ETS PRAXIS

Measuring the Power of Learning.™

The *Praxis*® Study Companion

General Science: Content Knowledge

5435

www.ets.org/praxis

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 Series® 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 43).

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.

Table of Contents

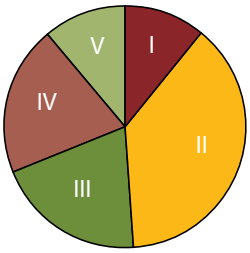
The Praxis® Study Companion guides you through the steps to success

1. Learn About Your Test

Learn about the specific test you will be taking

General Science: Content Knowledge (5435)

Test at a Glance	
Test Name	General Science: Content Knowledge
Test Code	5435
Time	2.5 hours
Number of Questions	135
Format	Selected-response questions
Test Delivery	Computer delivered



Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
I. Scientific Methodology, Techniques, and History	15	11%
II. Physical Science	51	38%
III. Life Science	27	20%
IV. Earth and Space Science	27	20%
V. Science, Technology, and Society	15	11%

About This Test

The General Science: Content Knowledge test is designed to measure the knowledge and competencies necessary for a beginning teacher of secondary school General Science. Examinees have typically completed or nearly completed a bachelor's degree program with appropriate coursework in science 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 science teachers, teacher-educators, and higher education content specialists to keep the test updated and representative of current standards.

The 135 selected-response questions include concepts, terms, phenomena, methods, applications, data analysis, and problem solving in science, and include an understanding of the impact of science and technology on the environment and human affairs. This also includes the ability to integrate basic topics from Chemistry, Physics, Life Science, and Earth and Space Science which are typically covered in introductory college-level courses in these disciplines, 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 in "6. Review Study Topics" on page 30.

I. Scientific Methodology, Techniques, and History

A. Methods of Scientific Inquiry and Design

1. Identifying problems based on observations
2. Forming and testing hypotheses
3. Development of theories, models, and laws
4. Experimental design, including independent and dependent variables, controls, and sources of error
5. Process skills including observing, comparing, inferring, categorizing, generalizing, and concluding
6. Nature of scientific knowledge
   a. subject to change
   b. consistent with evidence
   c. based on reproducible evidence
   d. includes unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)

B. Processes Involved in Scientific Data Collectionand Manipulation

1. Common units of measurement (metric and English) including unit conversion and prefixes such as *milli* and *kilo*
2. Scientific notation and significant figures in collected data
3. Organization and presentation of data
4. Basic data and error analysis including determining mean, accuracy, precision, and sources of error

C. Interpret and Draw Conclusions from Data Presented in Tables, Graphs, Maps, and Charts

1. Trends in data
2. Relationships between variables
3. Predictions based on data
4. Drawing valid conclusions based on the data

D. Procedures for Correct Preparation, Storage, Use, and Disposal of Laboratory Materials

1. Appropriate and safe use of materials (e.g., chemicals, lab specimens)
2. Safe disposal of materials
3. Appropriate storage
4. Preparation for classroom or field use (e.g., how to prepare a solution of given concentration, staining slides, labeling samples)

E. How to Use Standard Equipment in the Laboratory and the Field

1. Appropriate and safe use (e.g., Bunsen burner, glassware, GPS, microscope)
2. Appropriate storage (e.g., pH probes stored in appropriate buffer solution, dissection equipment, glassware)
3. Maintenance and calibration (e.g., cleaning microscopes, calibration of balances)
4. Preparation for classroom or field use (e.g., prelaboratory setup, classroom demonstrations, field research)

F. Safety and Emergency Procedures in the Laboratory

1. Location and use of standard safety equipment (e.g., eyewash, shower)
2. Laboratory safety rules for students
3. Appropriate apparel and conduct in the laboratory (e.g., wearing goggles)
4. Emergency procedures (e.g., fires, chemical spills, handling of injuries)

G. Major Historical Developments of Science

1. Accepted principles and models develop over time
2. Major developments in science (e.g., atomic theory, plate tectonics)
3. Contributions of major historical figures (e.g., Darwin, Newton)

II. Physical Science

A. Basic Principles

1. Structure of matter
   a. Elements, compounds, and mixtures
   b. Atoms, molecules, and ions
   c. Basic properties of solids, liquids, and gases
2. Basic structure of the atom
   a. Atomic models
   b. Atomic structure including nucleus, electrons, protons, and neutrons
   c. Atomic number, atomic mass, isotopes
   d. Electron arrangements (e.g., valence electrons)
3. Basic characteristics of radioactive materials
   a. Radioisotopes
   b. Radioactive decay processes and half-life
   c. Characteristics of alpha particles, beta particles, and gamma radiation
   d. Fission and fusion
4. Basic concepts and relationships involving energy and matter
   a. Conservation of energy (first law of thermodynamics)
   b. Entropy changes (second law of thermodynamics)
   c. Conservation of matter in chemical systems
   d. Kinetic and potential energy
   e. Transformations between different forms of energy (thermal, chemical, radiant, nuclear, mechanical, electrical, electromagnetic)
   f. Differences between chemical and physical properties/changes
   g. Various temperature scales (Celsius, Fahrenheit, Kelvin)
   h. Transfer of thermal energy and its basic measurement
      – conduction, convection, and radiation
      – specific heat capacity
      – calorimetry (e.g., predict heat transfer in various systems)
   i. Applications of energy and matter relationships
      – trophic level
      – matter cycling (carbon, nitrogen, water)
      – energy flow in ecosystems
      – convection currents in atmosphere, ocean, and mantle
      – conservation of mass in the rock cycle
      – chemical and physical changes in rocks
      – impact of solar radiation on Earth and life
      – energy transformations in living systems (e.g., photosynthesis, cellular respiration)

B. Chemistry

1. Periodicity and states of matter
   a. Periodic table of the elements
      – elements arranged in groups and periods
      – atomic number, atomic mass, and isotopic abundance
      – symbols of the elements
      – trends in physical properties based on position of elements on the periodic table (e.g., atomic radius, ionization energy)
      – trends in chemical reactivity based on position of elements on the periodic table (e.g., metals, nonmetals, noble gases)
   b. States of matter and factors that affect phase changes
      – basic assumptions of the kinetic theory of matter (e.g., particles in constant motion, average speed of gas particles related to temperature)
      – ideal gas laws (e.g., volume is proportional to temperature, pressure is inversely related to volume)
      – phase transitions and energy changes (e.g., heat of vaporization, heat of sublimation, phase diagrams, heating curves)
2. Chemical nomenclature, composition, and bonding
   a. Name of simple compounds and their chemical formulas
      – interpreting chemical formulas
      – naming compounds based on formula
      – writing formulas based on name
      – structural formulas (e.g., electron dot, Lewis structures)
   b. Types of chemical bonding
      – covalent and ionic
   c. Mole concept and its applications
      – Avogadro's number
   d. Molar mass and percent composition

3. Chemical reactions
   a. Basic concepts involved in chemical reactions
      – use and balance equations of simple chemical reactions
        • balance equations
        • simple stoichiometric calculations based on balanced equations
      – endothermic and exothermic reactions
      – factors that affect reaction rates (e.g., concentration, temperature, pressure, catalysts/enzymes, activation energy)
      – factors that affect reaction equilibrium (e.g., Le Châtelier's principle)
      – types of reactions (e.g., combustion, single or double replacement)
      – simple oxidation-reduction reactions
4. Acid-base chemistry
   a. Simple acid-base chemistry
      – chemical and physical properties of acids and bases
      – pH scale
      – neutralization
      – acid-base indicators (e.g., phenolphthalein, pH paper, litmus paper)
5. Solutions and solubility
   a. Different types of solutions
      – dilute and concentrated
      – saturated, unsaturated, supersaturated
      – solvent and solute
      – concentration terms (e.g., molarity, parts per million (ppm))
      – preparation of solutions of varying concentrations
   b. Factors affecting the solubility of substances and the dissolving process
      – effect of temperature, pressure, particle size, and agitation on the rate of dissolving
      – effect of temperature and pressure on solubility (e.g., solubility curves)
      – polar vs. nonpolar solvents and solutes
      – dissociation of ionic compounds such as salts in water (e.g., ionization, electrolytes)
      – precipitation
      – freezing point depression

