ETS PRAXIS

Measuring the Power of Learning.™

The *Praxis*® Study Companion

Physics: Content Knowledge

5265

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® 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 37).

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

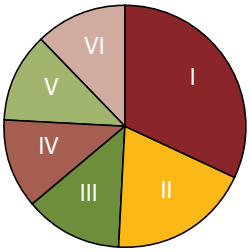
The Praxis® Study Companion guides you through the steps to success

1. Learn About Your Test

Learn about the specific test you will be taking

Physics: Content Knowledge (5265)

Test at a Glance	
Test Name	Physics: Content Knowledge
Test Code	5265
Time	2.5 hours
Number of Questions	125
Format	Selected-response questions; calculator use prohibited
Test Delivery	Computer delivered



Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
I. Mechanics	40	32%
II. Electricity and Magnetism	24	19%
III. Optics and Waves	16	13%
IV. Heat, Energy, and Thermodynamics	15	12%
V. Modern Physics, and Atomic and Nuclear Structure	15	12%
VI. Scientific Inquiry, Processes, and Social Perspectives	15	12%

About This Test

The Physics: Content Knowledge test is designed to measure the knowledge and competencies necessary for a beginning teacher of secondary school Physics. Examinees have typically completed or nearly completed a bachelor's degree program with appropriate coursework in Physics and education. This test may contain some questions that will not count towards 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 Physics teachers, teacher-educators, and higher education content specialists to keep the test updated and representative of current standards.

The 125 selected-response questions include concepts, terms, phenomena, methods, applications, data analysis, and problem solving in Physics, and include an understanding of the impact of science and technology on the environment and human affairs. The topics are typically those covered in introductory college-level Physics courses, although some questions of a more advanced nature are included, because secondary-school teachers must understand the subject matter from a more advanced viewpoint than that presented to their students.

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

Test Specifications

Test specifications in this chapter describe the knowledge and skills measured by the test. Study topics to help you prepare to answer test questions can be found on page 27.

I. Mechanics

A. Vectors and Scalars

1. Vector and scalar quantities in describing motion and forces.
   a. scalars (e.g., mass, speed, time, energy)
   b. vectors (e.g., displacement, velocity, acceleration, force, momentum)
   c. vector components
   d. addition of vectors
   e. resultant vector

B. Kinematics

1. Motion in terms of displacement, velocity, and acceleration.
   a. linear motion
   b. simple harmonic motion (e.g., pendulums, spring oscillation)
   c. circular motion
   d. projectile motion
   e. rotational kinematics (e.g., angular displacement, angular velocity, angular acceleration)
2. Frames of reference and their applications.
   a. frames of reference (e.g., coordinate systems, inertial reference frames)
   b. relative velocity

C. Dynamics and Fluid Mechanics

1. Newton's three laws of motion.
   a. Newton's first law of motion (e.g., mass, inertia, inertial reference frame)
   b. Newton's second law of motion (net force, mass, acceleration)
   c. Newton's third law of motion (action-reaction forces)
   d. applications (e.g., inclined planes, pendulums, Atwood machine)
2. Static equilibrium.
   a. sum of forces
   b. sum of torques
3. Friction, including forces and coefficients.
   a. normal force
   b. frictional force
   c. coefficients of static and kinetic friction
4. Circular motion.
   a. centripetal acceleration
   b. centripetal force
5. Simple harmonic motion.
   a. restoring force (e.g., Hooke's law)
   b. properties of simple harmonic motion (e.g., period, frequency, amplitude)
   c. pendulums
   d. spring oscillation
6. Work, mechanical energy, and power, and how they are related to one another.
   a. mechanical energy (e.g., kinetic energy, potential energy, conservation of energy)
   b. work
   c. work and energy
   d. power
   e. simple machines and mechanical advantage
7. Linear momentum and impulse and how they are related to one another.
   a. linear momentum
   b. impulse
   c. impulse and momentum
8. Rotational motion.
   a. center of mass
   b. angular momentum
   c. conservation of angular momentum
   d. torque
   e. rotational inertia (moment of inertia)

9. Differences between elastic and inelastic collisions.
    a. elastic collisions
    b. inelastic collisions
    c. conservation of momentum
    d. conservation of kinetic energy
    e. collisions in one dimension
    f. collisions in two dimensions
10. Laws of conservation of energy and conservation of linear momentum.
    a. conservation of energy
    b. conservation of linear momentum
    c. energy transformations
11. Newton's law of universal gravitation.
    a. Newton's law of universal gravitation
    b. satellites and orbital motion
    c. gravitational acceleration
12. Difference between weight and mass.
    a. weight and mass
    b. difference between weight and mass
    c. relationship between density and mass
13. Kepler's three laws of orbital motion.
    a. Kepler's first law (law of ellipses)
    b. Kepler's second law (law of equal areas)
    c. Kepler's third law (relationship between orbital period and mean orbital radius)
14. Fluid mechanics.
    a. Archimedes' principle
    b. Bernoulli's principle
    c. Pascal's principle
    d. properties of fluids (e.g., density, pressure, viscosity)

II. Electricity and Magnetism

1. Electrostatics.
    a. electric charge
    b. induced charge
    c. Coulomb's law
    d. electrostatic forces
    e. electric field
    f. electric flux
    g. electric potential
    h. electric potential energy
    i. potential difference
    j. Gauss's law
2. Electrical properties of conductors, insulators, and semiconductors.
    a. conductors
    b. insulators
    c. semiconductors
    d. material examples (e.g., metals, ceramics, superconductors)
3. Electrical current, resistance, potential difference, energy, power, and the relationships between them.
    a. electric current
    b. potential difference
    c. resistance
    d. resistivity
    e. Ohm's law
    f. energy
    g. power
    h. energy and power (e.g., kilowatt-hours vs. kilowatts)
4. Capacitance and inductance.
    a. capacitance and capacitors
    b. inductance and inductors
5. Differences between alternating and direct current.
    a. direct current
    b. alternating current
6. How to analyze simple series, parallel, and combination circuits.
    a. series circuits
    b. parallel circuits
    c. combination circuits
    d. Ohm's law
    e. equivalent resistance
    f. equivalent capacitance
    g. Kirchhoff's laws
    h. measurement devices within circuits (e.g., ammeters, voltmeters)
7. How sources generate electric potential.
    a. batteries
    b. photocells
    c. generators
    d. electromotive force (EMF)

