another question or if you state, for example, that there is no possible answer.

4) **Give a thorough and detailed response.** You must demonstrate that you have a thorough understanding of the subject matter. However, your response should be straightforward and not filled with unnecessary information.

5) **Reread your response.** Check that you have written what you thought you wrote. Be sure not to leave sentences unfinished or omit clarifying information.

**QUICK TIP:** You may find that it helps to take notes on scratch paper so that you don't miss any details. Then you'll be sure to have all the information you need to answer the question.
3. Practice with Sample Test Questions

Answer practice questions and find explanations for correct answers

Sample Test Questions

The sample questions that follow illustrate the kinds of questions on the test. They are not, however, representative of the entire scope of the test in either content or difficulty. Answers with explanations follow the questions.

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.

1. Which of the following is the correct IUPAC name for \( \text{Ca}_2(\text{PO}_4)_2 \)?
   (A) Calcium phosphide
   (B) Calcium(III) phosphate
   (C) Calcium phosphate
   (D) Calcium biphosphate

2. Based on its position on the periodic table, which of the following has the largest atomic radius?
   (A) \( \text{Cs} \)
   (B) \( \text{Mg} \)
   (C) \( \text{I} \)
   (D) \( \text{Se} \)

3. If 50 mL of 0.02 \( M \) \( \text{Na}_2\text{SO}_4 \) is diluted with sufficient water to make a total volume of 200 mL, which of the following is the concentration of \( \text{Na}^+ \) ions in the diluted solution?
   (A) 0.005 \( M \)
   (B) 0.01 \( M \)
   (C) 0.02 \( M \)
   (D) 0.04 \( M \)

4. Which of the following is the number of significant figures in a mass that was recorded as 0.00100 g?
   (A) 1
   (B) 3
   (C) 4
   (D) 6

5. Of the following, which best describes smoke?
   (A) A suspension
   (B) An alloy
   (C) A solution
   (D) A homogeneous mixture

6. Which of the following scientists is known for developing a model of the atom?
   (A) Rosalind Franklin
   (B) George Washington Carver
   (C) John Dalton
   (D) Louis Pasteur

7. Which of the following is the ground-state electron configuration of \( \text{Mg}^{2+} \)?
   (A) \( 1s^2 2s^2 2p^6 3s^2 \)
   (B) \( 1s^2 2s^2 2p^6 \)
   (C) \( 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 \)
   (D) \( 1s^2 2s^2 2p^6 3s^2 3p^6 \)

8. How many oxygen atoms are in 2 moles of \( \text{CuSO}_4 \)?
   (A) 4
   (B) 8
   (C) \( 6.02 \times 10^{23} \)
   (D) \( 4.82 \times 10^{24} \)
9. At standard temperature and pressure (STP), what volume of CO₂ is produced when 1.000 mol of C₈H₁₈ undergoes complete combustion?
   (A) 179.2 L
   (B) 89.6 L
   (C) 22.4 L
   (D) 8.00 L

10. Which of the following is the approximate pH of a 1.0 × 10⁻³ M NaOH solution?
    (A) pH = 3.0
    (B) pH = 4.0
    (C) pH = 10.0
    (D) pH = 11.0

11. A well-designed experiment always includes which of the following?
    (A) A scientific law
    (B) A well-written conclusion
    (C) Multiple independent variables
    (D) A plan about how to measure the dependent variable

12. Which of the following is a unit that is used to describe bond lengths?
    (A) Erg
    (B) Bar
    (C) Nanometer
    (D) Coloumb

13. If a 20 g sample of a substance is compared to a 10 g sample of the same substance, both at 25°C, the 20 g sample will have a higher
    (A) density
    (B) thermal heat content
    (C) temperature
    (D) boiling point

14. Naturally occurring Ce has four stable isotopes, one of which is much more abundant than the others. The atomic weight for Ce is listed on the periodic table as 140.1. Based on the data, which is the most abundant isotope?
    (A) ¹³⁶Ce
    (B) ¹³⁸Ce
    (C) ¹⁴⁰Ce
    (D) ¹⁴²Ce

15. What is the empirical formula for CH₃CH₂CH₂COOH?
    (A) C₂H₂O₂
    (B) C₂H₄O
    (C) CH₃CH₂CH₂COO⁻ + H⁺
    (D) CH₃C⁻ + OH⁻

16. A(g) + B(g) → C(g)
    For the reaction represented above, when the concentrations of the starting materials A and B are both doubled, the initial rate of the reaction is doubled. Which of the following is a possible initial rate law for the reaction? ([A] is the concentration of A and [B] is the concentration of B.)
    (A) Rate = k[A]²[B]
    (B) Rate = k[A]²[B]
    (C) Rate = k[A][B]
    (D) Rate = k[A]

17. If the concentration of H⁺ in an aqueous solution at 25°C is 0.0002 M, what is the concentration of OH⁻ in the solution?
    (A) 5 × 10⁻⁸ M
    (B) 2 × 10⁻¹⁰ M
    (C) 5 × 10⁻¹⁰ M
    (D) 1 × 10⁻¹⁴ M
18. \( A(g) \rightleftharpoons B(g) \)
Which of the following is a clear indication that the reaction represented above is at equilibrium?
(A) All of \( A \) has been converted to \( B \).
(B) The mass of \( B \) equals the initial mass of \( A \).
(C) The concentration of \( A \) equals the concentration of \( B \).
(D) The rate of formation of \( B \) equals the rate of formation of \( A \).

19. Of the following molecules, which has the most polar covalent bonds?
(A) \( \text{HBr} \)
(B) \( \text{CH}_4 \)
(C) \( \text{Cl}_2 \)
(D) \( \text{H}_2 \)

20. \( 2 \text{KMnO}_4 + 3 \text{Na}_2\text{SO}_3 + \text{H}_2\text{O} \rightarrow 2 \text{MnO}_2 + 3 \text{Na}_2\text{SO}_4 + 2 \text{KOH} \)
Which of the following species is reduced in the oxidation-reduction reaction represented above?
(A) \( \text{K}^+ \)
(B) \( \text{Mn}^{7+} \)
(C) \( \text{Na}^+ \)
(D) \( \text{S}^{4+} \)

21. If a weak acid is titrated with a strong base, which of the following could be the \( \text{pH} \) at the equivalence point?
(A) \( \text{pH} = 2.0 \)
(B) \( \text{pH} = 6.0 \)
(C) \( \text{pH} = 7.0 \)
(D) \( \text{pH} = 8.0 \)

22. Which of the following must be done under a fume hood?
(A) Heating a sample of \( \text{HgO} \)
(B) Dissolving \( \text{KMnO}_4 \) in water
(C) Dissolving sugar crystals in an ethanol-water mixture
(D) Diluting a solution of \( \text{CH}_3\text{OH} \) with water

23. Two moles of an ideal gas in a freely expandable piston are heated from \( T_1 = 300 \text{ K} \) to \( T_2 = 400 \text{ K} \), and the gas expands from \( V_1 = 2 \text{ L} \) to \( V_2 = 4 \text{ L} \). What is the pressure after the expansion?
(A) \( P_2 = P_1 \)
(B) \( P_2 = \frac{1}{2} P_1 \)
(C) \( P_2 = 2P_1 \)
(D) \( P_2 = \frac{2}{3} P_1 \)

24. Ozone in the atmosphere is most closely related to which of the following?
(A) Acid rain production
(B) Water pollution
(C) Absorption of ultraviolet radiation in the stratosphere
(D) Nuclear-power plant waste

25. Which of the following represents a positron emission?
(A) \( ^{6}_6\text{B} \rightarrow ^{6}_5\text{Be} + \gamma \text{e} \)
(B) \( ^{210}_8\text{Po} \rightarrow ^{206}_8\text{Pb} + ^{4}_2\text{He} \)
(C) \( ^{144}_{58}\text{Ce} \rightarrow ^{144}_{56}\text{Pr} + ^{0}_0\text{e} \)
(D) \( ^{12}_{6}\text{C} + ^{4}_2\text{He} \rightarrow ^{16}_{8}\text{O} + ^{0}_1\text{n} \)
26. Br₂ has a lower boiling point than H₂O because of hydrogen bonding between H₂O molecules in liquid water. Which of the following intermolecular interactions exist between Br₂ molecules in the liquid phase?