C. Physics

1. Mechanics
   a. Description of motion in one and two dimensions
      – speed, velocity, acceleration
      – displacement
      – linear momentum
      – vector and scalar quantities
   b. Newton's three laws of motion
      – First law: inertia
      – Second law: F = ma (i.e., net force, mass, and acceleration)
      – Third law: action-reaction forces
   c. Mass, weight, and gravity
      – distinguish between mass and weight
      – gravitational attraction (force of attraction between masses at various distances)
      – acceleration due to gravity
   d. Analysis of motion and forces
      – projectile motion
      – inclined planes
      – friction
      – collisions (e.g., elastic, inelastic) and conservation of linear momentum
      – circular motion (e.g., centripetal acceleration, centripetal force)
      – center of mass
      – periodic motion (e.g., pendulums, oscillating springs, planetary orbits, satellites)
      – conservation of energy
      – work, energy, and power
      – basic fluid mechanics (e.g., buoyancy, density, pressure)
   e. Simple machines
      – mechanical advantage
      – types of simple machines (e.g., wedge, screw, lever)
      – concept of torque
2. Electricity and magnetism
   a. Electrical nature of common materials
      – electric charges
      – electrostatic force (attraction and repulsion, Coulomb's law)
      – conductivity, conductors, and insulators
   b. Basic electrical concepts
      – DC and AC current
      – current, resistance, voltage, and power
      – Ohm's law
      – analyze basic series and parallel circuits
      – voltage sources (e.g., batteries, generators)

c. Basic properties of magnetic fields and forces
   - magnetic materials
   - magnetic forces and fields (e.g., magnetic poles, attractive and repulsive forces)
   - electromagnets

3. Optics and waves
   a. Electromagnetic spectrum
      - nature of light (e.g., wave properties, photons)
      - visible spectrum and color
      - electromagnetic spectrum (e.g., ultraviolet, microwave, gamma)

   b. Basic characteristics and types of waves
      - transverse and longitudinal
      - wave characteristics and relationships between them (e.g., frequency, amplitude, wavelength, speed, energy)

   c. Basic wave phenomena
      - reflection, refraction, diffraction, and dispersion
      - absorption and transmission
      - interference, scattering, and polarization
      - total internal reflection
      - Doppler effect (e.g., apparent frequency, moving source or observer, red/blue shift)

   d. Basic optics
      - mirrors
      - lenses and their applications (e.g., the human eye, microscope, telescope)
      - prisms

   e. Sound
      - pitch/frequency and loudness/intensity
      - sound wave production, air vibrations, and resonance (e.g., tuning forks)
      - application of the Doppler effect to sound

III. Life Science

A. Basic Structure and Function of Cells and Their Organelles

1. Structure and function of cell membranes (e.g., phospholipid bilayer, passive and active transport)
2. Structure and function of animal and plant cell organelles
3. Levels of organization (cells, tissues, organs, organ systems)
4. Major features of common animal cell types (e.g., blood cells, muscle, nerve, epithelial, gamete)
5. Prokaryotes (bacteria) and eukaryotes (animals, plants, fungi, protists)

B. Key Aspects of Cell Reproduction and Division

1. Cell cycle
2. Mitosis
3. Meiosis
4. Cytokinesis

C. Basic Biochemistry of Life

1. Cellular respiration
2. Photosynthesis
3. Biological molecules (e.g., DNA, carbohydrates, proteins, lipids, enzymes)

D. Basic Genetics

1. Structure (double helix, single stranded, and base pairs) and function of DNA and RNA (replication, transcription, and translation)
2. Chromosomes, genes, alleles
3. Dominant and recessive traits
4. Mendelian inheritance (e.g., genotype, phenotype, use of Punnett squares, pedigrees)
5. Mutations, chromosomal abnormalities, and common genetic disorders

E. Theory and Key Mechanisms of Evolution

1. Mechanisms of evolution (e.g., natural selection)
2. Isolation mechanisms and speciation
3. Supporting evidence (e.g., fossil record, comparative genetics, homologous structures)

F. Hierarchical Classification Scheme

1. Classification schemes (e.g., domain, class, genus)
2. Characteristics of bacteria, animals, plants, fungi, and protists

G. Major Structures of Plants and Their Functions

1. Characteristics of vascular and nonvascular plants
2. Structure and function of roots, leaves, and stems (e.g., stomata, xylem, phloem)
3. Asexual (budding) and sexual reproduction (flowers, fruit, seeds, spores)
4. Growth (e.g., germination, elongation)
5. Uptake and transport of nutrients and water
6. Responses to stimuli (e.g., light, temperature, water, gravity)

H. Basic Anatomy and Physiology of Animals, including the Human Body

1. Response to stimuli and homeostasis
2. Exchange with the environment (e.g., respiratory, excretory, and digestive systems)
3. Internal transport and exchange (e.g., heart, arteries, veins, capillaries)
4. Control systems (e.g., nervous and endocrine systems)
5. Movement and support (e.g., skeletal and muscular systems)
6. Reproduction and development
7. Immune system (e.g., antibodies, autoimmune disorders)

I. Key Aspects of Ecology

1. Population dynamics
   a. growth curves and carrying capacity
   b. behavior (e.g., territoriality)
   c. intraspecific relationships (e.g., mating systems, social systems, competition)
2. Community ecology
   a. niche
   b. species diversity
   c. interspecific relationships (e.g., predator-prey, parasitism)
3. Ecosystems
   a. biomes
   b. stability and disturbances (e.g., glaciation, climate change, succession)
   c. energy flow (e.g., trophic levels, food webs)
   d. biogeochemical cycles (e.g., water, nitrogen, and carbon cycles, biotic/abiotic interaction)

IV. Earth and Space Science

A. Physical Geology

1. Types and basic characteristics of rocks and minerals and their formation processes
   a. The rock cycle
   b. Characteristics of rocks and their formation processes (i.e., sedimentary, igneous, and metamorphic rock)
   c. Characteristics of minerals and their formation processes (e.g., classes of minerals, crystals, hardness)
2. Processes involved in erosion, weathering, and deposition of Earth's surface materials and soil formation
   a. Erosion and deposition (e.g., agents of erosion)
   b. Chemical and physical (mechanical) weathering
   c. Characteristics of soil (e.g., types, soil profile)
   d. Porosity and permeability
   e. Runoff and infiltration
3. Earth's basic structure and internal processes
   a. Earth's layers (e.g., lithosphere, mantle, core)
   b. Shape and size of Earth
   c. Geographical features (e.g., mountains, plateaus, mid-ocean ridges)
   d. Earth's magnetic field
   e. Plate tectonics theory and evidence
      – folding and faulting (e.g., plate boundaries)
      – continental drift, seafloor spreading, magnetic reversals
      – characteristics of volcanoes (e.g., eruptions, lava, gases, hot spots)
      – characteristics of earthquakes (e.g., epicenters, faults, tsunamis)
      – seismic waves and triangulation
4. The water cycle
   a. Evaporation and condensation
   b. Precipitation
   c. Runoff and infiltration
   d. Transpiration

B. Historical Geology

1. Historical geology
   a. Principle of uniformitarianism
   b. Basic principles of relative age dating (e.g., superposition, stratigraphic correlation, fossil succession)
   c. Absolute (radiometric) dating
   d. Geologic time scale (e.g., age of Earth, scope of time)
   e. Fossil record as evidence of the origin and development of life (e.g., fossilization methods, mass extinctions, ice ages, meteor impacts)