8. Magnetic fields, magnetic forces, and properties of magnetic materials.
    a. magnetic field
    b. magnetic flux
    c. magnetic force
    d. magnets (e.g., bar magnets and poles, permanent magnets, electromagnets)
    e. transformers, motors, and generators
    f. direction of fields and forces (e.g., right-hand rule)
    g. magnetic field generated by a steady current (e.g., Biot-Savart law)
    h. Ampere's law
    i. Lorentz force law (force on a moving charge)
    j. force between current-carrying wires
9. How a changing electric field produces a magnetic field and how a changing magnetic field produces an electric field.
    a. Ampere's law
    b. Lenz's law (direction of induced current)
    c. Faraday's law of induction
    d. motional EMF

III. Optics and Waves

1. Types of waves and their characteristics.
    a. transverse and longitudinal
    b. wave motion and propagation (mechanical vs. electromagnetic)
    c. amplitude, wavelength, frequency, period, speed, energy
    d. superposition and phase
    e. intensity and inverse square law
    f. standing waves
2. Wave phenomena such as reflection, refraction, interference, and diffraction.
    a. reflection, refraction, Snell's law, dispersion, total internal reflection
    b. diffraction, interference, superposition, Young's double-slit interference experiment
    c. polarization
    d. scattering, absorption, transmission
    e. resonance and natural frequencies, harmonics
3. Fundamentals of the Doppler effect.
    a. Doppler effect
    b. apparent frequency
    c. moving source
    d. moving observer
    e. redshift, blueshift
4. Characteristics of sound.
    a. compression waves
    b. speed of sound (e.g., sonic boom, sound barrier)
    c. pitch (frequency), loudness (intensity)
    d. beats
    e. air columns (open and closed pipes)
5. Electromagnetic waves and the electromagnetic spectrum.
    a. electromagnetic waves (e.g., electric and magnetic fields, speed of light, energy)
    b. electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays)
6. Geometric optics.
    a. ray tracing
    b. focal point, image distance, image size and magnification, real vs. virtual image, image orientation
    c. lenses (converging, diverging)
    d. mirrors (plane, convex, concave, spherical, parabolic)
    e. lens and mirror equations
    f. simple instruments (e.g., magnifying glass, telescope, microscope)
    g. prisms

IV. Heat, Energy, and Thermodynamics

1. Temperature, temperature scales, heat, and heat capacity.
    a. temperature (measure of average kinetic energy)
    b. temperature scales
    c. heat and thermal energy
    d. difference between temperature and thermal energy
    e. heat capacity and specific heat
    f. calorimetry
    g. thermal expansion
2. Mechanisms of heat transfer.
    a. conduction
    b. convection
    c. radiation
3. Different forms of energy and transformations between them.
    a. forms of energy (e.g., kinetic, potential, mechanical, electrical, electromagnetic, chemical, nuclear)
    b. energy transformations

4. Energy involved in phase transitions between the various states of matter.
    a. phase transitions
    b. phase diagrams
    c. heating/cooling diagrams
    d. heats of vaporization, fusion, and sublimation
5. Kinetic molecular theory and the ideal gas laws.
    a. kinetic molecular theory (e.g., assumptions of the theory, temperature, pressure, average molecular speeds)
    b. ideal gases and the ideal gas law
6. Laws of thermodynamics.
    a. First law (e.g., internal energy, conservation of energy, work, heat)
    b. Second law (entropy)
    c. Third law (absolute zero)
    d. Zeroth law (thermal equilibrium)
    e. P-V diagrams
    f. thermodynamic processes (e.g., isothermal, adiabatic, reversible/irreversible)
    g. heat engines and efficiency (e.g., ideal vs. actual efficiency, temperature differences)

V. Modern Physics, and Atomic and Nuclear Structure

1. Organization, structure and states of matter.
    a. atoms, molecules, ions
    b. solids, liquids, gases, plasmas
    c. chemical/physical properties and changes
2. Nature of atomic and subatomic structure including various models of the atom.
    a. atomic and subatomic structure (e.g., electrons, protons, neutrons, and isotopes)
    b. models of the atom (e.g., Bohr model, quantum model)
    c. experimental basis of models (e.g., Rutherford experiment, Millikan oil-drop experiment, Thomson experiment)
3. Relationship of atomic spectra to electron energy levels.
    a. electron energy transitions in atoms
    b. absorption and emission spectra
4. Characteristics, processes, and effects of radioactivity.
    a. radioactivity and radioactive decay processes
    b. alpha particles, beta particles, and gamma radiation
    c. half-life
    d. radioisotopes
    e. fission and fusion
5. Topics in modern physics.
    a. wave-particle duality
    b. photoelectric effect
    c. special relativity
    d. Heisenberg uncertainty principle
    e. de Broglie's hypothesis
    f. nuclear forces (strong and weak) and binding energy

VI. Scientific Inquiry, Processes, and Social Perspectives

A. History and Nature of Scientific Inquiry

1. Processes involved in scientific inquiry.
    a. identifying problems
    b. forming and testing hypotheses
    c. development of theories, models, and laws
    d. process skills, including observing, comparing, inferring, categorizing, generalizing, and concluding
2. Experimental design.
    a. experimental procedures used to test hypotheses
    b. reproducible procedures
    c. significance of controls
    d. dependent and independent variables
    e. determining what data need to be collected
3. Nature of scientific knowledge.
    a. is subject to change
    b. is consistent with evidence
    c. is based on reproducible evidence
    d. includes unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)
4. How major principles in physics developed historically and the contributions of major historical figures.
    a. how current principles and models developed over time
    b. major developments (e.g., atomic model, Newtonian mechanics, Rutherford experiment)
    c. major historical figures in the development of physics

B. Scientific Procedures and Techniques

1. How to collect, process, analyze, and report data including sources of error.
    a. organization and presentation of data
    b. units of measurement including SI, SI derived, and others (e.g., meter, newton, mile)
    c. unit conversion and dimensional analysis
    d. scientific notation and significant figures
    e. measurement equipment, including applications
    f. basic error analysis, including precision and accuracy
    g. identifying sources of error
    h. interpreting and drawing valid conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variables, predictions based on data)
2. Appropriate use of materials, equipment, and technology in the high school physics laboratory and classroom.
    a. appropriate use and storage
    b. appropriate prelab setup and classroom demonstrations
    c. safety procedures and precautions