(A) London dispersion forces
(B) Dipole-dipole forces
(C) Ionic bonding
(D) Covalent bonding

27. Which of the following is a carboxylic acid?

(A) CH₃CH₂COOH
(B) CH₃OCH₃
(C) H₂CO₃
(D) CH₃NH₂

28. For Mg(OH)₂ at room temperature, the solubility product $K_{sp}$ is approximately $1 \times 10^{-11}$. The magnitude of the solubility constant indicates which of the following about Mg(OH)₂?

(A) If sufficient Mg(OH)₂ is mixed with water, it can form $11 M$ Mg(OH)₂ (aq).
(B) It is a weak acid.
(C) It cannot form a saturated solution.
(D) It is only slightly soluble.

29. Of the following materials, which is most biodegradable?

(A) Glass bottle
(B) Petroleum
(C) Aluminum can
(D) Flashlight battery

30. Dry crystals of an unknown inorganic compound were heated in a dry glass test tube. The mass of the test tube and its solid contents was observed to be less after heating. Which TWO of the following could explain the observation?

(A) The crystals were a hydrate, and at least some of the water vaporized and escaped.
(B) The crystals were a compound that decomposed into two different solid compounds.
(C) A reaction occurred in which one of the products was a gas that escaped.
(D) The crystals were a compound that reacted with oxygen in the air to form a compound of lower mass than the original compound.

31. Which THREE of the following processes involve an increase in entropy?

(A) Ice melting
(B) Snow sublimating
(C) Dew forming on grass
(D) Sugar dissolving in water
Answers to Sample Questions

1. The correct answer is (C). Calcium phosphate is the correct name. Three calcium ions are bonded to two phosphate polyatomic ions.

2. The correct answer is (A). An atom of Cs has a larger radius than an atom of Mg, I, or Se based on its location on the periodic table. Going down the column, the atom radius generally increases, and going from left to right across a row, the atomic radius generally decreases. Cs is located near the lower corner on the left side of the periodic table.

3. The correct answer is (B). The concentration of \( Na^+ \) ions is 0.01 M:

\[
[Na^+] = \frac{(0.05 \text{ L})(0.2 M \text{ Na}_2\text{SO}_4)}{(0.2 \text{ L})} \times \frac{2 \text{ Na}^+}{\text{Na}_2\text{SO}_4} = 0.01 \text{ M}.
\]

Note that 50 mL is 0.05 L and 200 mL is 0.2 L.

4. The correct answer is (B). The numeral one and the two zeros following it are significant figures that reflect the precision of the measuring instrument that was used to determine the mass. The last zero is an estimate beyond the smallest increment that the instrument shows.

5. The correct answer is (A). Smoke is a suspension. Tiny particles are suspended by Brownian motion in the air (collisions with the molecules of nitrogen, oxygen, and other gases). Eventually, the particles may settle and collect on surfaces.

6. The correct answer is (C). John Dalton proposed an atomic theory in the 1800s, although he did scientific work in a number of other areas of science.

7. The correct answer is (B). The electron configuration for the \( Mg^{2+} \) ion based on the Aufbau principle is: \( 1s^2 2s^2 2p^6 \). Mg atoms each have 12 electrons, but \( Mg^{2+} \) ions each have 10 electrons.

8. The correct answer is (D). Two moles of \( \text{CuSO}_4 \) contain 8 moles of oxygen atoms. The number of oxygen atoms is 8 times Avogadro’s number:

\[ 8 \times 6.02 \times 10^{23} = 4.82 \times 10^{24} \text{ atoms}. \]

9. The correct answer is (A). The balanced equation for the reaction is:

\[ 2 \text{C}_2\text{H}_4\text{O}_2 + 25 \text{O}_2 \rightarrow 16 \text{CO}_2 + 18 \text{H}_2\text{O}. \]

Based on the balanced equation, 8 mol of \( \text{CO}_2 \) would be produced. The volume of 8 mol of \( \text{CO}_2 \) at STP is:

\[ 8 \times 22.4 \text{ L} = 179.2 \text{ L}. \]

10. The correct answer is (D). The concentration of \( H^+ \) in the solution is:

\[ [H^+] = 1 \times 10^{-14}/[\text{OH}^-]. \]

Since \( [\text{OH}^-] = 1 \times 10^{-3} \), then

\[ [H^+] = 1.0 \times 10^{-11}. \]

The pH of the solution is equal to:

\[ \log[H^+] = -\log(1.0 \times 10^{-11}) = 11.0. \]

11. The correct answer is (D). The experimental design should include a plan to measure the dependent variable and should have only one independent variable. Laws and conclusions are not part of an experimental design.

12. The correct answer is (C). Bond lengths are very small and are often described in terms of nanometers. A nanometer is \( 1 \times 10^{-9} \) meter. An erg is an energy unit, a bar is a pressure unit, and a coulomb is an electrical-charge unit.

13. The correct answer is (B). The 20 gram sample will have a higher thermal heat content because heat content depends on both the temperature and amount of the substance. Both samples will have the same density, temperature, and boiling point.

14. The correct answer is (C). The natural abundance of \( ^{140}\text{Ce} \) is 88.4%. The atomic mass list on the periodic table is a weighted average of the naturally occurring isotopes. Without doing calculations, it is clear that \( ^{140}\text{Ce} \) is most abundant, since the weighted average of the four isotopes is close to the atomic mass of \( ^{140}\text{Ce} \).

15. The correct answer is (B). The empirical formula is the smallest whole-number ratio of the atoms in the chemical compound. The empirical formula is \( \text{C}_3\text{H}_6\text{O} \).

16. The correct answer is (D). Rate = \( k[A] \) is a possible initial rate law that fits the data, because doubling \( A \) only would result in doubling the initial rate of reaction which agrees with the observed experimental results. Similarly, rate = \( k[B] \) is also a possible initial rate law that fits the data, but it is not one of the answer choices. The other answer choices would result in a larger increase in reaction rate than what was observed.

17. The correct answer is (C). At 298 K,

\[ K_w = 1 \times 10^{-14} = \frac{[H^+][\text{OH}^-]}{[\text{H}_2\text{O}]} \]

Based on this equilibrium,

\[ [\text{OH}^-] = 1 \times 10^{-14}/(0.0002) = 5 \times 10^{-11} M. \]
18. The correct answer is (D). At equilibrium, the rates of the forward and reverse reactions are equal. The concentrations of A and B can be found using the equilibrium constant. Since the concentrations of A and B will not be equal in most cases, answer choice (C) will not be a clear indication that the reaction is at equilibrium. The answer choices (A) and (B) are incorrect because the reactants in an equilibrium reaction are not completely converted to products.

19. The correct answer is (A). Since the difference in electronegativity between H and Br is greater than the electronegativity difference between C and H, the covalent bond between H and Br in HBr is more polar than the covalent bonds between C and H in CH4. There is a nonpolar covalent bond in Cl2 and in H2.

20. The correct answer is (B). Reduction involves a reduction of the formal oxidation number of the species. Mn4+ in KMnO4 is reduced to Mn2+ in MnO2. S6+ in Na2SO3 is oxidized to S4+ in Na2SO4. K+, Na+, and O2− and do not undergo a change in oxidation number.

21. The correct answer is (D). The pH of titration of a weak acid with a strong base will not be at 7.0 but will be at a basic pH, since the hydrolysis of the salt of the weak acid will provide OH− ions in solutions, resulting in a pH above 7.0. An example is the titration of the weak acid CH3COOH with the strong base NaOH. At the equivalence point of the titration, Na+ + CH3COO− + H2O have been produced. But there is a hydrolysis equilibrium that exists: H2O + CH3COO− → CH3COOH + OH−. Hence the pH will be above 7.0.

22. The correct answer is (A). When heated, mercuric oxide decomposes to liquid Hg and O2. It should be done under a fume hood. Mercuric oxide is toxic by inhalation or contact with skin and liquid Hg may form some Hg vapor. The other answer choices are safe to do without a fume hood.

23. The correct answer is (D). The pressure after the expansion (P2) is two-thirds the original pressure (P1). The relationship between the pressure, volume, and temperature before and after the process is: P2 = P1 × \( \frac{V_2}{V_1} \) × \( \frac{T_2}{T_1} \).

24. The correct answer is (C). Ozone absorbs harmful ultraviolet radiation in the stratosphere. It is not related to the other answer choices.

25. The correct answer is (A). It represents a positron emission. Answer choice (B) represents an alpha decay, answer choice (C) represents a negative beta emission, and answer choice (D) represents a nuclear fusion reaction.