C. Earth's Bodies of Water

1. Characteristics and processes of Earth's oceans and other bodies of water
   a. Distribution and location of Earth's water
   b. Seawater composition
   c. Coastline topography and topography of ocean floor
   d. Tides, waves, currents
   e. Estuaries and barrier islands
   f. Islands, reefs, and atolls
   g. Polar ice, icebergs, and glaciers
   h. Lakes, ponds, and wetlands
   i. Streams, rivers, and river deltas
   j. Groundwater, water table, wells, and aquifers
   k. Geysers and springs
   l. Properties of water that affect Earth systems (e.g., density changes on freezing, high heat capacity, polar solvent, hydrogen bonding)

D. Meteorology and Climate

1. Basic structure and composition of Earth's atmosphere
   a. Layers (e.g., stratosphere)
   b. Composition of atmosphere (e.g., percent oxygen and nitrogen)
   c. Atmospheric pressure and temperature
2. Basic concepts of meteorology
   a. Relative humidity
   b. Dew point
   c. Wind (e.g., how it is generated and modified)
   d. Cloud types and formation
   e. Types of precipitation (e.g., hail, rain)
   f. Air masses, fronts, storms, and severe weather (e.g., hurricanes, tornadoes)
   g. Development and movement of weather patterns
3. Major factors that affect climate and seasons
   a. Effects of latitude, geographical location, and elevation (e.g., mountains and oceans)
   b. Effects of atmospheric circulation (e.g., trade winds, jet stream)
   c. Effects of ocean circulation
   d. Characteristics and locations of climate zones (e.g., Tropics, Arctic)
   e. Effect of the tilt of Earth's axis on seasons
   f. Effects of natural phenomena (e.g., volcanic eruptions, solar radiation variations)
   g. El Niño, La Niña

E. Astronomy

1. Major features of the solar system
   a. Structure of the solar system
   b. Laws of motion (e.g., gravitation, planetary orbits, satellites)
   c. Characteristics of the Sun, Moon, and planets
   d. Characteristics of asteroids, meteoroids, comets, and dwarf/minor planets
   e. Theories of origin of the solar system
2. Interactions of the Earth-Moon-Sun system
   a. Earth's rotation and orbital revolution around the Sun
   b. Effect on seasons
   c. Phases of the Moon
   d. Effect on tides
   e. Solar and lunar eclipses
   f. Time zones
   g. Effect of solar wind on Earth
3. Major features of the universe
   a. Galaxies (e.g., definition, relative size, Milky Way)
   b. Characteristics of stars and their life cycles
      – life cycle of star, e.g., white dwarf, red giant, supernova, nebulae, black holes
      – color, temperature, apparent brightness, absolute brightness, luminosity
      – Hertzsprung-Russell diagrams
   c. Dark matter
   d. Theories about the origin of the universe (e.g., Big Bang)
4. Contributions of space exploration and technology to our understanding of the universe
   a. Remote sensing devices (e.g., satellites, space probes, telescopes, spectral analysis)
   b. Search for water and life on other planets

V. Science, Technology, and Society

A. Impact of Science and Technology on the Environment and Society

1. Air and water pollution (e.g., acid rain, eutrophication, groundwater pollution)
2. Climate change and greenhouse gases
3. Irrigation
4. Reservoirs and levees
5. Depletion of aquifers
6. Ozone layer depletion
7. Loss of biodiversity
8. Space exploration
9. Waste disposal (e.g., landfills)
10. Recycling
11. Environmentally friendly consumer products (e.g., biodegradable materials)

B. Major Issues associated with Energy Production and the Management of Natural Resources

1. Renewable and nonrenewable energy resources
2. Conservation and recycling
3. Pros and cons of power generation based on various resources including fossil and nuclear fuel, hydropower, wind power, solar power, geothermal power, and alternative energy sources
4. Issues associated with the use and extraction of Earth's resources (e.g., mining, land reclamation, deforestation)

C. Applications of Science and Technology in Daily Life

1. Chemical properties of household products
2. Communication (e.g., wireless devices, GPS, satellites)
3. Science principles applied in commonly used consumer products (e.g., batteries, lasers, polarized sunglasses, and fiber optic cables)
4. Water purification
5. Common agricultural practices (e.g., genetically modified crops, use of herbicides and insecticides)
6. DNA evidence in criminal investigations
7. Nanotechnology

D. Impact of Science on Public Health Issues

1. Nutrition, disease, and medicine (e.g., vitamins, viruses, vaccines)
2. Biotechnology (e.g., genetic engineering, in vitro fertilization)
3. Medical technologies (e.g., medical imaging, X-rays, radiation therapy)

2. Familiarize Yourself with Test Questions

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

The Praxis Series 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 options.

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

- **Clicking more than one oval** to select answers from a list of options.
- **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 options and drag your answers to the appropriate location in a table, paragraph of text or graphic.
- **Selecting options from a drop-down menu.** You may be asked to choose answers by selecting options from a drop-down menu (e.g., to complete a sentence).

Remember that with every question you will get clear instructions.

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.

For tests that have constructed-response questions, more detailed information can be found in "1. Learn About Your Test" on page 5.

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 statements below is followed by four suggested answers or completions. Select the one that is best in each case.

1. Which of the following poses the greatest safety risk while being heated in a school laboratory?

   (A) A mixture of iron and sulfur

   (B) Mercury(II) oxide

   (C) Sodium chloride

   (D) Copper(II) sulfate hydrate

2. A piece of paper that appears blue in sunlight is illuminated solely by a red light that is passed through a green filter. What color does the paper appear under this illumination?

   (A) Blue

   (B) Green

   (C) Red

   (D) Black

3. What quantity of oxygen, O_2, contains very nearly the same number of molecules as 36.0 grams of water, H_2O?

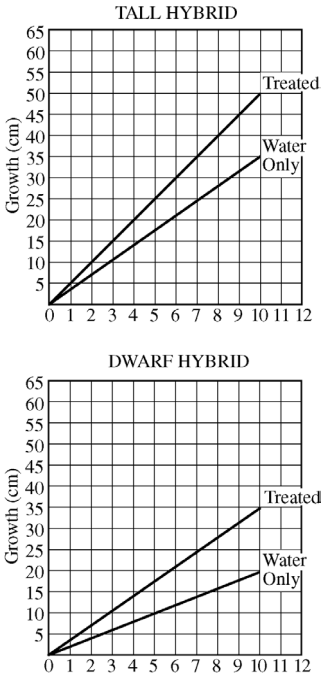
   (A) 64.0 grams

   (B) 32.0 grams

   (C) 16.0 grams

   (D) 8.0 grams

In an experiment to study the effect of a new fertilizer on the growth of tall hybrid corn and dwarf hybrid corn, from immediately after germination to 10 days of growth, the data below were obtained. Other growing conditions such as water and sunlight were the same for both groups.



4. Which of the following is the most reasonable conclusion that can be drawn from the data above?

   (A) The new fertilizer influences the growth of both corn varieties tested

   (B) The new fertilizer causes faster growth rate for both varieties than do other fertilizers

   (C) The new fertilizer improves the root system of the tall hybrid to a greater extent than it does that of the dwarf hybrid

   (D) The new fertilizer is effective in producing faster growth for both varieties for the first 10 days only

5. A person heterozygous for the recessive gene for cystic fibrosis marries a person who does not carry or have the trait (homozygous dominant). What is the probability that the couple's first child will be a carrier?

   (A) 0.0

   (B) 0.25

   (C) 0.50

   (D) 1.0

6. Which of the following is matched with its correct function?

   (A) Ovule ..... production of pollen

   (B) Vascular cambium ..... formation of apical meristem

   (C) Xylem ..... transport of sugars

   (D) Guard cell ..... regulation of transpiration rate

7. Scientists believe that a worldwide catastrophic event occurred during the late Cretaceous period and that this event likely caused which of the following?

   (A) The movement of aquatic animals onto land

   (B) The sudden demise of the dinosaurs

   (C) The emergence of *Homo sapiens* on the grasslands of Africa

   (D) The first appearance of mammals

8. Earth's seasons are caused by which of the following?

   (A) The tilt of Earth's axis of rotation relative to the ecliptic as Earth revolves around the Sun

   (B) The varying amount of sunspot activity

   (C) Earth's orbit about the Sun as an ellipse rather than a circle

   (D) The rotation of Earth during a 24-hour day

9. If each of the following meals provides the same number of calories, which meal requires the most land to produce the food?