C. Science, Technology, and Society

1. Impact of physics and technology on society and the environment.
    a. space exploration, communications, etc.
    b. climate change, ozone layer depletion, noise pollution, etc.
    c. production, storage, and disposal issues associated with consumer products
2. Major issues associated with energy use and production.
    a. renewable and nonrenewable energy resources
    b. conservation and recycling
    c. power generation based on various sources, such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power
    d. storage and distribution of renewable energy (e.g., alternative fuels, fuel cells, rechargeable batteries)
3. Applications of physics in daily life.
    a. communications (e.g., wireless devices, fiber optics, satellites)
    b. research tools (e.g., space telescopes, lasers, super colliders)
    c. medicine (e.g., medical imaging, lasers)
    d. transportation (e.g., superconductors, magnetic levitation)
    e. other applications

2. Familiarize Yourself with Test Questions

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

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

Understanding Computer-Delivered Questions

Questions on computer-delivered tests are interactive in the sense that you answer by selecting an option or entering text on the screen. If you see a format you are not familiar with, read the directions carefully. The directions always give clear instructions on how you are expected to respond.

For most questions, you respond by clicking an oval to select a single answer from a list of answer choices.

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

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

Remember that with every question you will get clear instructions.

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

Understanding Selected-Response Questions

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

Which of the following is a flavor made from beans?

(A) Strawberry

(B) Cherry

(C) Vanilla

(D) Mint

How would you answer this question?

All of the answer choices are flavors. Your job is to decide which of the flavors is the one made from beans.

Try following these steps to select the correct answer.

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

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

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

Try a more challenging example

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

Entries in outlines are generally arranged according to which of the following relationships of ideas?

(A) Literal and inferential

(B) Concrete and abstract

(C) Linear and recursive

(D) Main and subordinate

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

Sometimes it helps to put the question in your own words. Here, you could paraphrase the question in this way: "How are outlines usually organized?" Since the ideas in outlines usually appear as main ideas and subordinate ideas, the answer is (D).

QUICK TIP: Don't be intimidated by words you may not understand. It might be easy to be thrown by words like "recursive" or "inferential." Read carefully to understand the question and look for an answer that fits. An outline is something you are probably familiar with and expect to teach to your students. So slow down, and use what you know.

Watch out for selected-response questions containing "NOT," "LEAST," and "EXCEPT"

This type of question asks you to select the choice that does not fit. You must be very careful because it is easy to forget that you are selecting the negative. This question type is used in situations in which there are several good solutions or ways to approach something, but also a clearly wrong way.

How to approach questions about graphs, tables, or reading passages

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

How to approach unfamiliar formats

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

Tests may also include interactive questions. These questions take advantage of technology to assess knowledge and skills in ways that standard selected-response questions cannot. If you see a format you are not familiar with, **read the directions carefully**. The directions always give clear instructions on how you are expected to respond.

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

Understanding Constructed-Response Questions

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

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

Take a look at a few sample essay topics:

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

Keep these things in mind when you respond to a constructed-response question

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

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

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

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

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

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

For tests that have constructed-response questions, more detailed information can be found 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 incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.

1. Three resistors of 4 ohms each CANNOT be connected to give an equivalent resistance that is close to
   (A) 0.75 ohms
   (B) 2.66 ohms
   (C) 6 ohms
   (D) 12 ohms

2. A beam of light travels obliquely from one medium into another medium of higher index of refraction. All of the following are true statements about the beam of light EXCEPT:
   (A) Its speed increases.
   (B) Its wavelength decreases.
   (C) Its frequency remains the same.
   (D) It bends toward the normal.

3. Two satellites move in circular orbits around the Earth. The radius of the orbit of the outer satellite is three times the radius of the orbit of the inner satellite, as measured from the Earth's center. If the orbital speed of the inner satellite is v, then the orbital speed of the outer satellite is
   (A) $v/3$
   (B) $v/\sqrt{3}$
   (C) $\sqrt{3} \cdot v$
   (D) $3v$

4. Which of the following is an example of the Doppler effect?
   (A) Sudden increase in pitch when a moving sound source is moving away from a listener
   (B) Sudden increase in pitch when a moving listener is moving away from a sound source
   (C) Sudden drop in pitch as a moving sound source passes a listener
   (D) Continuous drop in pitch as a moving sound source approaches a listener

5. Supplies appropriate for the measurement in a school laboratory of the density of a small rock sample include all of the following EXCEPT
   (A) water
   (B) a graduated cylinder
   (C) a platform balance
   (D) a thermometer

6. Which of the following properties of a substance depends on the amount of the sample?
   (A) Temperature
   (B) Half-life
   (C) Density
   (D) Inertia

7. $n \rightarrow p + e^{-} + \bar{\nu}$

A nucleus can emit a negative beta particle according to the reaction above, where n = neutron, p = proton, e^{-} = electron, and $\bar{\nu}$ = antineutrino. Which of the following best states the information in this reaction?

(A) A neutron is composed of an electron and a proton.

(B) The mass of a neutron is equal to the mass of a proton plus the mass of an electron.

(C) Since a neutrino has no rest mass or charge, a neutron may decay into a proton and an electron.

(D) The mass of a neutron is greater than the mass of a proton plus the mass of an electron.

8. Faraday's law of electromagnetic induction describes how an electric field can be produced at a point in space by

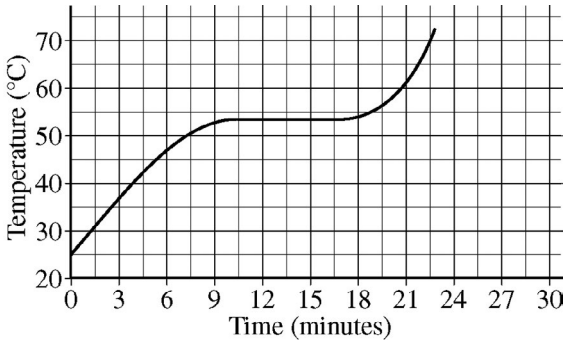
(A) an electric charge

(B) a constant magnetic field

(C) a changing magnetic field

(D) a steady current

9.



A sample of a pure solid substance is heated at a constant rate and its temperature recorded as a function of time. A graph of the data is shown above. At about what temperature is the heat added being used to melt the substance?

