Florida Teacher Certification Examinations

Test Information Guide

for

Physics 6–12

FLORIDA DEPARTMENT OF EDUCATION
www.fldoe.org

Third Edition

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Florida Department of Education

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Contents

1 Test and Test Information Guide Development

Teacher Certification Testing

Since 1980, Florida teacher certification candidates have been required to pass the Florida Teacher Certification Examinations (FTCE), which has consisted of tests in reading, writing, mathematics, and professional knowledge. The 1986 Florida Legislature modified the testing program by also requiring teacher candidates to pass a test in the subject area in which they wish to be certified. In addition, the Legislature substituted the Florida College-Level Academic Skills Test (CLAST) for the reading, writing, and mathematics portions of the FTCE. The 2000 Florida Legislature replaced the CLAST with the General Knowledge Test, effective July 1, 2002.

The subject area knowledge tested on the Physics 6–12 examination was identified and validated by committees of content specialists from within the state of Florida. Committee members included public school teachers, district supervisors, and college faculty with expertise in this field. Committee members were selected on the basis of recommendations by district superintendents, public school principals, deans of education, experts in the field, and other organizations. In developing the test, the committees used an extensive literature review, interviews with selected public school teachers, a large-scale survey of teachers, pilot tests, and their own professional judgment.

Role of the Test Information Guide

The purpose of this test information guide is to help candidates taking the subject area test in Physics 6–12 prepare effectively for the examination. The guide was designed to familiarize prospective test takers with various aspects of the examination, including the content that is covered and the way it is represented. The guide should enable candidates to direct their study and to focus on relevant material for review.

This test information guide is intended primarily for use by certification candidates, who may be students in a college or university teacher-preparation program, teachers with provisional certification, teachers seeking certification in an additional subject area, or persons making a career change to public school teaching. Candidates may have studied and worked in Florida or may be from out of state.

College or university faculty may also use the guide to prepare students for certification, and inservice trainers may find the guide useful for helping previously certified teachers prepare for recertification or multiple certification.

This test information guide is not intended as an all-inclusive source of subject area knowledge, nor is it a substitute for college course work in the subject area. The sample questions are representative of the content of the actual test; however, they are not actual test questions from an actual test form. Instead, the guide is intended to help candidates prepare for the subject area test by presenting an overview of the content and format of the examination.

2 Preparation for the Test

The following outline may help you to prepare for the examination. Adapt these suggestions to suit your own study habits and the time you have available for review.

Overview

- **Look over the organization of the test information guide.**

  Section 1 discusses the development of the test and test information guide.
  Section 2 (this section) outlines test preparation steps.
  Section 3 offers strategies for taking the test.
  Section 4 presents information about the content and structure of the test.
  Section 5 lists question formats and includes sample test questions.
  Section 6 provides an annotated bibliography of general references you may find useful in your review.
  Section 7 identifies a source of further information.

Self-Assessment

- **Decide which content areas you should review.**

  Section 4 includes the competencies and skills used to develop this subject area test and the approximate proportion of test questions from each competency area.

Review

- **Study according to your needs.**

  Review all of the competencies and concentrate on areas with which you are least familiar.

Practice

- **Acquaint yourself with the format of the examination.**

  Section 5 describes types of questions you may find on the examination.

- **Answer sample test questions.**

  Section 5 gives you an opportunity to test yourself with sample test questions and provides an answer key and information regarding the competency to which each question is linked.

Final preparation

- **Review test-taking advice.**

  Section 3 includes suggestions for improving your performance on the examination.

- **Refer to field-specific references.**

  Section 6 includes an annotated bibliography listing general references keyed to the competencies and skills used to develop this subject area test.

3 Test-Taking Advice

- Go into the examination prepared, alert, and well rested.
- Complete your travel arrangements prior to the examination date. Plan to arrive early so that you can locate the parking facilities and examination room without rushing.
- Dress comfortably and bring a sweater or jacket in case the room is too cool.
- Take the following with you to the test site:
  - — Admission ticket
  - — Proper identification as described in "Identification Policy"
- There are many strategies for taking a test and different techniques for dealing with different types of questions. Nevertheless, you may find the following general suggestions useful.
  - — Read each question and all the response options carefully before selecting your answer. Pay attention to all of the details.
  - — Go through the entire test once and answer all the questions you are reasonably certain about. Then go back and tackle the questions that require more thought.
  - — When you are not certain of the right answer, eliminate as many options as you can and choose the response that seems best. It is to your advantage to answer all the questions on the test, even if you are uncertain about some of your choices.
  - — After completing the examination, go back and check every question. Verify that you have answered all of the questions and that your responses are correctly entered.

4 Competencies and Skills and Test Blueprint

The table on the following pages lists the competencies and skills used as the basis for the Physics 6–12 examination. These competencies and skills represent the knowledge that teams of teachers, subject area specialists, and district-level educators have determined to be important for beginning teachers. This table could serve as a checklist for assessing your familiarity with each of the areas covered by the test. The competencies and skills should help you organize your review. The test blueprint indicates the approximate percentage of test questions that will cover the specific competency on the exam.