   (A) Red beans and rice

   (B) Steak and a baked potato

   (C) Corn tortilla and refried beans

   (D) Lentil soup and brown bread

10. Which of the following is most likely to cause a rise in the average temperature of Earth's atmosphere in the future?

    (A) Atomic warfare

    (B) CO_2 from fossil fuels

    (C) Dust clouds from volcanoes

    (D) Depletion of Earth's ozone layer

11. The symbol for a specific isotope of gold is ${}^{197}_{79}\mathrm{Au}$. Which of the following is consistent with this symbol?

    (A) 197 neutrons in the nucleus

    (B) 79 neutrons in the nucleus

    (C) 118 protons in the nucleus of each of its atoms

    (D) 79 electrons in a neutral atom

12. Which of the following statements is correct about a trophic structure in which a leaf-eating grasshopper is eaten by a frog, which in turn is eaten by a snake?

    (A) The frog is a herbivore.

    (B) The snake is a secondary consumer.

    (C) The grasshopper is a primary consumer.

    (D) The snakes outnumber the grasshoppers in the community.

13. The accumulation of stress along the boundaries of lithospheric plates results in which of the following?

    (A) Earthquakes

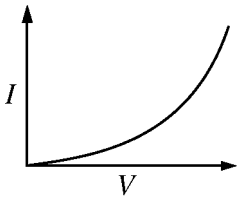
    (B) Magnetic reversals

    (C) Hurricanes

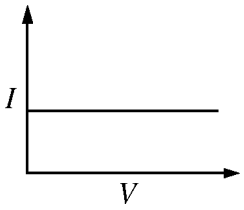
    (D) Increased deposition of deep-sea sediments

14. Which of the following graphs illustrates the operation of Ohm's law for a conductor that has constant resistance?

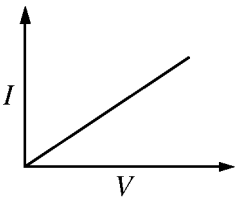
(A)



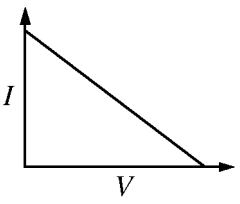
(B)



(C)



(D)



15. Which of the following elements is a metal?

(A) S
(B) Se
(C) I
(D) Ga

16. How many moles of HCl must be added to sufficient water to form 3 liters of a 2 M HCl solution?

(A) 1 mol
(B) 2 mol
(C) 3 mol
(D) 6 mol

17. When a gas turns into a liquid, the process is called

(A) condensation
(B) evaporation
(C) deposition
(D) sublimation

18. When cool air flows from a high mountain region to a region of lower elevation, the air will

(A) increase in moisture content
(B) condense, forming large amounts of dew
(C) undergo adiabatic warming
(D) undergo adiabatic cooling

19. Animals in which of the following groups may have a backbone and a spinal cord?

(A) Mollusks
(B) Chordates
(C) Invertebrates
(D) Echinoderms

20. Polarized sunglasses are used to cut glare from sunlight reflected at a glancing angle off cars, water, and other surfaces. Such sunglasses are a practical application of which of the following physical principles?

(A) Brewster's law
(B) Lenz's law
(C) Coulomb's law
(D) Snell's law

21. Which of the following parts of the Sun is easily visible only during a total solar eclipse?

(A) Core
(B) Photosphere
(C) Sunspots
(D) Corona

22. If equal and opposite charges are placed on the two plates of a parallel plate capacitor and the plates are then moved apart, which of the following remain(s) constant?

I. Voltage
II. Capacitance
III. Charge

(A) I only
(B) II only
(C) III only
(D) I and II only

23. The true length of a block of wood is 1.010 cm. Three measurements of this block produced the following values: 1.4 cm, 1.2 cm, and 0.9 cm. Which of the following statements is true concerning these measurements?

    (A) They are precise and accurate.

    (B) They are precise but not accurate.

    (C) The are accurate but not precise.

    (D) They are neither precise nor accurate.

24. Which of the following items will be attracted to the north pole of a permanent magnet by a magnetic force?

    (A) The north pole of another permanent magnet

    (B) A piece of iron that is not a permanent magnet

    (C) A positively charged glass rod

    (D) A negatively charged rubber rod

Answers to Sample Questions

1. The best answer is (B). Mercury(II) oxide breaks down on heating to metallic mercury and oxygen. Mercury vapor that is given off is highly toxic when inhaled or absorbed through the skin, and exposure to mercury in a school should be greatly limited if not eliminated altogether.

2. The correct answer is (D). The green filter absorbs all colors except green, which it passes. Therefore, the red light will be absorbed by the filter, which will pass no light. The paper will not be illuminated, and so it will appear black, regardless of its initial color.

3. The correct answer is (A). 36 grams of water is 2 moles (2 X 18 grams). A 2-mole sample of O_2 contains the same number of molecules as does 2 moles of any other substance. A 2-mole sample of O_2 would have a mass of 2 X 32.0 grams = 64.0 grams.

4. The correct answer is (A). The graphs indicate more rapid growth for the treated samples than for the untreated samples in both corn varieties. The other options describe results not tested in the experiments and so not indicated by the data.

5. The correct answer is (C). One parent will have the genotype *CC* and the other parent will have the genotype *Cc*. The possible genotypes of the offspring are, therefore, *CC*, *CC*, *Cc*, and *Cc*. Thus, 50 percent of the offspring will be homozygous dominant and 50 percent will be heterozygous and carriers.

6. The correct answer is (D). Stomata open and close due to the changing shape of the guard cells. Water exits freely through the stomata when they are open.

7. The correct answer is (B). The sudden disappearance of 90 percent of the dinosaur species occurred about 60 million years ago. Recent chemical evidence points to a catastrophic event, such as a large impact, occurring at that time.

8. The correct answer is (A). Seasons are best explained as resulting from Earth's axial tilt and not from distance variations, sunspot activity, atmospheric transparency, or rotation.

9. The correct answer is (B). Energy is lost as matter is transferred from one trophic level to another. It takes more land to produce the energy in steak than it does to produce the same amount of energy in food from plants. Therefore, (A), (C), and (D) are incorrect because these foods are derived from the primary producers (plants) only.

10. The correct answer is (B). Increased carbon dioxide (a greenhouse gas) in the atmosphere will probably result in global warming. Atomic warfare would more likely result in a "nuclear winter." Volcanoes would probably cause cooling due to high atmospheric dust absorbing the Sun's rays so they cannot reach the ground. The depletion of the ozone layer will let more ultraviolet radiation through the atmosphere but in itself should not cause warming.

11. The correct answer is (D). The numbers before the symbol for an element have the following meanings:

Top number: isotopic mass = the sum of the number of protons plus the number of neutrons in the nucleus of each of its atoms.

Bottom number: atomic number = the number of protons in the nucleus of each of its atoms.

Thus, each nucleus of this isotope contains 79 protons and 197 – 79 = 118 neutrons. In a neutral atom, the number of electrons is equal to the number of protons, 79 in this case.

12. The correct answer is (C). The grasshopper is the herbivore and thus the primary consumer.

13. The correct answer is (A). Earthquakes are the abrupt release of energy that occurs when a rock under stress fractures and displacement occurs.

14. The correct answer is (C). Ohm's law is stated V = IR or I = V/R, which is the equation of a straight line through the origin, with I increasing as V increases.

15. The correct answer is (D). The element Ga is a metal. S, Se, and I are nonmetals.

16. The correct answer is (D). A concentration of 2 M means there are 2 moles of HCl per liter of water. So 6 moles of HCl must be added to sufficient water to form 3 liters of a 2 M HCl solution.

17. The correct answer is (A). When a gas turns into a liquid, the process is called condensation.

18. The correct answer is (C). When cool air flows from a high mountain region to a region of lower elevation, the air undergoes adiabatic warming. Adiabatic warming occurs as the pressure of the air is increased as it descends.