(A) 25°C

(B) 41°C

(C) 53°C

(D) 60°C

10. If electrons have a velocity of 4.0×10^{6} meters per second at right angles to a magnetic field of 0.20 newton per ampere-meter, what is the magnitude of the force on a single electron?

(A) 1.3×10^{-13} N

(B) 1.6×10^{-14} N

(C) 6.4×10^{-19} N

(D) 3.2×10^{-26} N

Questions 11–12 refer to the following statements.

A mass is suspended from a vertical spring and displaced downward a distance *Y* from its equilibrium position. After being released, it oscillates with period *T*.

11. At a time $5T/4$, the velocity of the mass is

(A) a maximum and directed upward

(B) a maximum and directed downward

(C) constant

(D) zero

12. At a time $5T/4$, the acceleration of the mass is

(A) a maximum and directed upward

(B) a maximum and directed downward

(C) constant

(D) zero

13. In a test of an automobile air bag, a mannequin with a mass of 70 kilograms hits a stationary air bag. The velocity of the mannequin at the instant of impact is 25 meters per second. After 0.25 seconds the mannequin has come to a complete stop and the air bag has deflated. The average force on the mannequin during this interval is most nearly

(A) 70 N

(B) 700 N

(C) 7,000 N

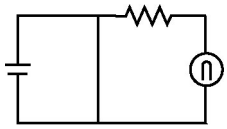
(D) 70,000 N

14. In which of the following is the battery short-circuited?

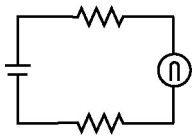
– battery – resistance – bulb

(A)

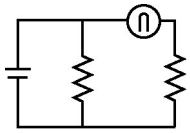
(B)



(C)



(D)



15. 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

16. A thin ring of mass 50 g and radius 5.0 cm is spinning at a frequency of 6.0 rev/s. Mass is added uniformly to the ring until it has a final mass of 75 g. What is the final spinning frequency of the ring?

(A) 0 rev/s
(B) 4 rev/s
(C) 6 rev/s
(D) 8 rev/s

17. A washer consists of a 3.00 cm diameter circle of sheet metal with a 1.00 cm diameter circular hole in the middle. If the metal washer is heated until the diameter of the washer is 3.03 cm, then the diameter of the hole will be

(A) 0.97 cm
(B) 0.99 cm
(C) 1.00 cm
(D) 1.01 cm

18. In a particle accelerator, it becomes increasingly difficult to increase a particle's speed because of

(A) relativistic mass increase
(B) time dilation
(C) length contraction
(D) inelastic collisions

19. 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) They are accurate but not precise.
(D) They are neither precise nor accurate.

20. 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 correct answer is (A). There are four possible series and parallel combinations involving three resistors of equal value. The following table lists these combinations along with their corresponding equivalent resistances.

COMBINATION	REQ
3 in series	12 Ω
3 in parallel	1.33 Ω
2 series, 1 parallel	2.66 Ω
1 series, 2 parallel	6.0 Ω

2. The correct answer is (A). According to Snell's law, $n_1 \sin\theta_1 = n_2 \sin\theta_2$, and when $n_2 > n_1$ then $\theta_2 < \theta_1$; that is, the beam bends toward the normal, so choice (D) is true. The frequency of the light will remain unchanged. Thus, choice (C) is true. The speeds v_1 and v_2 of the light in the two media are c/n_1 and c/n_2, respectively. Thus $v_2 < v_1$ for $n_2 > n_1$, and since the frequency remains the same, the wavelength decreases. That is, $\lambda_2 < \lambda_1$, so choice (B) is true. Finally, $v_2 < v_1$ indicates that choice (A) is false. Because choice (A) is false, it is the correct answer.

3. The correct answer is (B). For circular orbital motion in a gravitational field, $\frac{v^2}{R} = \frac{GM}{R^2}$ which gives $v^2 = \frac{GM}{R}$

Thus, letting v_i, R_i denote the velocity and radius of the orbit of the inner satellite and v_o, R_o the velocity and the radius of the orbit of the outer satellite, one has

$$\left(\frac{v_o}{v_i}\right)^2 = \frac{R_i}{R_o}, \text{ or } v_o = v\sqrt{\frac{R_i}{R_o}} = \frac{v}{\sqrt{3}}$$

since $v_i = v$.

4. The correct answer is (C). According to the Doppler effect, the frequency drops as a sound source passes and then moves away from a listener.

5. The correct answer is (D). The density of a rock is subject to very small variations with temperature, so the thermometer is not important. The other pieces of equipment are needed for the determination since density is mass per unit volume.

6. The correct answer is (D). Inertia is a property of a substance, proportional to its mass, and therefore depends on the amount of the sample.

7. The correct answer is (D). The antineutrino carries energy and has a very small but nonzero rest mass. Thus, the mass of a neutron must be greater than the mass of a proton plus the mass of an electron.

8. The correct answer is (C). For circuits, Faraday's law of electromagnetic induction states that the induced electromotive force in a circuit is equal to the rate of change of the magnetic flux through it. In general, Faraday's law relates an electric field in vacuum to the rate of change of a magnetic field. In differential form, the relation is clearly seen:

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

9. The correct answer is (C). When a substance is heated, its temperature increases unless it is undergoing a phase change. During melting, the temperature remains constant since the energy absorbed is being used to do work against the attractive forces in becoming liquid particles. In the diagram, melting begins around 9 minutes and a temperature around 53°C.

10. The correct answer is (A). According to the Lorentz force law,

$$F = qvB = (1.6 \times 10^{-19}\ \text{C})(4.0 \times 10^{6}\ \text{m/s})(0.20\ \text{N/Am}) = 1.3 \times 10^{-13}\ \text{N}$$

11. The correct answer is (A). At $5T/4$, the mass is situated midway between its highest and lowest positions; it is moving **upward** and has its maximum speed.

12. The correct answer is (D). At $5T/4$, the mass is situated midway between its highest and lowest positions. At this position, the sum of the two forces acting on the mass is zero; thus its acceleration is zero.