26. The correct answer is (A). There are London forces of attraction between Br2 molecules in the liquid phase. Covalent bonding is an intramolecular interaction in Br2, not an intermolecular interaction. Ionic bonding and dipole-dipole interactions do not exist in Br2 molecules. Dipole-dipole interactions exist between polar molecules.

27. The correct answer is (A). Carboxylic acids contain the carboxyl functional group (—COOH), which contains a carbonyl group bonded to a hydroxyl group. Answer choice (B) is an ether, answer choice (C) is carbonic acid, and answer choice (D) is an amine.

28. The correct answer is (D). A very low Ksp indicates that Mg(OH)2 is only slightly soluble and will form a saturated solution with a very small concentration of Mg2+ and OH− ions present in solution. Hence, a 11 M solution cannot be prepared. It is a base, not an acid.

29. The correct answer is (B). Of the answer choices, petroleum is most biodegradable. Glass and aluminum can biodegrade but over very long time periods. Many of the components of the flashlight battery will not biodegrade.

30. The correct answers are (A) and (C). Inorganic hydrates are compounds that in their solid state contain some H2O molecules within their crystal lattice. When heated the water can vaporize, resulting in a lower mass for the remaining solid. An example of a hydrate is MgCO3 • H2O. When a reaction occurs in an open vessel in which one of the products is a gas, the gas can escape, resulting in a loss of mass. A decomposition reaction that produced two solid compounds would not result in a loss of mass. If an oxide had been produced in a reaction with oxygen, the mass of the contents would have increased, not decreased.

31. The correct answers are (A), (B), and (D). Entropy increases as solid ice becomes liquid water, as snow changes to gaseous water as it sublimes, and as sugar dissolves in water. Entropy decreases as gas water vapor condenses as a liquid on grass.
4. Determine Your Strategy for Success

*Set clear goals and deadlines so your test preparation is focused and efficient*

Effective *Praxis* test preparation doesn’t just happen. You’ll want to set clear goals and deadlines for yourself along the way. Otherwise, you may not feel ready and confident on test day.

1) **Learn what the test covers.**

You may have heard that there are several different versions of the same test. It’s true. You may take one version of the test and your friend may take a different version a few months later. Each test has different questions covering the same subject area, but both versions of the test measure the same skills and content knowledge.

You’ll find specific information on the test you’re taking on page 5, which outlines the content categories that the test measures and what percentage of the test covers each topic. Visit [www.ets.org/praxis/testprep](http://www.ets.org/praxis/testprep) for information on other *Praxis* tests.

2) **Assess how well you know the content.**

Research shows that test takers tend to overestimate their preparedness—this is why some test takers assume they did well and then find out they did not pass.

The *Praxis* tests are demanding enough to require serious review of likely content, and the longer you’ve been away from the content, the more preparation you will most likely need. If it has been longer than a few months since you've studied your content area, make a concerted effort to prepare.

3) **Collect study materials.**

Gathering and organizing your materials for review are critical steps in preparing for the *Praxis* tests. Consider the following reference sources as you plan your study:

- Did you take a course in which the content area was covered? If yes, do you still have your books or your notes?
- Does your local library have a high school-level textbook in this area? Does your college library have a good introductory college-level textbook in this area?

Practice materials are available for purchase for many *Praxis* tests at [www.ets.org/praxis/testprep](http://www.ets.org/praxis/testprep). Test preparation materials include sample questions and answers with explanations.

4) **Plan and organize your time.**

You can begin to plan and organize your time while you are still collecting materials. Allow yourself plenty of review time to avoid cramming new material at the end. Here are a few tips:

- Choose a test date far enough in the future to leave you plenty of preparation time. Test dates can be found at [www.ets.org/praxis/register/dates_centers](http://www.ets.org/praxis/register/dates_centers).
- Work backward from that date to figure out how much time you will need for review.
- Set a realistic schedule—and stick to it.
5) Practice explaining the key concepts.

Praxis tests with constructed-response questions assess your ability to explain material effectively. As a teacher, you’ll need to be able to explain concepts and processes to students in a clear, understandable way. What are the major concepts you will be required to teach? Can you explain them in your own words accurately, completely, and clearly? Practice explaining these concepts to test your ability to effectively explain what you know.

6) Understand how questions will be scored.

Scoring information can be found on page 42.

7) Develop a study plan.

A study plan provides a road map to prepare for the Praxis tests. It can help you understand what skills and knowledge are covered on the test and where to focus your attention. Use the study plan template on page 26 to organize your efforts.

And most important—get started!

Would a Study Group Work for You?

Using this guide as part of a study group

People who have a lot of studying to do sometimes find it helpful to form a study group with others who are working toward the same goal. Study groups give members opportunities to ask questions and get detailed answers. In a group, some members usually have a better understanding of certain topics, while others in the group may be better at other topics. As members take turns explaining concepts to one another, everyone builds self-confidence.

If the group encounters a question that none of the members can answer well, the group can go to a teacher or other expert and get answers efficiently. Because study groups schedule regular meetings, members study in a more disciplined fashion. They also gain emotional support. The group should be large enough so that multiple people can contribute different kinds of knowledge, but small enough so that it stays focused. Often, three to six members is a good size.

Here are some ways to use this guide as part of a study group:

- **Plan the group’s study program.** Parts of the study plan template, beginning on page 26 can help to structure your group's study program. By filling out the first five columns and sharing the worksheets, everyone will learn more about your group's mix of abilities and about the resources, such as textbooks, that members can share with the group. In the sixth column (“Dates I will study the content”), you can create an overall schedule for your group's study program.

- **Plan individual group sessions.** At the end of each session, the group should decide what specific topics will be covered at the next meeting and who will present each topic. Use the topic headings and subheadings in the Test at a Glance table on page 5 to select topics, and then select practice questions, beginning on page 15.

- **Prepare your presentation for the group.** When it’s your turn to present, prepare something that is more than a lecture. Write two or three original questions to pose to the group. Practicing writing actual questions can help you better understand the topics covered on the test as well as the types of questions you will encounter on the test. It will also give other members of the group extra practice at answering questions.
• **Take a practice test together.** The idea of a practice test is to simulate an actual administration of the test, so scheduling a test session with the group will add to the realism and may also help boost everyone’s confidence. Remember, complete the practice test using only the time that will be allotted for that test on your administration day.

• **Learn from the results of the practice test.** Review the results of the practice test, including the number of questions answered correctly in each content category. For tests that contain constructed-response questions, look at the Sample Test Questions section, which also contain sample responses to those questions and shows how they were scored. Then try to follow the same guidelines that the test scorers use.

• **Be as critical as you can.** You’re not doing your study partner(s) any favors by letting them get away with an answer that does not cover all parts of the question adequately.

• **Be specific.** Write comments that are as detailed as the comments about the sample responses. Indicate where and how your study partner(s) are doing an inadequate job of answering the question. Writing notes in the margins of the answer sheet may also help.

• **Be supportive.** Include comments that point out what your study partner(s) got right.

Then plan one or more study sessions based on aspects of the questions on which group members performed poorly. For example, each group member might be responsible for rewriting one paragraph of a response in which someone else did an inadequate job.

Whether you decide to study alone or with a group, remember that the best way to prepare is to have an organized plan. The plan should set goals based on specific topics and skills that you need to learn, and it should commit you to a realistic set of deadlines for meeting those goals. Then you need to discipline yourself to stick with your plan and accomplish your goals on schedule.
Step 5: Develop Your Study Plan

5. Develop Your Study Plan

Develop a personalized study plan and schedule

Planning your study time is important because it will help ensure that you review all content areas covered on the test. Use the sample study plan below as a guide. It shows a plan for the Core Academic Skills for Educators: Reading test. Following that is a study plan template that you can fill out to create your own plan. Use the “Learn about Your Test” and “Test Specifications” information beginning on page 5 to help complete it.

Use this worksheet to:
1. Define Content Areas: List the most important content areas for your test as defined in chapter 1.
2. Determine Strengths and Weaknesses: Identify your strengths and weaknesses in each content area.
3. Identify Resources: Identify the books, courses, and other resources you plan to use for each content area.
4. Study: Create and commit to a schedule that provides for regular study periods.