19. The correct answer is (B). Most chordates posses a vertebral column (backbone) that surrounds a dorsal nerve cord. Mollusks (e.g., clams and mussels) and echinoderms (e.g., sea stars and sea urchins) are invertebrates that lack a vertebral column and dorsal nerve cord.

20. The correct answer is (A). According to Brewster's law, reflected light will always be polarized in a horizontal direction, parallel to the reflecting surface. Polarized sunglasses are constructed to block this reflected light and to transmit light polarized only in the vertical direction.

21. The correct answer is (D). The Sun's corona has extremely low density and is visible only during a total solar eclipse.

22. The correct answer is (C). The capacitance C of a parallel plate capacitor decreases as the distance between the plates increases. The charge Q on the plates is isolated and will not change. By the definition of capacitance, namely $C = Q/V$, the voltage V will increase, since C decreases and Q remains constant.

23. The correct answer is (D). The measurements differ from the true length by 0.39 cm, 0.19 cm, and -0.11 cm. Thus, the measurements are quite different in value from the true value, which means that they are not accurate. The measurements are also quite different in value from one another (not repeatable), which means that they are not precise.

24. The correct answer is (B). Iron is easily magnetized. When iron is brought close to a permanent magnet, the iron will become magnetized in such a way as to be attracted to the permanent magnet.

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 in "1. Learn About Your Test" 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 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. 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/centers_dates.
- 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 in "10. Understand Your Scores" on page 46.

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 28 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 28 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 17.
- **Prepare your presentation for the group.** When it's your to turn 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.

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

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

(continued on next page)

Content covered	Description of content	How well do I know the content? (scale 1–5)	What resources do I have/need for the content?	Where can I find the resources I need?	Dates I will study the content	Date completed
Language in different contexts	Determine whether information presented in a reading selection is presented as fact or opinion	4	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/1/15	8/1/15
Contextual meaning	Identify the meanings of words as they are used in the context of a reading selection	2	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/1/15	8/1/15
Figurative Language	Understand figurative language and nuances in word meanings	2	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/8/15	8/8/15
Vocabulary range	Understand a range of words and phrases sufficient for reading at the college and career readiness level	2	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/15/15	8/17/15
Integration of Knowledge and Ideas						
Diverse media and formats	Analyze content presented in diverse media and formats, including visually and quantitatively, as well as in words	2	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/22/15	8/24/15
Evaluation of arguments	Identify the relationship among ideas presented in a reading selection	4	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/24/15	8/24/15
Evaluation of arguments	Determine whether evidence strengthens, weakens, or is relevant to the arguments in a reading selection	3	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/27/15	8/27/15
Evaluation of arguments	Determine the logical assumptions upon which an argument or conclusion is based	5	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/28/15	8/30/15
Evaluation of arguments	Draw conclusions from material presented in a reading selection	5	High school textbook, college course notes	College library, course notes, high school teacher, college professor	8/30/15	8/31/15
Comparison of texts	Recognize or predict ideas or situations that are extensions of or similar to what has been presented in a reading selection	4	High school textbook, college course notes	College library, course notes, high school teacher, college professor	9/3/15	9/4/15
Comparison of texts	Apply ideas presented in a reading selection to other situations	2	High school textbook, college course notes	College library, course notes, high school teacher, college professor	9/5/15	9/6/15

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.

Praxis Test Name (Test Code): _____

Test Date: _____

Content covered	Description of content	How well do I know the content? (scale 1–5)	What resources do I have/need for this content?	Where can I find the resources I need?	Dates I will study this content	Date completed

(continued on next page)

Content covered	Description of content	How well do I know the content? (scale 1–5)	What resources do I have/need for the content?	Where can I find the resources I need?	Dates I will study the content	Date completed

6. Review Study Topics

Detailed study topics with questions for discussion

Using the Study Topics That Follow

The General Science: 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. Scientific Methodology, Techniques, and History

A. Methods of Scientific Inquiry and Design

1. Identifying problems based on observations
2. Forming and testing hypotheses
3. Development of theories, models, and laws
4. Experimental design, including independent and dependent variables, controls, and sources of error
5. Process skills including observing, comparing, inferring, categorizing, generalizing, and concluding
6. Nature of scientific knowledge
   a. subject to change
   b. consistent with evidence
   c. based on reproducible evidence
   d. includes unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)

B. Processes Involved in Scientific Data Collection and Manipulation

1. Common units of measurement (metric and English) including unit conversion and prefixes such as milli and kilo
2. Scientific notation and significant figures in collected data
3. Organization and presentation of data
4. Basic data and error analysis including determining mean, accuracy, precision, and sources of error

C. Interpret and Draw Conclusions from Data Presented in Tables, Graphs, Maps, and Charts

1. Trends in data
2. Relationships between variables
3. Predictions based on data
4. Drawing valid conclusions based on the data

D. Procedures for Correct Preparation, Storage, Use, and Disposal of Laboratory Materials

1. Appropriate and safe use of materials (e.g., chemicals, lab specimens)
2. Safe disposal of materials
3. Appropriate storage
4. Preparation for classroom or field use (e.g., how to prepare a solution of given concentration, staining slides, labeling samples)

E. How to Use Standard Equipment in the Laboratory and the Field

1. Appropriate and safe use (e.g., Bunsen burner, glassware, GPS, microscope)
2. Appropriate storage (e.g., pH probes stored in appropriate buffer solution, dissection equipment, glassware)
3. Maintenance and calibration (e.g., cleaning microscopes, calibration of balances)
4. Preparation for classroom or field use (e.g., prelaboratory setup, classroom demonstrations, field research)

F. Safety and Emergency Procedures in the Laboratory

1. Location and use of standard safety equipment (e.g., eyewash, shower)
2. Laboratory safety rules for students
3. Appropriate apparel and conduct in the laboratory (e.g., wearing goggles)
4. Emergency procedures (e.g., fires, chemical spills, handling of injuries)

G. Major Historical Developments of Science

1. Accepted principles and models develop over time
2. Major developments in science (e.g., atomic theory, plate tectonics)
3. Contributions of major historical figures (e.g., Darwin, Newton)

Discussion areas

- What are the characteristics of a valid scientific hypothesis?
- Name a scientific law and explain why it is a law rather than a theory.
- Design an experiment and identify the independent and dependent variable. Does the experimental design include a control?

- What is the difference between an observation and an inference?
- Compare information obtained from the television, a newspaper article, a Web site, and a scientific journal for accuracy, for understandability, and for use in the classroom setting.
- 1,000 kilometers is equivalent to how many millimeters?
- Express the number 0.002270 using scientific notation. How many significant figures does number have in decimal notation and in scientific notation?
- What is the density of a brass cube, expressed to the correct number of significant figures, if a side and the mass are measured and recorded as 2.5 cm and 64.92 g?
- Describe how to prepare 500 mL of 1 *M* HCl(*aq*) using 12 *M* HCl(*aq*) and distilled water.
- What is a volumetric flask used for?
- What safety precautions should be taken when preparing a dilute solution of HCl from concentrated HCl?
- What is the proper way to clean up a small spill of concentrated HCl?
- How have theories about the structure of the solar system changed over time?