13. The correct answer is (C). The average force $\bar{F}$ is equal in magnitude to the change in the momentum of the mannequin divided by the elapsed time, or

$$\bar{F} = \frac{m\Delta v}{\Delta t} = \frac{(70\text{ kg})(25\text{ m/s})}{0.25\text{ s}} = 7{,}000\text{ N}$$

14. The correct answer is (B). In this diagram the path of the circuit is such that current will be diverted from passing through the resistor and the bulb. When the part of a circuit with the most resistance is bypassed, and all of the current flows through the part with zero (negligible) resistance, a short circuit is said to exist.

15. 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.

16. The correct answer is (B). The additional mass is added uniformly to the ring, which means that no external torques act on the system and angular momentum is conserved. Now, the angular momentum is equal to the product of the ring's mass, the ring's angular velocity, and the square of the ring's radius. Because the radius is also constant, conservation of angular momentum gives (50 g) × (6.0 rev/s) = (75 g) × (final angular frequency), or final angular frequency = 4 rev/s.

17. The correct answer is (D). At a given radius, the linear expansion is the same in all radial directions and is equal to the product of the radius, the thermal expansion coefficient, and the temperature change. Thus, the expansion of the inner diameter will be equal to one-third the expansion of the outer diameter, or 0.01 cm, for a total internal diameter of 1.01 cm.

18. The correct answer is (A). In a particle accelerator, the particles are accelerated to relativistic speeds. According to the theory of special relativity, a particle's relativistic mass (inertia) increases as the particle's speed increases. Thus, greater and greater forces are needed to accelerate the particle as its speed increases.

19. 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.

20. 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 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 on page 40.

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 25 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 25 can help to structure your group's study program. By filling out the first five columns and sharing the worksheets, everyone will learn more about your group's mix of abilities and about the resources, such as textbooks, that members can share with the group. In the sixth column ("Dates I will study the content"), you can create an overall schedule for your group's study program.
- **Plan individual group sessions.** At the end of each session, the group should decide what specific topics will be covered at the next meeting and who will present each topic. Use the topic headings and subheadings in the Test at a Glance table on page 5 to select topics, and then select practice questions, beginning on page 15.
- **Prepare your presentation for the group.** When it's your turn to present, prepare something that is more than a lecture. Write two or three original questions to pose to the group. Practicing writing actual questions can help you better understand the topics covered on the test as well as the types of questions you will encounter on the test. It will also give other members of the group extra practice at answering questions.

- **Take a practice test together.** The idea of a practice test is to simulate an actual administration of the test, so scheduling a test session with the group will add to the realism and may also help boost everyone's confidence. Remember, complete the practice test using only the time that will be allotted for that test on your administration day.
- **Learn from the results of the practice test.** Review the results of the practice test, including the number of questions answered correctly in each content category. For tests that contain constructed-response questions, look at the Sample Test Questions section, which also contain sample responses to those questions and shows how they were scored. Then try to follow the same guidelines that the test scorers use.
- **Be as critical as you can.** You're not doing your study partner(s) any favors by letting them get away with an answer that does not cover all parts of the question adequately.
- **Be specific.** Write comments that are as detailed as the comments about the sample responses. Indicate where and how your study partner(s) are doing an inadequate job of answering the question. Writing notes in the margins of the answer sheet may also help.
- **Be supportive.** Include comments that point out what your study partner(s) got right.

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

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

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

Review detailed study topics with questions for discussion

Using the Study Topics That Follow

The Physics: 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. Mechanics

A. Vectors and Scalars

1. Vector and scalar quantities in describing motion and forces.
   a. scalars (e.g., mass, speed, time, energy)
   b. vectors (e.g., displacement, velocity, acceleration, force, momentum)
   c. vector components
   d. addition of vectors
   e. resultant vector

B. Kinematics

1. Motion in terms of displacement, velocity, and acceleration.
   a. linear motion
   b. simple harmonic motion (e.g., pendulums, spring oscillation)
   c. circular motion
   d. projectile motion
   e. rotational kinematics (e.g., angular displacement, angular velocity, angular acceleration)
2. Frames of reference and their applications.
   a. frames of reference (e.g., coordinate systems, inertial reference frames)
   b. relative velocity

C. Dynamics and Fluid Mechanics

1. Newton's three laws of motion.
   a. Newton's first law of motion (e.g., mass, inertia, inertial reference frame)
   b. Newton's second law of motion (net force, mass, acceleration)
   c. Newton's third law of motion (action-reaction forces)
   d. applications (e.g., inclined planes, pendulums, Atwood machine)
2. Static equilibrium.
   a. sum of forces
   b. sum of torques
3. Friction, including forces and coefficients.
   a. normal force
   b. frictional force
   c. coefficients of static and kinetic friction
4. Circular motion.
   a. centripetal acceleration
   b. centripetal force
5. Simple harmonic motion.
   a. restoring force (e.g., Hooke's law)
   b. properties of simple harmonic motion (e.g., period, frequency, amplitude)
   c. pendulums
   d. spring oscillation
6. Work, mechanical energy, and power, and how they are related to one another.
   a. mechanical energy (e.g., kinetic energy, potential energy, conservation of energy)
   b. work
   c. work and energy
   d. power
   e. simple machines and mechanical advantage
7. Linear momentum and impulse and how they are related to one another.
   a. linear momentum
   b. impulse
   c. impulse and momentum
8. Rotational motion.
   a. center of mass
   b. angular momentum
   c. conservation of angular momentum
   d. torque
   e. rotational inertia (moment of inertia)
9. Differences between elastic and inelastic collisions.
   a. elastic collisions
   b. inelastic collisions
   c. conservation of momentum
   d. conservation of kinetic energy
   e. collisions in one dimension
   f. collisions in two dimensions
10. Laws of conservation of energy and conservation of linear momentum.
    a. conservation of energy
    b. conservation of linear momentum
    c. energy transformations
11. Newton's law of universal gravitation.
    a. Newton's law of universal gravitation
    b. satellites and orbital motion
    c. gravitational acceleration
12. Difference between weight and mass.
    a. weight and mass
    b. difference between weight and mass
    c. relationship between density and mass

13. Kepler's three laws of orbital motion.
    a. Kepler's first law (law of ellipses)
    b. Kepler's second law (law of equal areas)
    c. Kepler's third law (relationship between orbital period and mean orbital radius)
14. Fluid mechanics.
    a. Archimedes' principle
    b. Bernoulli's principle
    c. Pascal's principle
    d. properties of fluids (e.g., density, pressure, viscosity)