Competencies are broad areas of content knowledge.

Skills identify specific behaviors that demonstrate the competencies.

Percentages indicate the approximate proportion of test questions that represent the competencies on the test.

The following excerpt illustrates the components of the table.

Competency

Approximate percentage of total test questions (test blueprint)

Competency/Skill		Approx. %
1	**Knowledge of the nature of scientific investigation and instruction in physics**	**7%**
1	Identify the characteristics and processes of scientific inquiry.	
2	Identify potentially hazardous situations in a physics laboratory and classroom, methods of prevention, and corrective actions.	
3	Select the appropriate laboratory equipment for specific scientific investigations.	
4	Relate the historical development of the major concepts, models, and investigations in physics to current knowledge (e.g., force and motion, conservation principles, fields, quantum theory).	
5	Distinguish between scientific theories and laws in terms of their specific roles and functions.	
6	Identify elements of guided inquiry (e.g., engaging through questioning, eliciting prior knowledge, engaging in thoughtful discussion, engaging in exploration, fostering data-based argumentation, providing for application) in the physics classroom and laboratory.	
7	Identify the areas of teacher liability and responsibility in science-related activities, including accommodations for diverse student populations	

Skills (1-7)

Table of Competencies, Skills, and Approximate Percentages of Questions

Competency/Skill			Approx. %
1	**Knowledge of the nature of scientific investigation and instruction in physics**		**7%**
	1	Identify the characteristics and processes of scientific inquiry.	
	2	Identify potentially hazardous situations in a physics laboratory and classroom, methods of prevention, and corrective actions.	
	3	Select the appropriate laboratory equipment for specific scientific investigations.	
	4	Relate the historical development of the major concepts, models, and investigations in physics to current knowledge (e.g., force and motion, conservation principles, fields, quantum theory).	
	5	Distinguish between scientific theories and laws in terms of their specific roles and functions.	
	6	Identify elements of guided inquiry (e.g., engaging through questioning, eliciting prior knowledge, engaging in thoughtful discussion, engaging in exploration, fostering data-based argumentation, providing for application) in the physics classroom and laboratory.	
	7	Identify the areas of teacher liability and responsibility in science-related activities, including accommodations for diverse student populations.	
2	**Knowledge of the mathematics of physics**		**8%**
	1	Determine the validity of a formula based on dimensional analysis.	
	2	Combine vectors using graphic and trigonometric methods.	
	3	Determine the dot product and cross product of two vectors.	
	4	Convert between units of a given quantity (e.g., length, area, volume, mass, time, temperature).	
	5	Identify prefixes in the metric system and standard units of measure (e.g., newtons, meters, kilowatt-hours, teslas, electron volts, calories, horsepower).	
	6	Estimate the order of magnitude of a physical quantity.	
	7	Interpret the slope of a graph or area under the curve in relation to physical concepts.	
	8	Apply the concepts of accuracy, precision, uncertainty, and significant figures to measurements and calculations.	

Competency/Skill		Approx. %
3	**Knowledge of thermodynamics**	**10%**
1	Relate changes in length, area, or volume of a system to changes in temperature.	
2	Distinguish between the three methods of heat transfer (i.e., conduction, convection, radiation).	
3	Determine the amount of heat transferred by conduction or radiation.	
4	Interpret segments of graphs of temperature versus heat added or removed (e.g., latent heats, specific heats).	
5	Analyze pressure, volume, and temperature relationships using the ideal gas law.	
6	Apply the first law of thermodynamics (i.e., energy conservation) to physical systems.	
7	Calculate work done by or on a gas from pressure versus volume diagrams.	
8	Interpret pressure versus volume diagrams (e.g., identify isobaric, isothermal, and adiabatic processes).	
9	Determine the specific heat, latent heat, or temperatures of a substance, given appropriate calorimetric data.	
10	Apply the second law of thermodynamics (i.e., entropy increase) to physical processes.	
11	Relate temperature or pressure to kinetic molecular theory.	
4	**Knowledge of mechanics**	**27%**
1	Analyze the motion of an object moving in one dimension, given a graph (e.g., displacement versus time, velocity versus time, acceleration versus time).	
2	Determine distance traveled, displacement, speed, velocity, acceleration, or time of travel for objects moving in one dimension.	
3	Determine distance traveled, displacement, speed, velocity, acceleration, or time of travel for objects moving in two dimensions (e.g., projectile motion).	
4	Apply Newton's laws of motion to problems involving linear motion of a body.	
5	Apply Newton's laws of motion to problems involving circular motion of a body.	
6	Identify action-reaction pairs of forces between two bodies.	