II. Physical Science

A. Basic Principles

1. Structure of matter
   a. elements, compounds, and mixtures
   b. atoms, molecules, and ions
   c. basic properties of solids, liquids, and gases
2. Basic structure of the atom
   a. atomic models
   b. atomic structure including nucleus, electrons, protons, and neutrons
   c. atomic number, atomic mass, isotopes
   d. electron arrangements (e.g., valence electrons)
3. Basic characteristics of radioactive materials
   a. radioisotopes
   b. radioactive decay processes and half-life
   c. characteristics of alpha particles, beta particles, and gamma radiation
   d. fission and fusion
4. Basic concepts and relationships involving energy and matter
   a. conservation of energy (first law of thermodynamics)
   b. entropy changes (second law of thermodynamics)
   c. conservation of matter in chemical systems
   d. kinetic and potential energy
   e. transformations between different forms of energy (thermal, chemical, radiant, nuclear, mechanical, electrical, electromagnetic)
   f. differences between chemical and physical properties/changes
   g. various temperature scales (Celsius, Fahrenheit, Kelvin)
   h. transfer of thermal energy and its basic measurement
      – conduction, convection, and radiation
      – specific heat capacity
      – calorimetry (e.g., predict heat transfer in various systems)
   i. applications of energy and matter relationships
      – trophic level
      – matter cycling (carbon, nitrogen, water)
      – energy flow in ecosystems
      – convection currents in atmosphere, ocean, and mantle
      – conservation of mass in the rock cycle
      – chemical and physical changes in rocks
      – impact of solar radiation on Earth and life
      – energy transformations in living systems (e.g., photosynthesis, cellular respiration)

Discussion areas

- Compare and contrast liquids and gases in terms of shape, volume, fluidity, and compressibility.
- What are the limitations of the Bohr model of the atom?
- What is the relationship between the position of an element on the periodic table and its electron configuration?

- Compare the mass and charge of alpha particles and beta particles. How is gamma radiation different from alpha and beta radiation?
- If a sample that initially contains 100 g of a radioactive isotope contains 25 g of the isotope after 4 days, what is the half-life of the radioactive isotope?
- Why is there lead mixed in with all deposits of uranium ores?
- How does the internal energy of a closed system change when a gas expands?
- What phase changes involve an increase in entropy?
- If 100 g of water at 20°C absorbs 5 kJ of heat, by what amount will the temperature of the water increase?

B. Chemistry

1. Periodicity and states of matter
   a. periodic table of the elements
      – elements arranged in groups and periods
      – atomic number, atomic mass, and isotopic abundance
      – symbols of the elements
      – trends in physical properties based on position of elements on the periodic table (e.g., atomic radius, ionization energy)
      – trends in chemical reactivity based on position of elements on the periodic table (e.g., metals, nonmetals, noble gases)
   b. states of matter and factors that affect phase changes
      – basic assumptions of the kinetic theory of matter (e.g., particles in constant motion, average speed of gas particles related to temperature)
      – ideal gas laws (e.g., volume is proportional to temperature, pressure is inversely related to volume)
      – phase transitions and energy changes (e.g., heat of vaporization, heat of sublimation, phase diagrams, heating curves)
2. Chemical nomenclature, composition, and bonding
   a. name of simple compounds and their chemical formulas
      – interpreting chemical formulas
      – naming compounds based on formula
      – writing formulas based on name
      – structural formulas (e.g., electron dot, Lewis structures)
   b. types of chemical bonding
      – covalent and ionic
   c. mole concept and its applications
      – Avogadro's number
   d. molar mass and percent composition
3. Chemical reactions
   a. basic concepts involved in chemical reactions
      – use and balance equations of simple chemical reactions
        • balance equations
        • simple stoichiometric calculations based on balanced equations
      – endothermic and exothermic reactions
      – factors that affect reaction rates (e.g., concentration, temperature, pressure, catalysts/enzymes, activation energy)
      – factors that affect reaction equilibrium (e.g., Le Châtelier's principle)
      – types of reactions (e.g., combustion, single or double replacement)
      – simple oxidation-reduction reactions
4. Acid-base chemistry
   a. simple acid-base chemistry
      – chemical and physical properties of acids and bases
      – pH scale
      – neutralization
      – acid-base indicators (e.g., phenolphthalein, pH paper, litmus paper)
5. Solutions and solubility
   a. different types of solutions
      – dilute and concentrated
      – saturated, unsaturated, supersaturated
      – solvent and solute
      – concentration terms (e.g., molarity, parts per million (ppm))
      – preparation of solutions of varying concentrations

b. factors affecting the solubility of substances and the dissolving process
   - effect of temperature, pressure, particle size, and agitation on the rate of dissolving
   - effect of temperature and pressure on solubility (e.g., solubility curves)
   - polar vs. nonpolar solvents and solutes
   - dissociation of ionic compounds such as salts in water (e.g., ionization, electrolytes)
   - precipitation
   - freezing point depression

Discussion areas

- List the elements H, He, Li, and Be in order of increasing atomic radius.
- How do the chemical properties of the elements in a period change as you move from left to right across the periodic table?
- Compare and contrast the arrangement and motions of molecules of a substance in the solid, liquid, and gaseous states.
- If a sample of gas is heated at a constant pressure, what will happen to the volume of the gas?
- How many carbon atoms are in one mole of propane?
- What information is provided in the formula for calcium hydroxide, $Ca(OH)_2$?
- Name each of the following compounds: Na_2O, Cu_2O, P_2O_5 .
- Write the electron dot and structural formulas for formaldehyde, CH_2O.
- Balance the following equation: $Al + CuCl_2 \rightarrow AlCl_3 + Cu$. What type(s) of reaction is it?
- Consider the following equilibrium reaction: $2\ NO_2(g) \rightleftharpoons N_2O_4(g) + 58$ kJ. Predict what will happen to the equilibrium if the temperature, pressure, or concentration of one of the reactants is changed.
- Is the following process an oxidation or reduction: $Ni^{2+} + 2\ e^- \rightarrow Ni$?
- If the pH of a solution decreases from 5 to 4, by how much does the concentration of hydrogen ions increase?
- What is an example of a buffer solution? How will the pH change as acid is added to the buffer solution?
- Why is ammonia gas very soluble in water while oxygen is only slightly soluble?
- Which of the following 1 *M* solutions will have the lowest freezing point: C_2H_5OH , KI, $MgCl_2$?

C. Physics

1. Mechanics

   a. description of motion in one and two dimensions
      - speed, velocity, acceleration
      - displacement
      - linear momentum
      - vector and scalar quantities

   b. Newton's three laws of motion
      - First law: inertia
      - Second law: $F = ma$ (i.e., net force, mass, and acceleration)
      - Third law: action-reaction forces

   c. mass, weight, and gravity
      - distinguish between mass and weight
      - gravitational attraction (force of attraction between masses at various distances)
      - acceleration due to gravity

   d. analysis of motion and forces
      - projectile motion
      - inclined planes
      - friction
      - collisions (e.g., elastic, inelastic) and conservation of linear momentum
      - circular motion (e.g., centripetal acceleration, centripetal force)
      - center of mass
      - periodic motion (e.g., pendulums, oscillating springs, planetary orbits, satellites)
      - conservation of energy
      - work, energy, and power
      - basic fluid mechanics (e.g., buoyancy, density, pressure)

   e. simple machines
      - mechanical advantage
      - types of simple machines (e.g., wedge, screw, lever)
      - concept of torque

2. Electricity and magnetism
   a. electrical nature of common materials
      - electric charges
      - electrostatic force (attraction and repulsion, Coulomb's law)
      - conductivity, conductors, and insulators
   b. basic electrical concepts
      - DC and AC current
      - current, resistance, voltage, and power
      - Ohm's law
      - analyze basic series and parallel circuits
      - voltage sources (e.g., batteries, generators)
   c. basic properties of magnetic fields and forces
      - magnetic materials
      - magnetic forces and fields (e.g., magnetic poles, attractive and repulsive forces)
      - electromagnets
3. Optics and waves
   a. electromagnetic spectrum
      - nature of light (e.g., wave properties, photons)
      - visible spectrum and color
      - electromagnetic spectrum (e.g., ultraviolet, microwave, gamma)
   b. basic characteristics and types of waves
      - transverse and longitudinal
      - wave characteristics and relationships between them (e.g., frequency, amplitude, wavelength, speed, energy)
   c. basic wave phenomena
      - reflection, refraction, diffraction, and dispersion
      - absorption and transmission
      - interference, scattering, and polarization
      - total internal reflection
      - Doppler effect (e.g., apparent frequency, moving source or observer, red/blue shift)
   d. basic optics
      - mirrors
      - lenses and their applications (e.g., the human eye, microscope, telescope)
      - prisms
   e. sound
      - pitch/frequency and loudness/intensity
      - sound wave production, air vibrations, and resonance (e.g., tuning forks)
      - application of the Doppler effect to sound