Discussion areas: Mechanics

- Be able to determine, for example, distance, displacement, average speed, average velocity, and average acceleration for an object in motion.
- Be able to determine, for example, the magnitude and direction of the resultant of two vectors.
- Be able to calculate, for example, the magnitude and direction of the vector (cross) product **A x B** of two vectors **A** and **B**.
- Be able to describe, for example, in graphical form the position, velocity, and acceleration of an object that is thrown vertically upward and returns to its starting point.
- Be able to determine, for example, displacement, distance, velocity, and acceleration from graphs of position versus time, velocity versus time, and acceleration versus time.
- Be able to calculate, for example, the horizontal and vertical components of velocity for a projectile.
- Be able to draw a free-body diagram of all the forces acting on an object.
- Be able to identify, compare, and sum, for example, the forces acting on a block that is accelerating or moving at constant velocity on a rough horizontal surface, including the reaction forces.
- Be able to explain, for example, why gymnasts performing on a balance beam raise their arms to regain their balance.
- Be familiar, for example, with the coefficients of static and kinetic friction.
- Be able to determine, for example, the coefficient of kinetic friction for a box sliding down an inclined plane at constant speed.
- Be able to calculate, for example, the centripetal force acting on an object moving at constant speed in a circular path.
- Be able to calculate, for example, the period and/or frequency of a simple pendulum or a spring in simple harmonic motion.
- Be able to plot, for example, the potential energy, kinetic energy, and total mechanical energy of a linear harmonic oscillator as a function of position.
- Be able to explain, for example, how an adult pushing a child on a swing adds energy to the swinging motion.
- Be able to explain, for example, why it is difficult to step out of a canoe.
- Be able to describe, for example, the changes that occur to the rotational inertia (moment of inertia), angular momentum, and rotational kinetic energy of a student who extends his or her arms outward from an initial downward position while rotating about a vertical axis on a frictionless platform.
- Be able to apply, for example, the principles of conservation of momentum and energy to predict the results of collisions between objects in one or two dimensions.
- Be able to use, for example, the law of conservation of energy to predict the energy transformations of a bungee-cord jumper.
- Be able to calculate, for example, the gravitational force between two masses separated by a certain distance.
- Be able to determine, for example, the acceleration and period of a satellite in circular orbit about Earth.
- Be able to describe, for example, the relationship between a planet's period about the Sun and its mean distance from the Sun.
- Be able to calculate, for example, the buoyant force acting on an object.

II. Electricity and Magnetism

1. Electrostatics.
    a. electric charge
    b. induced charge
    c. Coulomb's law
    d. electrostatic forces
    e. electric field
    f. electric flux
    g. electric potential
    h. electric potential energy
    i. potential difference
    j. Gauss's law
2. Electrical properties of conductors, insulators, and semiconductors.
    a. conductors
    b. insulators
    c. semiconductors
    d. material examples (e.g., metals, ceramics, superconductors)
3. Electrical current, resistance, potential difference, energy, power, and the relationships between them.
    a. electric current
    b. potential difference
    c. resistance
    d. resistivity
    e. Ohm's law
    f. energy
    g. power
    h. energy and power (e.g., kilowatt-hours vs. kilowatts)
4. Capacitance and inductance.
    a. capacitance and capacitors
    b. inductance and inductors
5. Differences between alternating and direct current.
    a. direct current
    b. alternating current
6. How to analyze simple series, parallel, and combination circuits.
    a. series circuits
    b. parallel circuits
    c. combination circuits
    d. Ohm's law
    e. equivalent resistance
    f. equivalent capacitance
    g. Kirchhoff's laws
    h. measurement devices within circuits (e.g., ammeters, voltmeters)
7. How sources generate electric potential.
    a. batteries
    b. photocells
    c. generators
    d. electromotive force (EMF)
8. Magnetic fields, magnetic forces, and properties of magnetic materials.
    a. magnetic field
    b. magnetic flux
    c. magnetic force
    d. magnets (e.g., bar magnets and poles, permanent magnets, electromagnets)
    e. transformers, motors, and generators
    f. direction of fields and forces (e.g., right-hand rule)
    g. magnetic field generated by a steady current (e.g., Biot-Savart law)
    h. Ampere's law
    i. Lorentz force law (force on a moving charge)
    j. force between current-carrying wires
9. How a changing electric field produces a magnetic field and how a changing magnetic field produces an electric field.
    a. Ampere's law
    b. Lenz's law (direction of induced current)
    c. Faraday's law of induction
    d. motional EMF

Discussion areas: Electricity and Magnetism

- Be able to calculate, for example, the electrostatic force between two point charges separated by a certain distance.
- Be able to determine, for example, the electric field and electric potential at a point midway between two point charges.
- Be able to determine, for example, the electric potential energy of a simple configuration of point charges.
- Be able to calculate, for example, the power dissipated by a resistor in a circuit.
- Be able to describe, for example, how the resistivity of a wire depends on its length and cross-sectional area.
- Be able to calculate, for example, the equivalent capacitance of two capacitors connected in series or two capacitors connected in parallel.
- Be able to calculate, for example, the capacitance of a parallel-plate capacitor.

- Be familiar, for example, with the effect of a dielectric on the capacitance of a parallel-plate capacitor.
- Be able to calculate, for example, the equivalent resistance of two resistors connected in series or two resistors connected in parallel.
- Be able to calculate, for example, the current in a circuit consisting of series and parallel combinations of resistors.
- Be able to describe, for example, how to measure the resistance of a resistor in a circuit using a voltmeter and an ammeter.
- Be able to determine, for example, the magnitude and direction of the electric field needed to allow an electron to travel eastward undeflected in Earth's magnetic field.
- Be able to determine, for example, the magnitude and direction of the resultant magnetic field at a point midway between two long, parallel wires carrying currents in opposite directions and separated by a certain distance.
- Be able to determine, for example, the magnitudes and directions of the magnetic forces on two long, parallel current-carrying wires.
- Be able to determine, for example, the direction of the current induced in a metal rod that is aligned east-west and is dropped in Earth's magnetic field.