Competency/Skill		**Approx. %**
7	Apply conservation of momentum to problems in one or two dimensions.	
8	Analyze problems using the impulse-momentum theorem.	
9	Analyze problems using Newton's universal law of gravitation (e.g., orbital motion).	
10	Analyze problems involving static or kinetic frictional forces.	
11	Apply conservation of mechanical energy.	
12	Use Newton's second law to analyze problems involving two connected masses (e.g., Atwood machine, Atwood machine on inclined plane, blocks, massless pulley).	
13	Analyze problems involving torque (e.g., equilibrium, rotational dynamics).	
14	Apply conservation of angular momentum and conservation of energy to problems involving rotational motion.	
15	Analyze problems involving work done on mechanical systems (e.g., power, work-energy theorem).	
16	Analyze problems involving the relationships between depth, density of fluid, and pressure.	
17	Analyze problems involving the buoyant force on a submerged or floating object (i.e., Archimedes' principle).	
18	Analyze problems involving moving fluids (e.g., mass conservation, Bernoulli's principle).	
19	Analyze problems involving center of mass.	
20	Use free-body diagrams to analyze static or dynamic problems in two or three dimensions.	
21	Analyze characteristics and examples of simple harmonic motion (e.g., oscillating springs, vibrating strings, pendula).	
5	**Knowledge of waves and optics**	**18%**
1	Identify characteristics of waves (e.g., velocity, frequency, amplitude, wavelength, period, pitch, intensity, phase, nodes, antinodes, transverse waveforms, longitudinal waveforms).	
2	Analyze the motion of particles in a medium in the presence of transverse and longitudinal waves.	
3	Identify factors that affect wave propagation and wave speed.	
4	Analyze problems involving the superposition, or interference, of waves (e.g., beats, standing waves, interference patterns).	

Competency/Skill	**Approx. %**
5 Analyze problems involving standing waves (e.g., open or closed tube, vibrating string).	
6 Analyze the Doppler effect due to the motion of a source or receiver.	
7 Analyze waves, using either graphical or mathematical representations.	
8 Analyze reflection and refraction problems using the law of reflection and Snell's law.	
9 Interpret the relationships between wavelength, frequency, and speed of light.	
10 Analyze the effects of linear polarizing filters on the polarization and intensity of light.	
11 Analyze the geometric optics of thin lenses and mirrors.	
12 Analyze patterns produced by diffraction and interference of light (e.g., single-slit, double-slit, diffraction gratings).	
13 Identify the use and characteristics of various optical instruments (e.g., eye, spectroscope, camera, telescope, microscope, corrective lenses).	
14 Apply the relationship between intensity and distance from a point source (i.e., inverse-square law).	
15 Compare qualitative features of the ranges of the electromagnetic spectrum.	
6 Knowledge of electricity and magnetism	**20%**
1 Determine the electric force on a point charge due to one or more other charges.	
2 Determine the electric potential difference between two points in an electric field.	
3 Analyze problems involving capacitance, with or without dielectrics.	
4 Analyze the electric field due to a charge distribution.	
5 Apply Gauss's law to determine or characterize an electric field.	
6 Analyze charge distributions in conductors and nonconductors.	
7 Simplify series and parallel combinations of resistors or capacitors.	
8 Solve problems using Ohm's law.	
9 Apply Kirchhoff's laws to analyze DC circuits.	
10 Determine the power dissipated through one or more elements of a DC circuit.	

Competency/Skill		Approx. %
11	Relate the resistance of a conductor to its geometry and resistivity.	
12	Analyze problems involving the direction and magnitude of the magnetic force acting on moving charges (e.g., mass spectrometer).	
13	Apply the laws of electromagnetic induction (i.e., Faraday's law, Lenz's law).	
14	Analyze problems involving AC circuits (e.g., transformers, peak current, root-mean-square voltage, frequency, reactance, resonant frequency, impedance).	
15	Identify principles and components involved in the operation of motors and generators.	
16	Predict the magnetic fields associated with current-carrying conductors (e.g., long straight wires, loops, solenoids).	
7	**Knowledge of modern physics**	**10%**
1	Analyze problems based on the energy of a photon (e.g., photoelectric effect, $E = hf$).	
2	Apply Einstein's theory of special relativity (e.g., light postulate, length contraction, time dilation).	
3	Apply Einstein's mass-energy equivalence ($E = mc^2$).	
4	Determine the allowed energies of quantum atomic states or of transitions between such states.	
5	Compare the characteristics of alpha, beta, and gamma radiation.	
6	Predict outcomes of radioactive decay processes (e.g., balancing a nuclear equation).	
7	Calculate the age of a radioactive source, given data (e.g., half-life, activity, remaining mass, decayed fraction).	
8	Differentiate between fission and fusion processes and their applications.	
9	Analyze problems involving Heisenberg's uncertainty principle (e.g., momentum versus position, energy versus time).	
10	Differentiate between historical models of the atom (e.g., Thomson's plum pudding, Rutherford, Bohr, electron cloud).	
11	Identify characteristics of subatomic and elementary particles (e.g., protons, neutrons, electrons, photons, neutrinos, quarks, antiparticles).	
12	Distinguish between the four fundamental forces of nature in terms of the particles they act upon, the relative distances over which they act, and their relative strengths.	
13	Identify characteristics of the dual (i.e., wave and particle) nature of light and matter.	