Discussion areas

- What is the difference between speed and velocity?
- What is meant by the term "terminal velocity"?
- What is the relationship between the distance that separates two objects and the force of gravitational attraction?
- What is the direction of the centripetal force acting on an object moving in uniform circular motion?
- A ball is dropped and another ball of smaller mass is fired horizontally from the same height. Which ball hits the ground first?
- What forces are acting on a crate at rest on an inclined ramp?
- What variables affect the period of a pendulum?
- How does the conservation of momentum apply to collisions?
- Which requires more work: lifting a 100-kilogram sack a vertical distance of 2 meters or lifting a 50-kilogram sack a vertical distance of 4 meters?
- Explain mechanical advantage using a lever as an example.
- Why are metals good conductors of electricity?
- How are series circuits different from parallel circuits?
- What is the energy transformation that occurs in a battery?
- Describe the orientation of field lines of a bar magnet.
- What color light is transmitted through a piece of blue glass?
- Compare the energy and frequency of gamma rays to that of microwaves.
- What wave phenomena are involved in the separation of white light into a spectrum of colors by a prism?

- Does the size of the image in a plane mirror change as the object moves away from the mirror?
- What happens to parallel rays of light when they pass through a convex lens?
- When you blow over a bottle, what happens to the frequency as you fill the bottle with water?

III. Life Science

A. Basic Structure and Function of Cells and Their Organelles

1. Structure and function of cell membranes (e.g., phospholipid bilayer, passive and active transport)
2. Structure and function of animal and plant cell organelles
3. Levels of organization (cells, tissues, organs, organ systems)
4. Major features of common animal cell types (e.g., blood cells, muscle, nerve, epithelial, gamete)
5. Prokaryotes (bacteria) and eukaryotes (animals, plants, fungi, protists)

B. Key Aspects of Cell Reproduction and Division

1. Cell cycle
2. Mitosis
3. Meiosis
4. Cytokinesis

C. Basic Biochemistry of Life

1. Cellular respiration
2. Photosynthesis
3. Biological molecules (e.g., DNA, carbohydrates, proteins, lipids, enzymes)

D. Basic Genetics

1. Structure (double helix, single stranded, and base pairs) and function of DNA and RNA (replication, transcription, and translation)
2. Chromosomes, genes, alleles
3. Dominant and recessive traits
4. Mendelian inheritance (e.g., genotype, phenotype, use of Punnett squares, pedigrees)
5. Mutations, chromosomal abnormalities, and common genetic disorders

E. Theory and Key Mechanisms of Evolution

1. Mechanisms of evolution (e.g., natural selection)
2. Isolation mechanisms and speciation
3. Supporting evidence (e.g., fossil record, comparative genetics, homologous structures)

F. Hierarchical Classification Scheme

1. Classification schemes (e.g., domain, class, genus)
2. Characteristics of bacteria, animals, plants, fungi, and protists

G. Major Structures of Plants and Their Functions

1. Characteristics of vascular and nonvascular plants
2. Structure and function of roots, leaves, and stems (e.g., stomata, xylem, phloem)
3. Asexual (budding) and sexual reproduction (flowers, fruit, seeds, spores)
4. Growth (e.g., germination, elongation)
5. Uptake and transport of nutrients and water
6. Responses to stimuli (e.g., light, temperature, water, gravity)

H. Basic Anatomy and Physiology of Animals, including the Human Body

1. Response to stimuli and homeostasis
2. Exchange with the environment (e.g., respiratory, excretory, and digestive systems)
3. Internal transport and exchange (e.g., heart, arteries, veins, capillaries)
4. Control systems (e.g., nervous and endocrine systems)
5. Movement and support (e.g., skeletal and muscular systems)
6. Reproduction and development
7. Immune system (e.g., antibodies, autoimmune disorders)

I. Key Aspects of Ecology

1. Population dynamics
   a. growth curves and carrying capacity
   b. behavior (e.g., territoriality)
   c. intraspecific relationships (e.g., mating systems, social systems, competition)

2. Community ecology
   a. niche
   b. species diversity
   c. interspecific relationships (e.g., predator-prey, parasitism)
3. Ecosystems
   a. biomes
   b. stability and disturbances (e.g., glaciation, climate change, succession)
   c. energy flow (e.g., trophic levels, food webs)
   d. biogeochemical cycles (e.g., water, nitrogen, and carbon cycles, biotic/abiotic interaction)

Discussion areas

- What structures would you expect to find in a typical plant cell but not in an animal cell? What functions do these unique structures carry out for the plant?
- Compare and contrast the daughter cells after mitosis and cytokinesis to the daughter cells from the same parent cell after meiosis.
- In general terms, what are the different pathways that are involved in cellular respiration under aerobic and anaerobic conditions?
- What is the percent likelihood that a biological child of parents with the blood types AB and O will have blood type A? What are the genotypes for blood type A?
- Why do more males have red-green color-blindness than females?
- How are Mendel's laws related to the behavior of chromosomes during the formation of gametes?
- Explain the following concepts relative to Darwin's theory of the origin of species: a) Descent with modification, b) Struggle for existence, and c) Survival of the fittest.
- How is genetic drift different from natural selection?
- What are some structures that organisms use for locomotion?
- What are the similarities and differences between fungi and plants?
- Under what environmental conditions would you expect the transpiration rate to be the highest in a mature deciduous tree?
- Describe how a germinating seed responds to gravity and light.
- What are the roles of insulin and glucagon in the human endocrine system?
- Why must the human body digest large macromolecules into small monomers before it can use them?
- Of proteins, carbohydrates, and fats, which type of nutrient has the highest caloric value per gram?
- Relate the structural differences between the three muscle types to their functions.
- Under what conditions would a population grow exponentially?
- What are the possible outcomes when two species strongly compete for the same resources?
- Compare the types of vegetation encountered with increasing altitude (e.g., traveling up a mountainside) and with increasing latitude (e.g., traveling toward the North Pole).
- What is the difference between primary and secondary succession?
- Create a food web, with organisms placed within an appropriate trophic level, with the following organisms: bald eagle, herring gull, lake trout, phytoplankton, smelt (small fish), and zooplankton. Based on the food web, describe how the pesticide DDT would be distributed through the ecosystem.

IV. Earth and Space Science

A. Physical Geology

1. Types and basic characteristics of rocks and minerals and their formation processes
   a. the rock cycle
   b. characteristics of rocks and their formation processes (i.e., sedimentary, igneous, and metamorphic rock)
   c. characteristics of minerals and their formation processes (e.g., classes of minerals, crystals, hardness)

2. Processes involved in erosion, weathering, and deposition of Earth's surface materials and soil formation
   a. erosion and deposition (e.g., agents of erosion)
   b. chemical and physical (mechanical) weathering
   c. characteristics of soil (e.g., types, soil profile)
   d. porosity and permeability
   e. runoff and infiltration
3. Earth's basic structure and internal processes
   a. Earth's layers (e.g., lithosphere, mantle, core)
   b. shape and size of Earth
   c. geographical features (e.g., mountains, plateaus, mid-ocean ridges)
   d. Earth's magnetic field
   e. plate tectonics theory and evidence
      – folding and faulting (e.g., plate boundaries)
      – continental drift, seafloor spreading, magnetic reversals
      – characteristics of volcanoes (e.g., eruptions, lava, gases, hot spots)
      – characteristics of earthquakes (e.g., epicenters, faults, tsunamis)
      – seismic waves and triangulation
4. The water cycle
   a. evaporation and condensation
   b. precipitation
   c. runoff and infiltration
   d. transpiration

B. Historical Geology

1. Historical geology
   a. principle of uniformitarianism
   b. basic principles of relative age dating (e.g., superposition, stratigraphic correlation, fossil succession)
   c. absolute (radiometric) dating
   d. geologic time scale (e.g., age of Earth, scope of time)
   e. fossil record as evidence of the origin and development of life (e.g., fossilization methods, mass extinctions, ice ages, meteor impacts)