Praxis Test Name (Test Code): Core Academic Skills for Educators: Reading (5712)
Test Date: 9/15/15

<table>
<thead>
<tr>
<th>Content covered</th>
<th>Description of content</th>
<th>How well do I know the content? (scale 1–5)</th>
<th>What resources do I have/need for the content?</th>
<th>Where can I find the resources I need?</th>
<th>Dates I will study the content</th>
<th>Date completed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key Ideas and Details</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close reading</td>
<td>Draw inferences and implications from the directly stated content of a reading selection</td>
<td>3</td>
<td>Middle school English textbook</td>
<td>College library, middle school teacher</td>
<td>7/15/15</td>
<td>7/15/15</td>
</tr>
<tr>
<td>Determining Ideas</td>
<td>Identify summaries or paraphrases of the main idea or primary purpose of a reading selection</td>
<td>3</td>
<td>Middle school English textbook</td>
<td>College library, middle school teacher</td>
<td>7/17/15</td>
<td>7/17/15</td>
</tr>
<tr>
<td>Determining Ideas</td>
<td>Identify summaries or paraphrases of the supporting ideas and specific details in a reading selection</td>
<td>3</td>
<td>Middle and high school English textbook</td>
<td>College library, middle and high school teachers</td>
<td>7/20/15</td>
<td>7/21/15</td>
</tr>
<tr>
<td><strong>Craft, Structure, and Language Skills</strong></td>
<td></td>
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</tr>
<tr>
<td>Interpreting tone</td>
<td>Determine the author’s attitude toward material discussed in a reading selection</td>
<td>4</td>
<td>Middle and high school English textbook</td>
<td>College library, middle and high school teachers</td>
<td>7/25/15</td>
<td>7/26/15</td>
</tr>
<tr>
<td>Analysis of structure</td>
<td>Identify key transition words and phrases in a reading selection and how they are used</td>
<td>3</td>
<td>Middle and high school English textbook, dictionary</td>
<td>College library, middle and high school teachers</td>
<td>7/25/15</td>
<td>7/27/15</td>
</tr>
<tr>
<td>Analysis of structure</td>
<td>Identify how a reading selection is organized in terms of cause/effect, compare/contrast, problem/solution, etc.</td>
<td>5</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
<td>8/1/15</td>
<td>8/1/15</td>
</tr>
<tr>
<td>Author’s purpose</td>
<td>Determine the role that an idea, reference, or piece of information plays in an author’s discussion or argument</td>
<td>5</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
<td>8/1/15</td>
<td>8/1/15</td>
</tr>
</tbody>
</table>

(continued on next page)
### Step 5: Develop Your Study Plan

<table>
<thead>
<tr>
<th>Content covered</th>
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<th>How well do I know the content? (scale 1–5)</th>
<th>What resources do I have/need for the content?</th>
<th>Where can I find the resources I need?</th>
<th>Dates I will study the content</th>
<th>Date completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language in different contexts</td>
<td>Determine whether information presented in a reading selection is presented as fact or opinion</td>
<td>4</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
<td>8/1/15</td>
<td>8/1/15</td>
</tr>
<tr>
<td>Contextual meaning</td>
<td>Identify the meanings of words as they are used in the context of a reading selection</td>
<td>2</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
<td>8/1/15</td>
<td>8/1/15</td>
</tr>
<tr>
<td>Figurative Language</td>
<td>Understand figurative language and nuances in word meanings</td>
<td>2</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
<td>8/8/15</td>
<td>8/8/15</td>
</tr>
<tr>
<td>Vocabulary range</td>
<td>Understand a range of words and phrases sufficient for reading at the college and career readiness level</td>
<td>2</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
<td>8/15/15</td>
<td>8/17/15</td>
</tr>
<tr>
<td>Integration of Knowledge and Ideas</td>
<td>Diverse media and formats Analyze content presented in diverse media and formats, including visually and quantitatively, as well as in words</td>
<td>2</td>
<td>High school textbook, college course notes</td>
<td>College library, course notes, high school teacher, college professor</td>
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<td>Evaluation of arguments</td>
<td>Identify the relationship among ideas presented in a reading selection</td>
<td>4</td>
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<td>College library, course notes, high school teacher, college professor</td>
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<td>Evaluation of arguments</td>
<td>Determine whether evidence strengthens, weakens, or is relevant to the arguments in a reading selection</td>
<td>3</td>
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<td>College library, course notes, high school teacher, college professor</td>
<td>8/27/15</td>
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<tr>
<td>Evaluation of arguments</td>
<td>Determine the logical assumptions upon which an argument or conclusion is based</td>
<td>5</td>
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<td>Evaluation of arguments</td>
<td>Draw conclusions from material presented in a reading selection</td>
<td>5</td>
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<td>Comparison of texts</td>
<td>Recognize or predict ideas or situations that are extensions of or similar to what has been presented in a reading selection</td>
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<td>Comparison of texts</td>
<td>Apply ideas presented in a reading selection to other situations</td>
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<td>College library, course notes, high school teacher, college professor</td>
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# My Study Plan

Use this worksheet to:

1. **Define Content Areas:** List the most important content areas for your test as defined in chapter 1.
2. **Determine Strengths and Weaknesses:** Identify your strengths and weaknesses in each content area.
3. **Identify Resources:** Identify the books, courses, and other resources you plan to use for each content area.
4. **Study:** Create and commit to a schedule that provides for regular study periods.

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<table>
<thead>
<tr>
<th>Content covered</th>
<th>Description of content</th>
<th>How well do I know the content? (scale 1–5)</th>
<th>What resources do I have/need for this content?</th>
<th>Where can I find the resources I need?</th>
<th>Dates I will study this content</th>
<th>Date completed</th>
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### Step 5: Develop Your Study Plan

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<th>Where can I find the resources I need?</th>
<th>Dates I will study the content</th>
<th>Date completed</th>
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6. Study Topics

Detailled study topics with questions for discussion

Using the Study Topics That Follow

The Chemistry: Content Knowledge test is designed to measure the knowledge and skills necessary for a beginning teacher.

This chapter is intended to help you organize your preparation for the test and to give you a clear indication of the depth and breadth of the knowledge required for success on the test.

Virtually all accredited programs address the topics covered by the test; however, you are not expected to be an expert on all aspects of the topics that follow.

You are likely to find that the topics below are covered by most introductory textbooks. Consult materials and resources, including lecture and laboratory notes, from all your coursework. You should be able to match up specific topics and subtopics with what you have covered in your courses.

Try not to be overwhelmed by the volume and scope of content knowledge in this guide. Although a specific term may not seem familiar as you see it here, you might find you can understand it when applied to a real-life situation. Many of the items on the actual test will provide you with a context to apply to these topics or terms.

Discussion Areas

Interspersed throughout the study topics are discussion areas, presented as open-ended questions or statements. These discussion areas are intended to help test your knowledge of fundamental concepts and your ability to apply those concepts to situations in the classroom or the real world. Most of the areas require you to combine several pieces of knowledge to formulate an integrated understanding and response. If you spend time on these areas, you will gain increased understanding and facility with the subject matter covered on the test. You may want to discuss these areas and your answers with a teacher or mentor.

Note that this study companion does not provide answers for the discussion area questions, but thinking about the answers to them will help improve your understanding of fundamental concepts and will probably help you answer a broad range of questions on the test.
Study Topics

An overview of the areas covered on the test, along with their subareas, follows.

I. Basic Principles of Matter and Energy; Thermodynamics

A. Matter and Energy

1. Organization of matter
   a. pure substances (elements and compounds)
   b. mixtures (homogeneous, heterogeneous, solutions, suspensions)
   c. states of matter (solid, liquid, gas, plasma)

2. Particulate structure of matter
   a. atoms, ions, molecules

3. Differences between chemical and physical properties and chemical and physical changes
   a. chemical versus physical properties
   b. chemical versus physical changes
   c. intensive versus extensive properties

4. Conservation of energy and the conservation of matter in chemical processes
   a. law of conservation of energy
   b. law of conservation of matter

5. Different forms of energy
   a. kinetic and potential
   b. chemical, electrical, electromagnetic, nuclear, and thermal energy
   c. conversions between different forms of energy within chemical systems

Discussion areas: Matter and Energy

- Test tubes contain three colorless liquids: alcohol, water, and a weak solution of ammonia. What properties could be used to identify the liquids?
- What are some examples of the different types of mixtures?
- What is a cation?
- In their standard state, which of the following elements are diatomic: bromine, chlorine, argon, and helium?
- What are some examples of chemical properties?
- Describe a process that involves both a chemical change and a physical change?