5 Test Format and Sample Questions

The Physics 6–12 subject area test consists of approximately 90 multiple-choice questions. You will have two and one-half hours to complete the test.

Each question will contain four response options, and you will indicate your answer by selecting **A**, **B**, **C**, or **D**.

Calculators are permitted for the Physics 6–12 test. The test center will provide scientific calculators. Candidates may not bring a calculator.

The table below presents types of questions on the examination and refers you to a sample question of each type.

Type of Question	Sample
Scenario Examine a situation, problem, or case study. Then answer a question, make a diagnosis, or recommend a course of action by selecting the best response option.	Question 2, page 17
Command Select the best response option.	Question 3, page 17
Graphics Examine a question involving a number line, a geometric figure, graphs of lines or curves, a table, or a chart, and select the best response option.	Question 8, page 19
Direct question Choose the response option that best answers the question.	Question 12, page 21
Sentence completion Select the response option that best completes the sentence.	Question 20, page 23

Sample Questions

The following questions represent both the form and content of questions on the examination. These questions will acquaint you with the general format of the examination; however, these sample questions do not cover all of the competencies and skills that are tested and will only approximate the degree of examination difficulty.

An answer key follows at the end of the sample questions. The answer key includes information regarding the competency to which each question is linked.

CONSTANTS, DATA, AND CONVERSIONS FOR PHYSICS EXAM

Acceleration due to gravity near Earth's surface $(g) = 9.80\ \text{m/s}^2 = 9.80\ \text{N/kg}$

Atomic mass unit $(\text{amu}) = 1.66 \times 10^{-27}\text{kg} = 931.5\ \text{MeV/c}^2$

Avogadro's constant $(N_\text{A}) = 6.02 \times 10^{23}/\text{mol}$

Boltzmann constant $(k_\text{B}) = 1.38 \times 10^{-23}\ \text{J/K}$

calorie $= 4.18\ \text{J}$

Coulomb constant $(k) = 1/(4\pi\varepsilon_0) = 8.99 \times 10^9\ \text{N}\bullet\text{m}^2/\text{C}^2$

Density of air at STP $= 1.29\ \text{kg/m}^3$

Density of water at 20°C and 1 atm $= 1.00 \times 10^3\ \text{kg/m}^3$

Electron charge $(e^-) = 1.60 \times 10^{-19}\text{C}$

Electron mass $(m_\text{e}) = 9.11 \times 10^{-31}\ \text{kg} = 5.49 \times 10^{-4}\ \text{amu} = 0.511\ \text{MeV/c}^2$

Electron volt (eV) $= 1.60 \times 10^{-19}\ \text{J}$

Gas constant $(R) = 8.31\ \text{J/mol}\bullet\text{K} = 0.0821\ \text{atm}\bullet\text{L/mol}\bullet\text{K}$

Gravitational constant $(G) = 6.67 \times 10^{-11}\ \text{N}\bullet\text{m}^2/\text{kg}^2$

Heat of fusion of ice at STP $= 80.0\ \text{cal/g} = 3.33 \times 10^5\ \text{J/kg}$

Heat of vaporization of water at 100°C and 1 atm $= 540\ \text{cal/g} = 2.26 \times 10^6\ \text{J/kg}$

Moment of inertia of solid object about axis through the center of mass:

- Solid sphere, $\frac{2}{5}MR^2$
- Solid cylinder, $\frac{1}{2}MR^2$ (axis of rotation along the axis of cylinder)
- Long thin rod, $\frac{1}{12}ML^2$ (axis perpendicular to rod through the center)
- Ring, MR^2

Permeability of free space $(\mu_0) = 4\pi \times 10^{-7}\ \text{H/m or N/A}^2$

Permittivity of free space = $(\varepsilon_0) = 1/(4\pi k) = 8.85 \times 10^{-12}\ \text{C}^2/\text{N} \bullet \text{m}^2$

Planck's constant $(h) = 6.626 \times 10^{-34}\ \text{J} \bullet \text{s} = 4.136 \times 10^{-15}\ \text{eV} \bullet \text{s}$

Specific heat of water $= 1.00\ \text{cal/g} \bullet {}^\circ\text{C} = 4186\ \text{J/kg} \bullet {}^\circ\text{C}$

Speed of light $(c) = 3.00 \times 10^{8}\ \text{m/s}$

Speed of sound in air at 20°C and 1 atm $= 343\ \text{m/s}$

Standard atmosphere pressure $= 1\ \text{atm} = 1.01\ \text{bar} = 1.01 \times 10^{5}\ \text{Pa}$

$= 1.01 \times 10^{5}\ \text{N/m}^2 = 760\ \text{mm Hg}$

Stefan-Boltzmann constant $= 5.67 \times 10^{-8}\ \text{W/m}^2 \bullet \text{K}^4$

DIRECTIONS: Read each question and select the best response.