III. Optics and Waves

1. Types of waves and their characteristics.
   a. transverse and longitudinal
   b. wave motion and propagation (mechanical vs. electromagnetic)
   c. amplitude, wavelength, frequency, period, speed, energy
   d. superposition and phase
   e. intensity and inverse square law
   f. standing waves
2. Wave phenomena such as reflection, refraction, interference, and diffraction.
   a. reflection, refraction, Snell's law, dispersion, total internal reflection
   b. diffraction, interference, superposition, Young's double-slit interference experiment
   c. polarization
   d. scattering, absorption, transmission
   e. resonance and natural frequencies, harmonics
3. Fundamentals of the Doppler effect.
   a. Doppler effect
   b. apparent frequency
   c. moving source
   d. moving observer
   e. redshift, blueshift
4. Characteristics of sound.
   a. compression waves
   b. speed of sound (e.g., sonic boom, sound barrier)
   c. pitch (frequency), loudness (intensity)
   d. beats
   e. air columns (open and closed pipes)
5. Electromagnetic waves and the electromagnetic spectrum.
   a. electromagnetic waves (e.g., electric and magnetic fields, speed of light, energy)
   b. electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays)
6. Geometric optics.
   a. ray tracing
   b. focal point, image distance, image size and magnification, real vs. virtual image, image orientation
   c. lenses (converging, diverging)
   d. mirrors (plane, convex, concave, spherical, parabolic)
   e. lens and mirror equations
   f. simple instruments (e.g., magnifying glass, telescope, microscope)
   g. prisms

Discussion areas: Optics and Waves

- Be able to explain, for example, why the sky appears blue.
- Be able to explain, for example, why colors are observed when sunlight falls on a soap bubble or an oil slick.

- Be able to calculate, for example, the fundamental frequency and harmonics of an organ pipe that is closed at one end.
- Be familiar, for example, with the procedures for ray tracing.
- Be able to locate and describe, for example, the image formed when an object is placed 50 centimeters in front of a thin converging lens of focal length 20 centimeters.

IV. Heat, Energy, and Thermodynamics

1. Temperature, temperature scales, heat, and heat capacity.
   a. temperature (measure of average kinetic energy)
   b. temperature scales
   c. heat and thermal energy
   d. difference between temperature and thermal energy
   e. heat capacity and specific heat
   f. calorimetry
   g. thermal expansion
2. Mechanisms of heat transfer.
   a. conduction
   b. convection
   c. radiation
3. Different forms of energy and transformations between them.
   a. forms of energy (e.g., kinetic, potential, mechanical, electrical, electromagnetic, chemical, nuclear)
   b. energy transformations
4. Energy involved in phase transitions between the various states of matter.
   a. phase transitions
   b. phase diagrams
   c. heating/cooling diagrams
   d. heats of vaporization, fusion, and sublimation
5. Kinetic molecular theory and the ideal gas laws.
   a. kinetic molecular theory (e.g., assumptions of the theory, temperature, pressure, average molecular speeds)
   b. ideal gases and the ideal gas law
6. Laws of thermodynamics.
   a. First law (e.g., internal energy, conservation of energy, work, heat)
   b. Second law (entropy)
   c. Third law (absolute zero)
   d. Zeroth law (thermal equilibrium)
   e. P-V diagrams
   f. thermodynamic processes (e.g., isothermal, adiabatic, reversible/irreversible)
   g. heat engines and efficiency (e.g., ideal vs. actual efficiency, temperature differences)

Discussion areas: Heat, Energy, and Thermodynamics

- Be able to describe, for example, the difference between heat and temperature.
- Be able to determine, for example, the amount of thermal energy needed for a given amount of ice at 0°C to change to a gaseous state at 100°C.
- Be able to explain, for example, why metal feels cooler to the touch than wood at the same temperature.
- Be able to make calculations, for example, involving the ideal gas law.
- Be able to calculate, for example, the work done during the isothermal expansion of an ideal gas.
- Be able to describe, for example, the relationship between internal energy and the first law of thermodynamics.
- Be able to describe, for example, the relationship between entropy and the second law of thermodynamics.
- Be familiar, for example, with the properties of a Carnot engine.

V. Modern Physics, and Atomic and Nuclear Structure

1. Organization, structure and states of matter.
   a. atoms, molecules, ions
   b. solids, liquids, gases, plasmas
   c. chemical/physical properties and changes
2. Nature of atomic and subatomic structure including various models of the atom.
   a. atomic and subatomic structure (e.g., electrons, protons, neutrons, and isotopes)
   b. models of the atom (e.g., Bohr model, quantum model)
   c. experimental basis of models (e.g., Rutherford experiment, Millikan oil-drop experiment, Thomson experiment)

3. Relationship of atomic spectra to electron energy levels.
    a. electron energy transitions in atoms
    b. absorption and emission spectra
4. Characteristics, processes, and effects of radioactivity.
    a. radioactivity and radioactive decay processes
    b. alpha particles, beta particles, and gamma radiation
    c. half-life
    d. radioisotopes
    e. fission and fusion
5. Topics in modern physics.
    a. wave-particle duality
    b. photoelectric effect
    c. special relativity
    d. Heisenberg uncertainty principle
    e. de Broglie's hypothesis
    f. nuclear forces (strong and weak) and binding energy

Discussion areas: Modern Physics, and Atomic and Nuclear Structure

- Be familiar, for example, with the assumptions of the Bohr model of the atom.
- Be familiar, for example, with the Bohr expression for the frequency of the light emitted or absorbed when an electron makes a transition between two energy levels.
- Be able to distinguish, for example, between nuclear fission and nuclear fusion.
- Be able to explain, for example, why energy is released when helium is formed from the fusion of two deuterium nuclei.
- Be able to determine, for example, the amount of radioactive substance left after a specified number of half-lives have elapsed.
- Be able to identify, for example, the daughter nucleus that results from the alpha decay of a uranium-238 nucleus.
- Be able to describe, for example, the relationship between the frequency of light incident on a metal and the energy of the ejected photoelectrons.
- Be able to apply, for example, the Lorentz transformation equations to problems involving time dilation or length contraction.