B. Thermodynamics in Chemistry

1. Temperature, thermal energy, and heat capacity, including temperature scales, units of energy, and calculations involving these concepts
   a. temperature and temperature scales
   b. thermal energy and units of energy
   c. heat transfer
   d. heat capacity and specific heat
   e. calorimetric calculations

2. Concepts and calculations involving phase transitions between the various states of matter
   a. phase transitions and diagrams
   b. heats of vaporization, fusion, and sublimation
   c. heating curves

3. Kinetic molecular theory and ideal gas laws
   a. assumptions of the kinetic molecular theory
   b. ideal gases and the ideal gas laws (e.g., applications, calculations)
   c. real gas behavior

4. Energetics of chemical reactions
   a. exothermic and endothermic reactions
   b. bond energy; Hess’s law

5. How the laws of thermodynamics relate to chemical reactions and phase changes
   a. laws of thermodynamics
   b. spontaneous/reversible processes
   c. change in enthalpy, entropy, and Gibbs energy in chemical/physical processes

Discussion areas: Thermodynamics in Chemistry

- Convert $350 \text{ K}$ to degrees Celsius.
- Which of the following are units of energy: ergs, joules, electron volts, ohms?
Step 6: Study Topics

• If a substance has high heat capacity, will its temperature increase faster as heat is absorbed than for a substance with lower heat capacity absorbing the same amount of heat?

• How much heat is absorbed as 10 g of ice melts at the freezing point?

• What is the boiling point of water at high altitudes compared to sea level and why is it different?

• When a gas expands from 5 L to 10 L as its temperature increases from 300 K to 500 K, what is the change in the pressure of the gas?

• What are the major differences between an ideal gas and a real gas?

• Given the heats of formation of H₂O, CO₂, and CH₄, calculate the heat of combustion of CO₄

• Is the combustion of CH₄ an exothermic or endothermic process?

• Based on the first and second laws of thermodynamics, predict whether a reaction is spontaneous.

• Describe some processes in which the entropy of the system is increasing.

II. Atomic and Nuclear Structure

1. Current model of atomic structure
   a. description of atomic model (e.g., subatomic particles, orbitals, quantum numbers)
   b. experimental basis (e.g., cathode ray tube, gold foil experiment, spectral lines)
   c. isotopes (mass number, average atomic mass)

2. Electron configuration of the elements based on the periodic table
   a. Aufbau principle, Hund’s rule, Pauli exclusion principle
   b. correlation between electron configuration and periodic table
   c. relationship between electron configuration and chemical and physical properties

3. Radioactivity
   a. characteristics of alpha particles, beta particles, and gamma radiation
   b. radioactive decay processes; half life
   c. fission, fusion, and other nuclear reactions
   d. balancing nuclear reactions and identifying products of nuclear reactions

4. How the electronic absorption and emission spectra of elements are related to electron energy levels
   a. electronic energy transitions in atoms (e.g., ground state, excited states, emission/absorption of energy)
   b. energy of electronic absorption/emission spectral lines in various regions of the electromagnetic spectrum

Discussion areas: Atomic and Nuclear Structure

• How are isotopes of the same element alike? How are they different?

• An element has three isotopes, each with a different mass. Explain why the mass number for the element that is listed on the periodic table is not equal to the mass of any of the isotopes.

• What are the electron configurations for atoms of sodium and sulfur?

• Based on their electron configurations, what is the formula of the compound that forms in the reaction of sodium and sulfur?

• Give an example of Hund’s rule.

• Given that the half-life of carbon-14 is 5,730 years, estimate the age of a piece of charcoal that has a carbon-14 content equal to 12.5% of that in living matter.

• How is fission different than fusion or radioactive decay?

• What is the wavelength of the energy emitted for an electronic transition in a hydrogen atom from \( n = 3 \) to \( n = 2 \) electronic energy level?

• What part of the electromagnetic spectrum are electron emission spectral lines?
III. **Nomenclature; Chemical Composition; Bonding and Structure**

A. **Nomenclature and Chemical Composition**

1. Systematic names and chemical formulas of simple inorganic compounds
   - a. binary compounds
   - b. acids, bases, and salts
   - c. hydrates

2. Names of common organic compounds based on their functional groups
   - a. alkanes, alkenes, and alkynes
   - b. alcohols, ethers, ketones, aldehydes, amines

3. Mole concept and how it applies to chemical composition
   - a. Avogadro’s number, molar mass, and mole conversions
   - b. calculation of empirical and molecular formulas
   - c. percent composition

B. **Bonding and Structure**

1. Common properties of bonds
   - a. relative bond lengths
   - b. relative bond strengths

2. Bond types
   - a. ionic bonding
   - b. covalent bonding (polar, nonpolar, hybridization)
   - c. metallic bonding

3. Structural formulas and molecular geometry (shape)
   - a. Lewis structures including formal charges
   - b. resonance structures
   - c. molecular geometry (shape and approximate bond angles)

4. Identify polar and nonpolar molecules
   - a. analysis of bonding in the molecule
   - b. symmetry of molecular structure

5. Intermolecular interactions
   - a. hydrogen bonding
   - b. London forces (instantaneous induced dipole-dipole)
   - c. dipole-dipole
   - d. dipole-induced dipole

6. How bonding and structure correlate with physical properties
   - a. boiling points and melting points
   - b. solubility
   - c. equilibrium vapor pressure

**Discussion areas: Nomenclature; Chemical Composition; Bonding and Structure**

- What are the IUPAC names for the following compounds: $\text{HClO}_4$, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, and $\text{CuCl}_2$?
- Write the molecular formula for each of the following compounds: acetone, ethanol, ethanal, and formic acid.
- What is the number of moles of oxygen atoms in 5 moles of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$?
- What is the molecular formula of a compound that has the empirical formula $\text{C}_2\text{H}_4\text{O}$ and a molar mass of 88 g?
- Which of the following molecules has the shortest bond length: $\text{HF}$, $\text{HCl}$, $\text{N}_2$, or $\text{O}_2$?
- Which type of bonding is found in each of the following solids: KCl, NaSO$_4$, and Cu?
- What is the difference between a pi bond and a sigma bond?
- Why is the geometry of $\text{NH}_3$ trigonal pyramidal?
- What are the Lewis dot and the structural formulas for $\text{CH}_4$?
- What are the resonance structures for the carbonate ion?
- Does $\text{CO}_2$ have any polar bonds? Is it a polar molecule? Why?
- What is the predominate intermolecular force involved between two PCl$_3$ molecules?
- Correlate the relative boiling points of the following compounds with their molecular structure and intermolecular interactions: $\text{H}_2\text{O}$, Cl$_2$, Br$_2$, HCl, and H$_2$. 
IV. Chemical Reactions; Periodicity

A. Periodicity

1. Basis of the periodic table and general layout
   a. arranged in groups and periods
   b. atomic number and mass
   c. symbols of the elements
   d. metals, nonmetals, metalloids
   e. transition elements

2. Periodic trends in physical and chemical properties of the elements
   a. atomic/ionic radius
   b. ionization energy
   c. electron affinity
   d. electronegativity
   e. physical properties (e.g., boiling/melting points, conductivity)
   f. chemical reactivity

B. Chemical Reactions and Basic Principles

1. Balancing chemical equations
   a. simple chemical equations
   b. chemical equations involving oxidation-reduction

2. Stoichiometric calculations
   a. simple calculations based on balanced chemical equations involving moles, mass, and volume
   b. limiting reagent calculations and percent yield

3. Identify, write, and predict products of simple reaction types
   a. combustion, neutralization
   b. decomposition, dehydration
   c. single and double replacement
   d. oxidation-reduction

4. Chemical kinetics
   a. rate laws, rate constants, and reaction order
   b. activation energy and reaction mechanisms including catalysts
   c. factors affecting reaction rate such as concentration, surface area, and temperature

5. Chemical reaction equilibrium
   a. equilibrium constants
   b. Le Châtelier’s principle

6. Oxidation-reduction reactions and how to determine oxidation states
   a. oxidation states
   b. identify oxidation-reduction reactions and half reactions
   c. standard reduction potentials
   d. electrochemical reactivity series
   e. electrochemical cells

C. Biochemistry and Organic Chemistry

1. Important biochemical compounds
   a. carbohydrates, including simple sugars
   b. lipids
   c. proteins and amino acids
   d. DNA and RNA
   e. products of photosynthesis and respiration

2. Common organic compounds (i.e., identify functional groups)
   a. alcohols
   b. ketones and aldehydes
   c. alkanes, alkenes, and alkynes
   d. ethers
   e. carboxylic acids
   f. amines
   g. benzene

Discussion areas: Chemical reactions; Periodicity

• In what location of the periodic table are nonmetals generally found?

• List some examples of transition elements

• How do the atomic radii, ionization energies, and melting points change across period and down columns in the periodic table?