1. The work of which of the following scientists introduced the impossibility of simultaneously specifying the exact position of a particle and its momentum?
   A. George Paget Thomson
   B. Ernest Rutherford
   C. Werner Heisenberg
   D. Louis de Broglie

2. A class is learning about pendula. The teacher asks the class for a list of factors they believe will affect the period of a pendulum. After writing the factors on the board, which of the following would be the most appropriate next step for the teacher to take?
   A. giving students a pretest on the motion of a pendulum
   B. calculating for the class the momentum of a pendulum
   C. giving students appropriate materials to make a pendulum
   D. calculating for the class the tension in the string of a pendulum

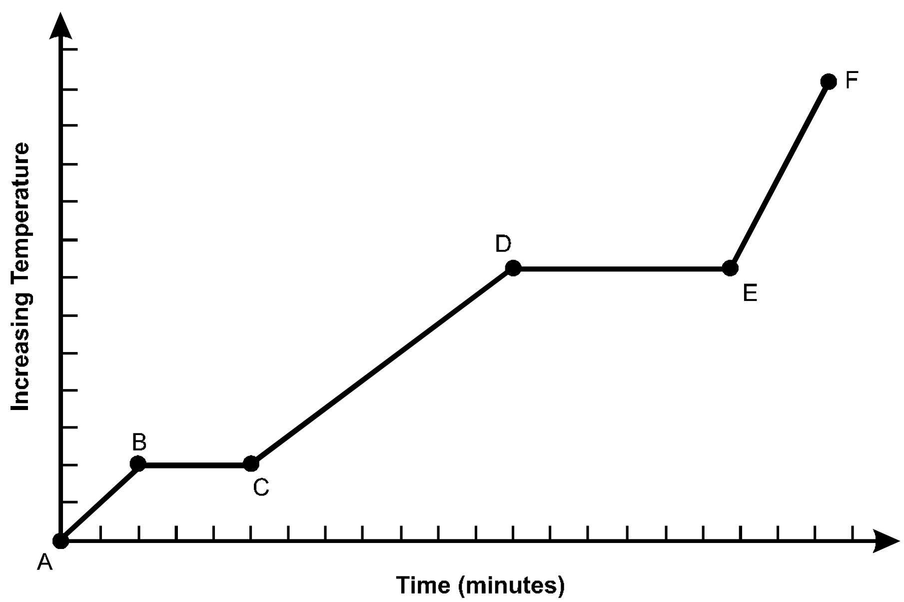
3. The equation for electric resistance in terms of the resistivity, ρ, of a material is $R = \rho \frac{\ell}{A}$. If ℓ is length, A is area, and R is resistance, determine the units of ρ for the equation to be valid.
   A. $\frac{\Omega}{\text{m}}$
   B. $\Omega \bullet \text{m}$
   C. $\frac{\Omega}{\text{m}^3}$
   D. $\Omega \bullet \text{m}^3$

4. The temperature at which copper melts is 1.00×10^3 K. What is this temperature as expressed on the Fahrenheit scale ($T_c = T - 273.15$, $T_f = \frac{9}{5}T_c + 32$)?
   A. 1.28×10^3°F
   B. 1.34×10^3°F
   C. 2.26×10^3°F
   D. 2.32×10^3°F

5. How many farads are in 152 picofarads?
   A. 1.52×10^{10}
   B. 1.52×10^{5}
   C. 1.52×10^{-5}
   D. 1.52×10^{-10}

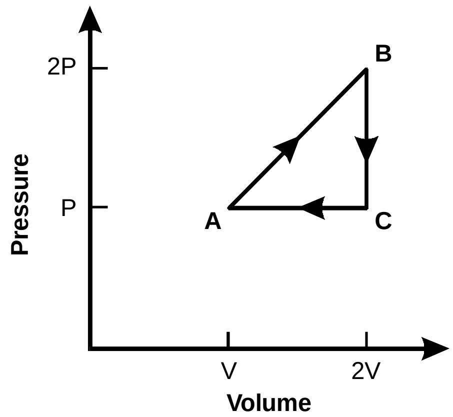
6. A force of 3.2 N is applied to an object that has a mass of 0.024 kg. According to the rule of significant figures, what is the acceleration of the object?
   A. 1.3×10^{2} m/s^2
   B. 1.33×10^{2} m/s^2
   C. 1.333×10^{2} m/s^2
   D. 1.3333×10^{2} m/s^2

7. This graph shows the change in a material's temperature as heat is added at a constant rate. In which of the following segments of the graph is the material in both solid and liquid states?



   A. segment AB
   B. segment BC
   C. segment CD
   D. segment DE

8. An ideal gas initially at pressure *P* and volume *V* goes through the cycle shown in the P-V diagram. In terms of *P* and *V*, what is the net work done by the gas per cycle?