C. Earth's Bodies of Water

1. Characteristics and processes of Earth's oceans and other bodies of water
   a. distribution and location of Earth's water
   b. seawater composition
   c. coastline topography and topography of ocean floor
   d. tides, waves, currents
   e. estuaries and barrier islands
   f. islands, reefs, and atolls
   g. polar ice, icebergs, and glaciers
   h. lakes, ponds, and wetlands
   i. streams, rivers, and river deltas
   j. groundwater, water table, wells, and aquifers
   k. geysers and springs
   l. properties of water that affect Earth systems (e.g., density changes on freezing, high heat capacity, polar solvent, hydrogen bonding)

D. Meteorology and Climate

1. Basic structure and composition of Earth's atmosphere
   a. layers (e.g., stratosphere)
   b. composition of atmosphere (e.g., percent oxygen and nitrogen)
   c. atmospheric pressure and temperature
2. Basic concepts of meteorology
   a. relative humidity
   b. dew point
   c. wind (e.g., how it is generated and modified)
   d. cloud types and formation
   e. types of precipitation (e.g., hail, rain)
   f. air masses, fronts, storms, and severe weather (e.g., hurricanes, tornadoes)
   g. development and movement of weather patterns
3. Major factors that affect climate and seasons
   a. effects of latitude, geographical location, and elevation (e.g., mountains and oceans)
   b. effects of atmospheric circulation (e.g., trade winds, jet stream)
   c. effects of ocean circulation
   d. characteristics and locations of climate zones (e.g., Tropics, Arctic)
   e. effect of the tilt of Earth's axis on seasons
   f. effects of natural phenomena (e.g., volcanic eruptions, solar radiation variations)
   g. El Niño, La Niña

E. Astronomy

1. Major features of the solar system
   a. structure of the solar system
   b. laws of motion (e.g., gravitation, planetary orbits, satellites)
   c. characteristics of the Sun, Moon, and planets
   d. characteristics of asteroids, meteoroids, comets, and dwarf/minor planets
   e. theories of origin of the solar system

2. Interactions of the Earth-Moon-Sun system
   a. Earth's rotation and orbital revolution around the Sun
   b. effect on seasons
   c. phases of the Moon
   d. effect on tides
   e. solar and lunar eclipses
   f. time zones
   g. effect of solar wind on Earth
3. Major features of the universe
   a. galaxies (e.g., definition, relative size, Milky Way)
   b. characteristics of stars and their life cycles
      – life cycle of star, e.g., white dwarf, red giant, supernova, nebulae, black holes
      – color, temperature, apparent brightness, absolute brightness, luminosity
      – Hertzsprung-Russell diagrams
   c. dark matter
   d. theories about the origin of the universe (e.g., Big Bang)
4. Contributions of space exploration and technology to our understanding of the universe
   a. remote sensing devices (e.g., satellites, space probes, telescopes, spectral analysis)
   b. search for water and life on other planets

Discussion areas

- What are the source materials for the ingredients of sedimentary rocks?
- What properties are most commonly used by geologists in the field to characterize minerals?
- What are the major agents of erosion?
- What factors determine the amounts of runoff and infiltration?
- What does the behavior of seismic waves reveal about the structure and physical characteristics of Earth's interior?
- What information is represented on a topographic map?
- Describe the different tectonic processes that lead to the formation of mountain ranges.
- Rift valleys are associated with what type of tectonic plate motion?
- Transpiration is most closely related to what other process in the water cycle?
- What are index fossils?
- What appeared first in the fossil record: angiosperms or insects?
- How do the Sun and Moon influence tides?
- Why in general do two high tides occur every day even though the Moon is directly above any given portion of Earth's surface only once a day?
- Why do waves break as they approach the shore?
- What is the primary source of water in a lake?
- List the layers of the atmosphere and describe the temperature profile of each layer.
- How does the Sun influence global and local winds?
- What weather would you predict for the next day if you observed a lowering sequence of stratiform clouds over a day or two?
- How are air masses classified?
- Why do tropical cyclones generally move in a westward direction?
- What is the Coriolis effect and how does it influence atmospheric and ocean circulation?
- How does a volcanic eruption affect both regional and worldwide climate conditions?
- Describe the orbits of the planets. What do they have in common?
- Compare the surface features and atmospheres of the other terrestrial planets to those of Earth.
- How do the Sun and other stars generate their energy?
- Describe the temperature and length of the day at the North Pole, the midlatitudes, and the Equator on the summer and winter solstices.
- Why does the length of daylight change from day to day?

- List the common astronomical units of length in order of increasing distance.
- Use the Hertzsprung-Russell (H-R) diagram to describe the life cycle of the Sun.
- What limitation of Earth-based telescopes has been solved by the Hubble space telescope?

V. Science, Technology, and Society

A. Impact of Science and Technology on the Environment and Society

1. Air and water pollution (e.g., acid rain, eutrophication, groundwater pollution)
2. Climate change and greenhouse gases
3. Irrigation
4. Reservoirs and levees
5. Depletion of aquifers
6. Ozone layer depletion
7. Loss of biodiversity
8. Space exploration
9. Waste disposal (e.g., landfills)
10. Recycling
11. Environmentally friendly consumer products (e.g., biodegradable materials)

B. Major Issues associated with Energy Production and the Management of Natural Resources

1. Renewable and nonrenewable energy resources
2. Conservation and recycling
3. Pros and cons of power generation based on various resources including fossil and nuclear fuel, hydropower, wind power, solar power, geothermal power, and alternative energy sources
4. Issues associated with the use and extraction of Earth's resources (e.g., mining, land reclamation, deforestation)

C. Applications of Science and Technology in Daily Life

1. Chemical properties of household products
2. Communication (e.g., wireless devices, GPS, satellites)
3. Science principles applied in commonly used consumer products (e.g., batteries, lasers, polarized sunglasses, and fiber optic cables)
4. Water purification
5. Common agricultural practices (e.g., genetically modified crops, use of herbicides and insecticides)
6. DNA evidence in criminal investigations
7. Nanotechnology

D. Impact of Science on Public Health Issues

1. Nutrition, disease, and medicine (e.g., vitamins, viruses, vaccines)
2. Biotechnology (e.g., genetic engineering, in vitro fertilization)
3. Medical technologies (e.g., medical imaging, X-rays, radiation therapy)

Discussion areas

- What are the beneficial and adverse effects on humans and the environment of engineered structures such as dams, levees, and canals used to control or divert water?
- Give some reasons why electronic waste such as computers should be recycled.
- Compare the availability and limitation of the following sources of power: geothermal, nuclear, hydroelectric, solar, and fossil fuel.
- Why do polarized sunglasses reduce glare, while non-polarized sunglasses simply reduce the total amount of light reaching the eyes?
- What technique enables forensic scientists to be able to generate a DNA profile of a suspect from a small sample of DNA collected from a crime scene?
- List some childhood diseases that are commonly prevented through immunization.
- How has recombinant DNA technology been used to treat diabetes?

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 Series* tests at 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 that may make it easier 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/accommodations/plne.

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 for the most up-to-date information.

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

The Praxis Series 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.

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.

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.

Visit http://www.ets.org/s/praxis/pdf/sample_score_report.pdf to see a sample score report.
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.

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 test or other tests in *The Praxis Series* over 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 Series 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 the *Praxis* Subject Assessments (formerly the *Praxis II*® tests) for professional licensing.

Do all states require these tests?

The Praxis Series 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 Series* tests?

Your state chose *The Praxis Series* 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 Series* test development process. First, ETS asked them which 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/centers_dates 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.

*ETS Standards for Quality and Fairness (2003, Princeton, NJ) are consistent with the "Standards for Educational and Psychological Testing," industry standards issued jointly by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education (1999, Washington, DC).

Your teaching career is worth preparing for, so start today!

Let the *Praxis*® *Study Companion* guide you.

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

www.ets.org/praxis/testprep

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

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