• Using the location of the elements on the periodic table, predict the formula of the compound that would exist containing Mg and O.

• What needs to be considered when balancing oxidation-reduction reactions that does not need to be accounted for when balancing a standard formation reaction such as:

  \[ 2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O} \]?

• At standard temperature and pressure, what is the ratio of the volumes of hydrogen gas and oxygen gas that react to form water?

• What is the limiting reagent in the reaction to form water, when 10 g of hydrogen is mixed with 32 g of oxygen?
• How is a decomposition reaction different from a dehydration reaction?
• What is the effect of temperature and catalysts on reaction rates?
• How are simple rate equations determined based on experimental data?
• What changes will occur to chemical systems that are at equilibrium when pressure or concentration of one of the reactants or products is changed?
• What is the effect of temperature on equilibrium constants?
• Based on a table of standard reduction potentials, predict whether the following reaction will occur spontaneously:
  \[ \text{Cu} + \text{FeCl}_2 \rightarrow \text{CuCl}_2 + \text{Fe} \]
• What is the oxidation state of Mn in \( \text{KMnO}_4 \) ?
• What are the structures in the following types of molecules that distinguish them from other biochemical compounds:
  Carbohydrates, amino acids, and DNA?
• Identify the functional group in each of the following compounds:
  \( \text{CH}_3\text{OCH}_3 \), \( \text{CH}_3\text{NH}_2 \), \( \text{CH}_3\text{OH} \), and \( \text{CH}_3\text{COOH} \).

V. Solutions and Solubility; Acid-Base Chemistry

A. Solutions and Solubility
1. Solution terminology and calculations
   a. dilute, concentrated
   b. saturated, unsaturated, supersaturated
   c. solvent, solute
   d. concentration units (e.g., molarity, molality, mole fraction, parts per million (ppm), parts per billion (ppb), percent by mass or volume)
   e. preparation of solutions of varying concentrations
2. Factors affecting solubility and dissolution rate
   a. dissolution rate (i.e., temperature, pressure, surface area, agitation)
   b. solubility and solubility curves (temperature and pressure dependent)
3. Solution phenomena based on colligative properties
   a. freezing point depression
   b. boiling point elevation
   c. vapor pressure effects
   d. osmotic pressure
4. Common applications of equilibrium in ionic solutions
   a. solubility of ionic compounds (e.g., solubility rules, slightly soluble compounds)
   b. \( K_{sp} \) calculations including percent dissociation and precipitation
   c. common ion effect
   d. electrolytes, nonelectrolytes, and electrical conductivity

B. Acid-Base Chemistry
1. Define and identify acids and bases and know their properties
   a. Arrhenius acids and bases
   b. Brønsted-Lowry acids and bases
   c. Lewis acids and bases
   d. neutralization and equivalence point
2. The pH scale and calculations involving pH and pOH
   a. pH scale
   b. calculation of pH and pOH
   c. calculation of \( [\text{H}^+] \) and \( [\text{OH}^-] \)
   d. knows the meaning of \( K_W \)
3. Concepts and calculations involving acid-base titrations
   a. use and selection of indicators (e.g., phenolphthalein, litmus paper)
   b. endpoint determination
   c. calculations based on titrations
4. Equilibrium relationships in acid-base chemistry
   a. strong/weak acids and bases, including common examples
   b. monoprotic and polyprotic acids
   c. \( K_{b1} \) and \( K_{b2} \), and percent dissociation
   d. hydrolysis (acidic and basic salts)
   e. buffer solutions

Discussion areas: Solutions and Solubility; Acid-Base Chemistry
• How many grams of solute are present in 1.5 L of 0.30 M \( \text{KNO}_3 \)?
• What is the difference between a 1 molar \( \text{NaCl} \) solution and a 1 molal \( \text{NaCl} \) solution?
Step 6: Study Topics

- Is a very concentrated solution saturated, supersaturated, or unsaturated? What else do you need to know to answer the question?
- Why is ammonia gas very soluble in water while oxygen is only slightly soluble?
- What is the relationship between surface area and dissolution rate?
- Will increasing temperature increase the solubility of any substance?
- How will the vapor pressure, boiling point, and freezing point of water change when a nonvolatile solute is added to water?
- Compare the degree of dissociation of HCl and \( \text{H}_2\text{S} \) in water.
- Write a chemical equation that illustrates the common ion effect.
- Is \( \text{CCl}_4 \) an electrolyte?
- When an aqueous solution of NaCl is mixed with an aqueous solution of \( \text{AgNO}_3 \) the precipitate AgCl forms. Why?
- Select an acid that is both a Brønsted-Lowry acid and a Lewis acid and explain why it fits both definitions.
- What is \( [\text{H}^+] \) in an aqueous solution with \( \text{pH} = 5.5 \) ?
- What is the \( \text{pOH} \) of a solution with \( [\text{H}^+] = 1 \times 10^{-8} \text{ M} \) ?
- Based on a titration curve, determine the \( \text{pK}_a \) of the acid and the volume of base required to neutralize the acid.
- What indicator would be used in a titration involving a strong acid and a weak base and why?
- Is HF a strong acid? Why or why not?
- If Na\(_2\)CO\(_3\) is dissolved in water, will the solution be acidic, basic, or neutral?
- For an acid HA, \( K_a = 1 \times 10^{-10} \), what is the pH of 0.001 M HA?

VI. Scientific Inquiry and Social Perspectives of Science

A. History and Nature of Scientific Inquiry

1. Processes involved in scientific inquiry
   - formulating problems
   - forming and testing hypotheses
   - development of theories, models, and laws (postulates, assumptions)
   - process skills including observing, concluding, comparing, inferring, categorizing, and generalizing

2. Experimental design
   - testing hypotheses
   - significance of controls
   - use and identification of variables
   - data collection planning

3. Nature of scientific knowledge
   - subject to change
   - consistent with experimental evidence
   - reproducibility
   - unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)

4. Major historical developments in chemistry and the contributions of major historical figures
   - how current chemical principles and models developed over time
   - major developments in chemistry (e.g., atomic model, ideal gas behavior) including major historical figures

B. Science, Technology, Society, and the Environment

1. Impact of chemistry and technology on society and the environment
   - pharmaceuticals
   - acid rain
   - medical imaging
   - air and water pollution
   - greenhouse gases
   - ozone layer depletion
   - waste disposal and recycling
   - nanotechnology

2. Applications of chemistry in daily life
   - plastics, soap, batteries, fuel cells, and other consumer products
   - water purification
   - chemical properties of household products
Step 6: Study Topics

3. Advantages and disadvantages associated with various types of energy production
   a. renewable and nonrenewable energy resources
   b. conservation and recycling
   c. pros and cons of power generation based on various sources such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power

Discussion area: Scientific Inquiry and Social Perspectives of Science

• What are the similarities and differences between laws, hypotheses, and theories?
• What is the difference between independent and dependent variables? Describe an experiment and identify the independent and the dependent variables.
• Describe something in chemistry that illustrates the relationship between form and function.
• What is Boyle’s law and what is Charles’s law?
• What was the role of Bohr’s model of the atom in the development of modern atomic theory?
• What are the major contributors of acid rain?
• What are some of the reactions in the stratosphere that lead to ozone depletion?
• What are the acid-base properties of commonly used consumer products such as ammonia cleaner, vinegar, and orange juice?
• Describe the reverse osmosis process that is sometimes used for water purification.
• In what settings is solar power most effective?
• What are some examples of nonrenewable energy resources?