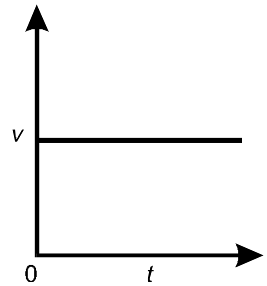


A. $\frac{1}{2}PV$
B. $\frac{2}{3}PV$
C. $2PV$
D. $4PV$

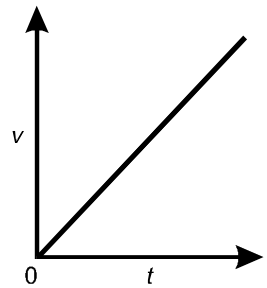
9. If 55.0 g of water at 80.0°C is mixed in a thermally isolated container with 45.0 g of water at 30.0°C, the final temperature of the mixture is
A. 47.0°C.
B. 50.0°C.
C. 57.5°C.
D. 62.5°C.

10. Which of the following velocity versus time graphs best represents uniform non-zero acceleration?

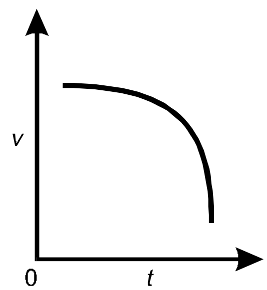
A.



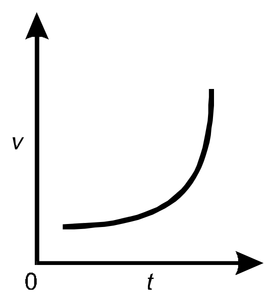
B.



C.



D.



11. A ball rolling at a velocity of 8.0 m/s across a frictionless table with a height of 2.5 m falls from the edge of the table. Choose the closest approximation of time of flight in seconds.
    A. 0.25
    B. 0.50
    C. 0.71
    D. 1.0

12. A force of 50 N is applied to a 10 kg box. What is the acceleration of the box?
    A. 0.2 m/s^2
    B. 0.5 m/s^2
    C. 5 m/s^2
    D. 10 m/s^2

13. The mass of Mars is about $\frac{1}{10}$ the mass of Earth, and the diameter of Mars is about half that of Earth. Based on this information, what is the acceleration of a freely falling body on Mars?
    A. 3.9 m/s^2
    B. 4.9 m/s^2
    C. 9.8 m/s^2
    D. 14.7 m/s^2

14. A 0.350 m wrench creates a net torque of magnitude 50.0 N·m on the nut of a tire bolt. If the length of the wrench is doubled, what applied force will produce the same net torque?
    A. 49.3 N
    B. 50.7 N
    C. 71.4 N
    D. 143 N

15. Two disks with moments of inertia I_1 and I_2, respectively, are rotating on a common frictionless axis with constant angular velocities ω_1 and ω_2. The disks are then pushed together and rigidly connected and continue to rotate. What is the final angular velocity of the disks?

A. $\dfrac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

B. $\dfrac{I_1\omega_1 - I_2\omega_2}{I_1 - I_2}$

C. $\dfrac{I_1\omega_1 - I_2\omega_2}{I_1 + I_2}$

D. $\dfrac{I_1\omega_1 + I_2\omega_2}{I_1 - I_2}$

16. A wave propagates through a medium. If the individual particles of the medium move only parallel to the direction of the propagation of the wave, the wave is

A. longitudinal.
B. standing.
C. traveling.
D. transverse.

17. A person notices crests of waves passing the bow of an anchored boat every 4.0 seconds. The person measures the distance between two successive crests to be 2.0 m. How fast are the waves traveling?

A. 0.5 m/s
B. 2.0 m/s
C. 4.0 m/s
D. 8.0 m/s

18. Which of the following phenomena best explains the ability of fiber-optic cables to carry signals?
    A. diffraction of light
    B. polarization of light
    C. optical dispersion
    D. total internal reflection

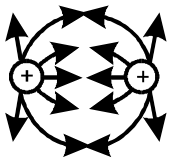
19. Two polarizing filters are held together. The maximum intensity of light passing through the two filters will occur when the transmission axes are aligned
    A. parallel to each other.
    B. perpendicular to each other.
    C. at 45° to each other.
    D. at 30° and 60° to each other.

20. In a vacuum, red light has a longer wavelength than blue light. This means that in a vacuum, red light
    A. moves faster than blue light.
    B. moves slower than blue light.
    C. has a higher frequency than blue light.
    D. has a lower frequency than blue light.

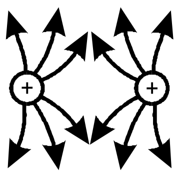
21. An electron and a proton are 2.0 nm apart. What is the magnitude of the electrostatic force of attraction between the particles?
    A. 2.3×10^{-29} N
    B. 3.6×10^{-20} N
    C. 6.3×10^{-15} N
    D. 5.8×10^{-11} N

22. Which of the following diagrams best represents the electric field surrounding two positively charged spheres?

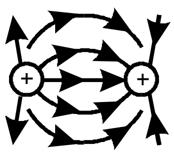
A.



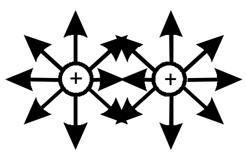
B.



C.