VI. Scientific Inquiry, Processes, and Social Perspectives

A. History and Nature of Scientific Inquiry

1. Processes involved in scientific inquiry.
    a. identifying problems
    b. forming and testing hypotheses
    c. development of theories, models, and laws
    d. process skills, including observing, comparing, inferring, categorizing, generalizing, and concluding
2. Experimental design.
    a. experimental procedures used to test hypotheses
    b. reproducible procedures
    c. significance of controls
    d. dependent and independent variables
    e. determining what data need to be collected
3. Nature of scientific knowledge.
    a. is subject to change
    b. is consistent with evidence
    c. is based on reproducible evidence
    d. includes unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)
4. How major principles in physics developed historically and the contributions of major historical figures.
    a. how current principles and models developed over time
    b. major developments (e.g., atomic model, Newtonian mechanics, Rutherford experiment)
    c. major historical figures in the development of physics

B. Scientific Procedures and Techniques

1. How to collect, process, analyze, and report data including sources of error.
    a. organization and presentation of data
    b. units of measurement including SI, SI derived, and others (e.g., meter, newton, mile)
    c. unit conversion and dimensional analysis
    d. scientific notation and significant figures
    e. measurement equipment, including applications
    f. basic error analysis, including precision and accuracy
    g. identifying sources of error

h. interpreting and drawing valid conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variables, predictions based on data)

2. Appropriate use of materials, equipment, and technology in the high school physics laboratory and classroom.
   a. appropriate use and storage
   b. appropriate prelab setup and classroom demonstrations
   c. safety procedures and precautions

C. Science, Technology, and Society

1. Impact of physics and technology on society and the environment.
   a. space exploration, communications, etc.
   b. climate change, ozone layer depletion, noise pollution, etc.
   c. production, storage, and disposal issues associated with consumer products
2. Major issues associated with energy use and production.
   a. renewable and nonrenewable energy resources
   b. conservation and recycling
   c. power generation based on various sources, such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power
   d. storage and distribution of renewable energy (e.g., alternative fuels, fuel cells, rechargeable batteries)
3. Applications of physics in daily life.
   a. communications (e.g., wireless devices, fiber optics, satellites)
   b. research tools (e.g., space telescopes, lasers, super colliders)
   c. medicine (e.g., medical imaging, lasers)
   d. transportation (e.g., superconductors, magnetic levitation)
   e. other applications

Discussion areas: Scientific Inquiry, Processes, and Social Perspectives

- Be able to present, for example, a scientific argument with supporting data.
- Be able to explain, for example, the difference between a hypothesis and a theory.
- Be able to determine and control, for example, the parameters of measuring devices.
- Be able to explain, for example, how the concepts of mass and energy are integrated.
- Be familiar, for example, with expressing numbers in scientific notation.
- Be proficient, for example, with the use of significant figures.
- Be able to determine, for example, the number of significant digits from various measurement instruments.
- Be able to develop, for example, mathematical and graphical representations of experimental data.
- Be able to provide, for example, reasons for and against the use of alcohol- or mercury-filled thermometers in a laboratory.
- Be able to identify, for example, the factors that should be taken into account when purchasing radioactive samples.
- Be able to explain, for example, what is meant by the greenhouse effect.
- Be able to identify, for example, the environmental reasons underlying the development of new refrigerants.
- Be able to describe, for example, the procedures to be followed when discarding consumer products.
- Be able to identify, for example, the factors that must be taken into consideration when discarding nuclear waste.
- Be familiar, for example, with the applications of lasers in daily life.

7. Review Smart Tips for Success

Follow test-taking tips developed by experts

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

Should I guess?

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

Can I answer the questions in any order?

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

Are there trick questions on the test?

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

Are there answer patterns on the test?

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

Can I write on the scratch paper I am given?

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

Smart Tips for Taking the Test

1. **Skip the questions you find extremely difficult.** Rather than trying to answer these on your first pass through the test, you may want to leave them blank and mark them so that you can return to them later. Pay attention to the time as you answer the rest of the questions on the test, and try to finish with 10 or 15 minutes remaining so that you can go back over the questions you left blank. Even if you don't know the answer the second time you read the questions, see if you can narrow down the possible answers, and then guess. Your score is based on the number of right answers, so it is to your advantage to answer every question.

2. **Keep track of the time.** The on-screen clock will tell you how much time you have left. You will probably have plenty of time to answer all of the questions, but if you find yourself becoming bogged down, you might decide to move on and come back to any unanswered questions later.

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

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

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

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

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

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

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

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

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

9. Do Your Best on Test Day

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

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

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

On the day of the test, you should:

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

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

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

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

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

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

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

Test centers assume no responsibility for your personal items.

If you have health-related needs requiring you to bring equipment, beverages or snacks into the testing room or to take extra or extended breaks, you need to request accommodations in advance. Procedures for requesting accommodations are described in the Bulletin Supplement for Test Takers with Disabilities or Health-related Needs (PDF).

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

Are You Ready?

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

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

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

10. Understand Your Scores

Understand how tests are scored and how to interpret your test scores

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

What are the score requirements for my state?

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

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

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

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 *Praxis* test or other *Praxis* tests in the last 10 years, your score report also lists the highest score you earned on each test taken.

Content category scores and score interpretation

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

Score scale changes

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

These resources may also help you interpret your scores:

- *Understanding Your Praxis Scores* (PDF), found at www.ets.org/praxis/scores/understand
- *The Praxis Passing Scores* (PDF), found at www.ets.org/praxis/scores/understand
- State requirements, found at www.ets.org/praxis/states

Appendix: Other Questions You May Have

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

What do the *Praxis* tests measure?

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

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

Who takes the tests and why?

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

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

Do all states require these tests?

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

What is licensure/certification?

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

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

Why does my state require the *Praxis* tests?

Your state chose the *Praxis* tests because they assess the breadth and depth of content—called the "domain"—that your state wants its teachers to possess before they begin to teach. The level of content knowledge, reflected in the passing score, is based on recommendations of panels of teachers and teacher educators in

each subject area. The state licensing agency and, in some states, the state legislature ratify the passing scores that have been recommended by panels of teachers.

How were the tests developed?

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

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

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

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

How are the tests updated to ensure the content remains current?

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

How long will it take to receive my scores?

Scores for tests that do not include constructed-response questions are available on screen immediately after the test. Scores for tests that contain constructed-response questions or essays aren't available immediately after the test because of the scoring process involved. Official score reports are available to you and your designated score recipients approximately two to three weeks after the test date for tests delivered continuously, or two to three weeks after the testing window closes for other tests. See the test dates and deadlines calendar at www.ets.org/praxis/register/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* (2014, Princeton, N.J.) 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 (2014, Washington, D.C.).

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

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

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

www.ets.org/praxis/testprep

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

www.ets.org/praxis/store

www.ets.org