VII. Scientific Procedures and Techniques

1. Collect, evaluate, manipulate, interpret, and report data
   a. significant figures in collected data and calculations
   b. organization and presentation of data
   c. knows how to interpret and draw conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variables, predictions and conclusions based on data)

2. Units of measurement, notation systems, conversions, and mathematics used in chemistry
   a. standard units of measurement
   b. unit conversion
   c. scientific notation
   d. measurement equipment

3. Basic error analysis
   a. determining mean
   b. accuracy and precision
   c. identifying sources and effects of error
   d. percent error

4. Appropriate preparation, use, storage, and disposal of materials in the laboratory
   a. appropriate use and storage
   b. safe disposal
   c. preparation for classroom use
   d. safe procedures and safety precautions

5. Appropriate use, maintenance, and calibration of laboratory equipment
   a. appropriate use and storage
   b. maintenance and calibration
   c. preparation for classroom use
   d. safety procedures and precautions when using equipment

6. Safety procedures and precautions for the high school chemistry laboratory
   a. location and use of standard safety equipment such as eyewash and shower
   b. laboratory safety rules for students
   c. appropriate apparel and conduct in the laboratory, such as wearing goggles
   d. emergency procedures

Discussion areas: Scientific Procedures and Techniques

• What is the uncertainty in volume measurements made when using a buret and how many significant figures should be included in the recorded volume?
Step 6: Study Topics

- How many significant figures are in 0.1360 g?
- Determine the endpoint in an acid-base titration using a plot of pH versus the volume of base added to an acid.
- What is the mass in grams of a sample that has a mass of 20 mg?
- Express the number 0.000450 in scientific notation.
- What is the difference between the accuracy and the precision of a data set?
- How do you prepare 200 mL of 0.5 M CaSO₄ from a stock solution of 2.0 M CaSO₄?
- Can a very dilute solution of HCl acid be disposed of in a sink with running water?
- What are the following pieces of equipment used for in the laboratory: buret, pipet, Erlenmeyer flask, and volumetric flask?
- When and why is a fume hood needed in a chemistry laboratory?
7. Review Smart Tips for Success

**Follow test-taking tips developed by experts**

Learn from the experts. Take advantage of the following answers to questions you may have and practical tips to help you navigate the *Praxis* test and make the best use of your time.

**Should I guess?**

Yes. Your score is based on the number of questions you answer correctly, with no penalty or subtraction for an incorrect answer. When you don't know the answer to a question, try to eliminate any obviously wrong answers and then guess at the correct one. Try to pace yourself so that you have enough time to carefully consider every question.

**Can I answer the questions in any order?**

You can answer the questions in order or skip questions and come back to them later. If you skip a question, you can also mark it so that you can remember to return and answer it later. Remember that questions left unanswered are treated the same as questions answered incorrectly, so it is to your advantage to answer every question.

**Are there trick questions on the test?**

No. There are no hidden meanings or trick questions. All of the questions on the test ask about subject matter knowledge in a straightforward manner.

**Are there answer patterns on the test?**

No. You might have heard this myth: the answers on tests follow patterns. Another myth is that there will never be more than two questions in a row with the correct answer in the same position among the choices. Neither myth is true. Select the answer you think is correct based on your knowledge of the subject.

**Can I write on the scratch paper I am given?**

Yes. You can work out problems on the scratch paper, make notes to yourself, or write anything at all. Your scratch paper will be destroyed after you are finished with it, so use it in any way that is helpful to you. But make sure to select or enter your answers on the computer.

**Smart Tips for Taking the Test**

1. **Skip the questions you find extremely difficult.** Rather than trying to answer these on your first pass through the test, you may want to leave them blank and mark them so that you can return to them later. Pay attention to the time as you answer the rest of the questions on the test, and try to finish with 10 or 15 minutes remaining so that you can go back over the questions you left blank. Even if you don't know the answer the second time you read the questions, see if you can narrow down the possible answers, and then guess. Your score is based on the number of right answers, so it is to your advantage to answer every question.
2. **Keep track of the time.** The on-screen clock will tell you how much time you have left. You will probably have plenty of time to answer all of the questions, but if you find yourself becoming bogged down, you might decide to move on and come back to any unanswered questions later.

3. **Read all of the possible answers before selecting one.** For questions that require you to select more than one answer, or to make another kind of selection, consider the most likely answers given what the question is asking. Then reread the question to be sure the answer(s) you have given really answer the question. Remember, a question that contains a phrase such as “Which of the following does NOT …” is asking for the one answer that is NOT a correct statement or conclusion.

4. **Check your answers.** If you have extra time left over at the end of the test, look over each question and make sure that you have answered it as you intended. Many test takers make careless mistakes that they could have corrected if they had checked their answers.

5. **Don’t worry about your score when you are taking the test.** No one is expected to answer all of the questions correctly. Your score on this test is not analogous to your score on the GRE® or other tests. It doesn’t matter on the Praxis tests whether you score very high or barely pass. If you meet the minimum passing scores for your state and you meet the state’s other requirements for obtaining a teaching license, you will receive a license. In other words, what matters is meeting the minimum passing score. You can find passing scores for all states that use the Praxis tests at [http://www.ets.org/s/praxis/pdf/passing_scores.pdf](http://www.ets.org/s/praxis/pdf/passing_scores.pdf) or on the web site of the state for which you are seeking certification/licensure.

6. **Use your energy to take the test, not to get frustrated by it.** Getting frustrated only increases stress and decreases the likelihood that you will do your best. Highly qualified educators and test development professionals, all with backgrounds in teaching, worked diligently to make the test a fair and valid measure of your knowledge and skills. Your state painstakingly reviewed the test before adopting it as a licensure requirement. The best thing to do is concentrate on answering the questions.
8. Check on Testing Accommodations

See if you qualify for accommodations to take the Praxis test

What if English is not my primary language?

Praxis tests are given only in English. If your primary language is not English (PLNE), you may be eligible for extended testing time. For more details, visit www.ets.org/praxis/register/plne_accommodations/.

What if I have a disability or other health-related need?

The following accommodations are available for Praxis test takers who meet the Americans with Disabilities Act (ADA) Amendments Act disability requirements:

• Extended testing time
• Additional rest breaks
• Separate testing room
• Writer/recorder of answers
• Test reader
• Sign language interpreter for spoken directions only
• Perkins Brailler
• Braille slate and stylus
• Printed copy of spoken directions
• Oral interpreter
• Audio test
• Braille test
• Large print test book
• Large print answer sheet
• Listening section omitted

For more information on these accommodations, visit www.ets.org/praxis/register/disabilities.

Note: Test takers who have health-related needs requiring them to bring equipment, beverages, or snacks into the testing room or to take extra or extended breaks must request these accommodations by following the procedures described in the Bulletin Supplement for Test Takers with Disabilities or Health-Related Needs (PDF), which can be found at http://www.ets.org/s/disabilities/pdf/bulletin_supplement_test_takers_with_disabilities_health_needs.pdf.

You can find additional information on available resources for test takers with disabilities or health-related needs at www.ets.org/disabilities.
9. Do Your Best on Test Day

Get ready for test day so you will be calm and confident

You followed your study plan. You prepared for the test. Now it’s time to prepare for test day.

Plan to end your review a day or two before the actual test date so you avoid cramming. Take a dry run to the test center so you’re sure of the route, traffic conditions, and parking. Most of all, you want to eliminate any unexpected factors that could distract you from your ultimate goal—passing the Praxis test!

On the day of the test, you should:

- be well rested
- wear comfortable clothes and dress in layers
- eat before you take the test
- bring an acceptable and valid photo identification with you
- bring an approved calculator only if one is specifically permitted for the test you are taking (see Calculator Use, at http://www.ets.org/praxis/test_day/policies/calculators)
- be prepared to stand in line to check in or to wait while other test takers check in

You can’t control the testing situation, but you can control yourself. Stay calm. The supervisors are well trained and make every effort to provide uniform testing conditions, but don’t let it bother you if the test doesn’t start exactly on time. You will have the allotted amount of time once it does start.

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

What items am I restricted from bringing into the test center?

You cannot bring into the test center personal items such as:

- handbags, knapsacks, or briefcases
- water bottles or canned or bottled beverages
- study materials, books, or notes
- pens, pencils, scrap paper, or calculators, unless specifically permitted for the test you are taking (see Calculator Use, at http://www.ets.org/praxis/test_day/policies/calculators)
- any electronic, photographic, recording, or listening devices

Personal items are not allowed in the testing room and will not be available to you during the test or during breaks. You may also be asked to empty your pockets. At some centers, you will be assigned a space to store your belongings, such as handbags and study materials. Some centers do not have secure storage space available, so please plan accordingly.

Test centers assume no responsibility for your personal items.
If you have health-related needs requiring you to bring equipment, beverages or snacks into the testing room or to take extra or extended breaks, you need to request accommodations in advance. Procedures for requesting accommodations are described in the Bulletin Supplement for Test Takers with Disabilities or Health-related Needs (PDF).

Note: All cell phones, smart phones (e.g., Android® devices, iPhones®, etc.), and other electronic, photographic, recording, or listening devices are strictly prohibited from the test center. If you are seen with such a device, you will be dismissed from the test, your test scores will be canceled, and you will forfeit your test fees. If you are seen using such a device, the device will be confiscated and inspected. For more information on what you can bring to the test center, visit www.ets.org/praxis/test_day/bring.

Are You Ready?