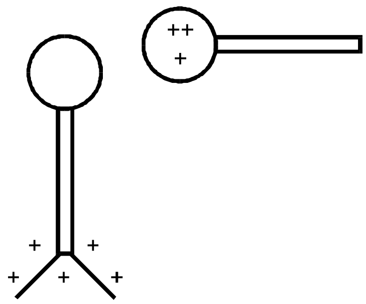


D.

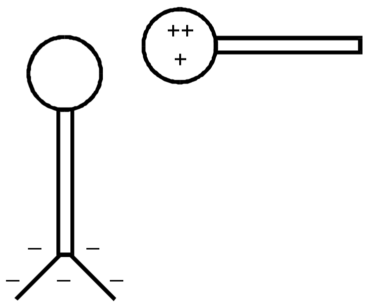


23. Which of the following diagrams best illustrates an electroscope when a positively charged sphere comes close to the knob?

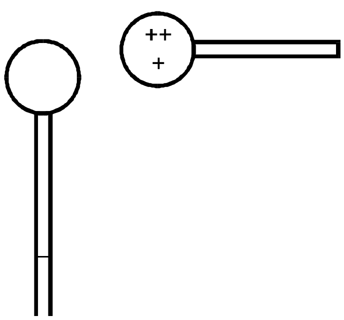
A.



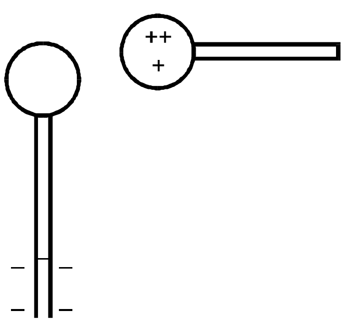
B.



C.



D.



24. How many turns on a coil are required to produce an induced emf of 0.5 volts? (The coil experiences a change in flux linkage at the rate of 0.005 webers per second.)
    A. 10 turns
    B. 100 turns
    C. 500 turns
    D. 1000 turns

25. Light of wavelength 465 nm produces photoelectrons of 1.50 eV kinetic energy when the light illuminates a metal surface. What is the work function of the metal?
    A. 0.17 eV
    B. 0.84 eV
    C. 1.17 eV
    D. 1.34 eV

26. If a meson has a rest energy of 130 MeV, approximately how many times greater is the mass of the meson compared with the mass of an electron?
    A. 150
    B. 250
    C. 350
    D. 450

27. Which of the following radioactive decay processes changes neither the atomic number Z nor the mass number A of a nucleus?
    A. α
    B. β^+
    C. β^-
    D. γ

28. Thermonuclear fusion is the source of energy in
    A. stars.
    B. planets.
    C. rocket engines.
    D. nuclear power plants.

29. What are the two basic interactions that act over a short range of distances?
    A. electromagnetic and gravitational
    B. electromagnetic and strong nuclear
    C. gravitational and weak nuclear
    D. weak nuclear and strong nuclear

30. Which of the following observable phenomena best shows that particles can behave as waves?
    A. AC current
    B. photoelectric effect
    C. diffraction of electrons
    D. annihilation

Answer Key

Question Number	Correct Response	Competency
1.	C	1
2.	C	1
3.	B	2
4.	B	2
5.	D	2
6.	A	2
7.	B	3
8.	A	3
9.	C	3
10.	B	4
11.	C	4
12.	C	4
13.	A	4
14.	C	4
15.	A	4
16.	A	5
17.	A	5
18.	D	5
19.	A	5
20.	D	5
21.	D	6
22.	B	6
23.	A	6
24.	B	6
25.	C	7
26.	B	7
27.	D	7
28.	A	7
29.	D	7
30.	C	7

6 Annotated Bibliography

The annotated bibliography that follows includes basic references that you may find useful in preparing for the exam. Each resource is keyed to the competencies and skills found in Section 4 of this guide.

This bibliography is representative of the most important and most comprehensive texts as reflected in the competencies and skills. The Florida Department of Education does not endorse these references as the only appropriate sources for review; many comparable texts currently used in teacher preparation programs also cover the competencies and skills that are tested on the exam.

1. Arons, A. B. (1997). *Teaching introductory physics*. New York: Wiley.

Presents observations from throughout the physics teaching community that have a direct bearing on classroom practice. Divided into three parts: basic teaching techniques, developing homework and tests, and introduction to classical conservation laws. Serves as a guide to teaching students of all levels using a systematic approach. Useful for review of competency 1.

2. Cutnell, J. D., & Johnson, K. W. (2008). *Physics* (8th ed). Hoboken, NJ: Wiley.

Covers basic concepts of general physics, including modern physics. Includes diverse conceptual and computational questions and problems. Useful for review of competencies 1–7.

3. Giancoli, D. C. (2005). *Physics: Principles with applications* (6th ed.). Upper Saddle River, NJ: Pearson Education.

Combines conceptual understanding with an algebra-based approach. Contains a large number of practice problems. Addresses introductory and intermediate physics concepts. Useful for review of competencies 1–7.