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

- Do you know the testing requirements for the license or certification you are seeking in the state(s) where you plan to teach?
- Have you followed all of the test registration procedures?
- Do you know the topics that will be covered in each test you plan to take?
- Have you reviewed any textbooks, class notes, and course readings that relate to the topics 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 types of questions for your test?
- Are you familiar with the recommended test-taking strategies?
- Have you practiced by working through the practice questions in this study companion or in a study guide or practice test?
- If constructed-response questions are part of your test, do you understand the scoring criteria for these questions?
- If you are repeating a Praxis test, have you analyzed your previous score report to determine areas where additional study and test preparation could be useful?

If you answered "yes" to the questions above, your preparation has paid off. Now take the Praxis test, do your best, pass it—and begin your teaching career!
10. Understand Your Scores

_Understand how tests are scored and how to interpret your test scores_

Of course, passing the _Praxis_ test is important to you so you need to understand what your scores mean and what your state requirements are.

**What are the score requirements for my state?**

States, institutions, and associations that require the tests set their own passing scores. Visit [www.ets.org/praxis/states](http://www.ets.org/praxis/states) for the most up-to-date information.

**If I move to another state, will my new state accept my scores?**

The _Praxis_ tests are part of a national testing program, meaning that they are required in many states for licensure. The advantage of a national program is that if you move to another state that also requires _Praxis_ tests, you can transfer your scores. Each state has specific test requirements and passing scores, which you can find at [www.ets.org/praxis/states](http://www.ets.org/praxis/states).

**How do I know whether I passed the test?**

Your score report will include information on passing scores for the states you identified as recipients of your test results. If you test in a state with automatic score reporting, you will also receive passing score information for that state.

A list of states and their passing scores for each test are available online at [www.ets.org/praxis/states](http://www.ets.org/praxis/states).

**What your _Praxis_ scores mean**

You received your score report. Now what does it mean? It’s important to interpret your score report correctly and to know what to do if you have questions about your scores.


To access _Understanding Your Praxis Scores_, a document that provides additional information on how to read your score report, visit [www.ets.org/praxis/scores/understand](http://www.ets.org/praxis/scores/understand).

**Put your scores in perspective**

Your score report indicates:

- Your score and whether you passed
- The range of possible scores
- The raw points available in each content category
- The range of the middle 50 percent of scores on the test

If you have taken the same _Praxis_ test or other _Praxis_ tests in the last 10 years, your score report also lists the highest score you earned on each test taken.
Content category scores and score interpretation

Questions on the Praxis tests are categorized by content. To help you in future study or in preparing to retake the test, your score report shows how many raw points you earned in each content category. Compare your “raw points earned” with the maximum points you could have earned (“raw points available”). The greater the difference, the greater the opportunity to improve your score by further study.

Score scale changes

ETS updates Praxis tests on a regular basis to ensure they accurately measure the knowledge and skills that are required for licensure. When tests are updated, the meaning of the score scale may change, so requirements may vary between the new and previous versions. All scores for previous, discontinued tests are valid and reportable for 10 years, provided that your state or licensing agency still accepts them.

These resources may also help you interpret your scores:

- Understanding Your Praxis Scores (PDF), found at www.ets.org/praxis/scores/understand
- The Praxis Passing Scores (PDF), found at www.ets.org/praxis/scores/understand
- State requirements, found at www.ets.org/praxis/states
Appendix: Other Questions You May Have

Here is some supplemental information that can give you a better understanding of the Praxis tests.

What do the Praxis tests measure?
The Praxis tests measure the specific knowledge and skills that beginning teachers need. The tests do not measure an individual’s disposition toward teaching or potential for success, nor do they measure your actual teaching ability. The assessments are designed to be comprehensive and inclusive but are limited to what can be covered in a finite number of questions and question types. Teaching requires many complex skills that are typically measured in other ways, including classroom observation, video recordings, and portfolios.

Ranging from Agriculture to World Languages, there are more than 80 Praxis tests, which contain selected-response questions or constructed-response questions, or a combination of both.

Who takes the tests and why?
Some colleges and universities use the Praxis Core Academic Skills for Educators tests (Reading, Writing, and Mathematics) to evaluate individuals for entry into teacher education programs. The assessments are generally taken early in your college career. Many states also require Core Academic Skills test scores as part of their teacher licensing process.

Individuals entering the teaching profession take the Praxis content and pedagogy tests as part of the teacher licensing and certification process required by many states. In addition, some professional associations and organizations require Praxis Subject Assessments for professional licensing.

Do all states require these tests?
The Praxis tests are currently required for teacher licensure in approximately 40 states and United States territories. These tests are also used by several professional licensing agencies and by several hundred colleges and universities. Teacher candidates can test in one state and submit their scores in any other state that requires Praxis testing for licensure. You can find details at www.ets.org/praxis/states.

What is licensure/certification?
Licensure in any area—medicine, law, architecture, accounting, cosmetology—is an assurance to the public that the person holding the license possesses sufficient knowledge and skills to perform important occupational activities safely and effectively. In the case of teacher licensing, a license tells the public that the individual has met predefined competency standards for beginning teaching practice.

Because a license makes such a serious claim about its holder, licensure tests are usually quite demanding. In some fields, licensure tests have more than one part and last for more than one day. Candidates for licensure in all fields plan intensive study as part of their professional preparation. Some join study groups, others study alone. But preparing to take a licensure test is, in all cases, a professional activity. Because a licensure exam surveys a broad body of knowledge, preparing for a licensure exam takes planning, discipline, and sustained effort.

Why does my state require the Praxis tests?
Your state chose the Praxis tests because they assess the breadth and depth of content—called the “domain”—that your state wants its teachers to possess before they begin to teach. The level of content knowledge, reflected in the passing score, is based on recommendations of panels of teachers and teacher educators in
each subject area. The state licensing agency and, in some states, the state legislature ratify the passing scores that have been recommended by panels of teachers.

How were the tests developed?
ETS consulted with practicing teachers and teacher educators around the country during every step of the Praxis test development process. First, ETS asked them what knowledge and skills a beginning teacher needs to be effective. Their responses were then ranked in order of importance and reviewed by hundreds of teachers.

After the results were analyzed and consensus was reached, guidelines, or specifications, for the selected-response and constructed-response tests were developed by teachers and teacher educators. Following these guidelines, teachers and professional test developers created test questions that met content requirements and ETS Standards for Quality and Fairness.*

When your state adopted the research-based Praxis tests, local panels of teachers and teacher educators evaluated each question for its relevance to beginning teachers in your state. During this “validity study,” the panel also provided a passing-score recommendation based on how many of the test questions a beginning teacher in your state would be able to answer correctly. Your state’s licensing agency determined the final passing-score requirement.

ETS follows well-established industry procedures and standards designed to ensure that the tests measure what they are intended to measure. When you pass the Praxis tests your state requires, you are proving that you have the knowledge and skills you need to begin your teaching career.

How are the tests updated to ensure the content remains current?
Praxis tests are reviewed regularly. During the first phase of review, ETS conducts an analysis of relevant state and association standards and of the current test content. State licensure titles and the results of relevant job analyses are also considered. Revised test questions are then produced following the standard test development methodology. National advisory committees may also be convened to review and revise existing test specifications and to evaluate test forms for alignment with the specifications.

How long will it take to receive my scores?
Scores for tests that do not include constructed-response questions are available on screen immediately after the test. Scores for tests that contain constructed-response questions or essays aren’t available immediately after the test because of the scoring process involved. Official score reports are available to you and your designated score recipients approximately two to three weeks after the test date for tests delivered continuously, or two to three weeks after the testing window closes for other tests. See the test dates and deadlines calendar at www.ets.org/praxis/register/dates_centers for exact score reporting dates.

Can I access my scores on the web?
All test takers can access their test scores via My Praxis Account free of charge for one year from the posting date. This online access replaces the mailing of a paper score report.

The process is easy—simply log into My Praxis Account at www.ets.org/praxis and click on your score report. If you do not already have a Praxis account, you must create one to view your scores.

Note: You must create a Praxis account to access your scores, even if you registered by mail or phone.

Your teaching career is worth preparing for, so start today! Let the *Praxis Study Companion* guide you.

To search for the *Praxis* test prep resources that meet your specific needs, visit:

[www.ets.org/praxis/testprep](http://www.ets.org/praxis/testprep)

To purchase official test prep made by the creators of the *Praxis* tests, visit the ETS Store:

[www.ets.org/praxis/store](http://www.ets.org/praxis/store)

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