4. Halliday, D., Resnick, R., & Walker, J. (2008). *Fundamentals of physics* (8th ed.). New York: Wiley.

Calculus-based text introduces physics at the college level. Provides a foundational understanding of fundamental physics concepts, and helps readers apply this conceptual understanding to quantitative problem solving. Combines authoritative content and stimulating applications. Useful for review of competencies 1–7.

5. Hewitt, P. G. (2008). *Conceptual physics fundamentals*. San Francisco: Pearson Addison-Wesley.

Develops a solid conceptual understanding of basic physics while introducing necessary problem solving skills. Author's presentation of concepts available on supplemental video. Useful for review of competencies 1–7.

6. Knight, R. D. (2008). *Physics for scientists and engineers: A strategic approach with modern physics* (2nd ed.). San Francisco: Pearson Addison-Wesley.

Introductory, calculus-based college-level text. Addresses common misconceptions and preconceptions. Combines quantitative coverage with an inductive approach to core concepts. Useful for review of competencies 1–7.

7. Knight, R. D., Jones, B., & Field, S. (2007). *College physics: A strategic approach with MasteringPhysics™ .* San Francisco: Pearson Addison-Wesley.

Introductory college-level text. Uses real-life examples to build problem-solving abilities. Explicitly addresses common misconceptions and preconceptions. Useful for review of competencies 1–7.

8. McDermott, L. C. (1996). *Physics by inquiry.* New York: Wiley.

Offers a step-by-step introduction to physics and physical sciences through laboratory-based modules. Presents fundamental topics to help students develop critical scientific reasoning skills. Provides practice in relating scientific concepts, representations, and models to existing phenomena. Useful for review of competency 1.

9. National Science Teachers Association (2007). *NSTA position statement: Liability of science educators for laboratory safety.* [Online].

Identifies the responsibilities of science teachers, school administrators, district personnel, and school board members for ensuring safety in school science laboratories. Useful for review of competency 1.

10. Serway, R. A., & Faughn, J. S. (2006). *College physics* (7th ed.). Belmont, CA: Thomson Brooks/Cole.

Covers standard topics in classical and modern physics. Includes a discussion of Newtonian mechanics and the physics of fluids; heat and thermodynamics; wave motion and sound; electricity and magnetism; properties of light and the field of geometric and wave optics; and an introduction to special relativity, quantum physics, and atomic and nuclear physics. Useful for review of competencies 1–7.

11. Serway, R. A., & Faughn, J. S. (2006). *Holt physics*. Orlando, FL: Holt, Rinehart & Winston.

Introduces physics concepts such as basic collisions, fluids, rotational motion, relativity, and quantum mechanics. Covers mechanics in both one and two dimensions. Useful for review of competencies 1–7.

12. Serway, R. A., & Jewett, J. W. (2007). *Physics for scientists and engineers with modern physics* (7th ed.). Boston: Cengage Learning.

Calculus-based resource with numerous online tutorials. Contains many examples, conceptual questions, and problems. Useful for review of competencies 1–7.

13. TERC (2006). *Physics that works*. Dubuque, IA: Kendall/Hunt.

Uses design projects to help students develop physics understanding. Promotes learning and understanding through five extended design, engineering, and technology challenges. Useful for review of competencies 1–6.

14. Texley, J., Terry, K., & Summers, J. (2004). *Investigating safely: A guide for high school teachers.* Arlington, VA: NSTA Press.

Examines the special safety requirements of specific disciplines such as physics, chemistry, Earth/space science, and biology. Topics include equipping labs, storing and disposing of chemicals and other hazardous materials, maintaining documentation, and organizing field trips. Discusses how to accommodate students with special needs as well as how to help students share responsibility for safety in science classes. Useful for review of competency 1.

15. Walker, J. S. (2007). *Physics with MasteringPhysics*™ (3rd ed.). San Francisco: Pearson Addison-Wesley.

Integrates conceptual understanding with quantitative problem solving. Useful for review of competencies 1–7.

16. Wilson, J. D., & Buffa, A. J. (2007). *College physics* (6th ed.). San Francisco: Pearson Addison-Wesley.

Presents fundamental physics concepts with an emphasis on biomedical applications. Useful for review of competencies 1–7.

17. Wolfson, R. (2006). *Essential university physics*. San Francisco: Pearson Addison-Wesley.

Calculus-based text introduces fundamentals of physics. Emphasizes conceptual understanding and makes connections to the real world. Includes annotated figures and step-by-step problem-solving strategies. Useful for review of competencies 1–7.

18. Young, H. D., Freedman, R. A., Ford, A. L., & Sears, F. W. (2007). *Sears and Zemansky's university physics: With modern physics* (12th ed.). San Francisco: Pearson Addison-Wesley.

Provides a calculus-based, college-level introduction to mechanics, waves and acoustics, thermodynamics, electromagnetism, optics, and modern physics. Useful for review of competencies 1–7.

7 Additional Information

Please visit the following Web site to review FTCE registration details and to find additional FTCE information, including test locations and passing scores.

www.fldoe.org/accountability/assessments/postsecondary-assessment/ftce/