

Illinois Certification Testing System

STUDY GUIDE

Science: Physics (116)



Illinois State Board of Education

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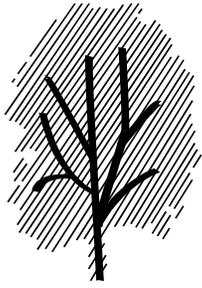
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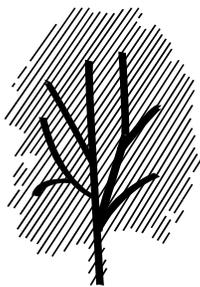
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General Information About the Illinois Certification Testing System

The first section of the study guide is available in a separate PDF file. Click the link below to view or print this section.

[General Information About the Illinois Certification Testing System](#)



Field-Specific Information

- **Test Subareas and Objectives**
- **Practice Test Questions**
- **Explanation of the Test Score Report**

INTRODUCTION

The content tests are designed to assess a candidate's knowledge of content in the specific teaching, school service personnel, or administrative field in which certification is sought. The tests are based on current and relevant expectations for teacher preparation students and for teachers in Illinois as defined by the Illinois Content Area Standards for Educators. This study guide is designed to focus your preparation by helping you become familiar with the format and content to be covered on the tests.

This section includes a list of the test subareas and objectives, practice test questions for the field covered by this study guide, an answer key, and an explanation of the test score report.

TEST SUBAREAS AND OBJECTIVES

The content covered by the test is organized into subareas. You will find a list of subareas at the beginning of the list of test objectives. Within each subarea, the content is further defined by a set of objectives. Each objective comprises two major parts:

1. the *objective statement*, which broadly defines the knowledge and skills that an entry-level educator needs to know; and
2. the *descriptive statements*, which describe in greater detail the types of knowledge and skills covered by the test objective.

The test objectives are broad, conceptual, and meaningful statements, written in language that reflects the skills, knowledge, and understanding that an entry-level teacher needs in order to teach effectively in an Illinois classroom. A test consists of test questions that measure an examinee's mastery of these test objectives.

Below is an example of a test objective statement and its accompanying descriptive statements for the Elementary/Middle Grades test.

Objective Statement

Understand word analysis strategies and vocabulary development and how to use effective, developmentally appropriate approaches to promote students' word analysis and vocabulary skills.

Descriptive Statements

- Demonstrate knowledge of phonics and its role in decoding; of ways to assess students' phonic skills; and of effective instructional strategies, activities, and materials for promoting students' phonetic analysis skills.
- Demonstrate knowledge of word analysis strategies, including syllabication, morphology (e.g., use of affixes and roots), and context clues; of ways to assess students' use of word analysis strategies; and of effective instructional strategies, activities, and materials for promoting students' word analysis and contextual analysis skills.
- Demonstrate knowledge of the role of vocabulary development in reading; of ways to assess students' vocabulary development; and of effective instructional strategies, activities, and materials for promoting students' vocabulary development.

SPECIAL NOTE REGARDING SCIENCE TEST FIELDS

The test objectives for each of the science fields (i.e., Biology, Chemistry, Earth and Space Science, Environmental Science, and Physics) contain a set of common objectives in addition to objectives unique to the specialty field. The set of common objectives measures the candidate's core knowledge across all science fields. The test questions matched to these common objectives are identical across all science fields.

CALCULATORS

Examinees taking Science: Biology, Science: Chemistry, Science: Earth and Space Science, Science: Environmental Science, and Science: Physics will be provided with a scientific calculator at the test administration. Please consult the current version of the ICTS Registration Bulletin for more information on scientific calculators.

PRACTICE TEST QUESTIONS

The practice test questions included in this section are designed to give the examinee an introduction to the nature of the test questions included on the ICTS test for each field. The practice test questions represent the various types of test questions you may expect to see on an actual test; however, they are **not** designed to provide diagnostic information to help you identify specific areas of individual strengths and weaknesses or predict your performance on the test as a whole. Use the answer key located after the practice test questions to check your answers.

To help you identify which test objective is being assessed, the objective statement to which the question corresponds is listed in the answer key. When you are finished with the practice test questions, you may wish to go back and review the entire list of test objectives and descriptive statements once again.

SCIENCE: PHYSICS TEST OBJECTIVES

- I. Science and Technology
- II. Life Science
- III. Physical Science
- IV. Earth Systems and the Universe
- V. Physics Skills, Motion, Forces, and Waves
- VI. Heat, Electricity, Magnetism, and Modern Physics

SUBAREA I—SCIENCE AND TECHNOLOGY

0001 Understand and apply knowledge of science as inquiry.

- Recognize the assumptions, processes, purposes, requirements, and tools of scientific inquiry.
- Use evidence and logic in developing proposed explanations that address scientific questions and hypotheses.
- Identify various approaches to conducting scientific investigations and their applications.
- Use tools and mathematical and statistical methods for collecting, managing, analyzing (e.g., average, curve fit, error determination), and communicating results of investigations.
- Demonstrate knowledge of ways to report, display, and defend the results of an investigation.

0002 Understand and apply knowledge of the concepts, principles, and processes of technological design.

- Recognize the capabilities, limitations, and implications of technology and technological design and redesign.
- Identify real-world problems or needs to be solved through technological design.
- Apply a technological design process to a given problem situation.
- Identify a design problem and propose possible solutions, considering such constraints as tools, materials, time, costs, and laws of nature.
- Evaluate various solutions to a design problem.

0003 Understand and apply knowledge of accepted practices of science.

- Demonstrate an understanding of the nature of science (e.g., tentative, replicable, historical, empirical) and recognize how scientific knowledge and explanations change over time.
- Compare scientific hypotheses, predictions, laws, theories, and principles and recognize how they are developed and tested.
- Recognize examples of valid and biased thinking in reporting of scientific research.
- Recognize the basis for and application of safety practices and regulations in the study of science.

0004 Understand and apply knowledge of the interactions among science, technology, and society.

- Recognize the historical and contemporary development of major scientific ideas and technological innovations.
- Demonstrate an understanding of the ways that science and technology affect people's everyday lives, societal values and systems, the environment, and new knowledge.
- Analyze the processes of scientific and technological breakthroughs and their effects on other fields of study, careers, and job markets.
- Analyze issues related to science and technology at the local, state, national, and global levels (e.g., environmental policies, genetic research).
- Evaluate the credibility of scientific claims made in various forums (e.g., the media, public debates, advertising).

0005 Understand and apply knowledge of the major unifying concepts of all sciences and how these concepts relate to other disciplines.

- Identify the major unifying concepts of the sciences (e.g., systems, order, and organization; constancy, change, and measurement) and their applications in real-life situations.
- Recognize connections within and among the traditional scientific disciplines.
- Apply fundamental mathematical language, knowledge, and skills at the level of algebra and statistics in scientific contexts.
- Recognize the fundamental relationships among the natural sciences and the social sciences.

SUBAREA II—LIFE SCIENCE

0006 Understand and apply knowledge of cell structure and function.

- Compare and contrast the structures of viruses and prokaryotic and eukaryotic cells.
- Identify the structures and functions of cellular organelles.
- Describe the processes of the cell cycle.
- Explain the functions and applications of the instruments and technologies used to study the life sciences at the molecular and cellular levels.

0007 Understand and apply knowledge of the principles of heredity and biological evolution.

- Recognize the nature and function of the gene, with emphasis on the molecular basis of inheritance and gene expression.
- Analyze the transmission of genetic information (e.g., Punnett squares, sex-linked traits, pedigree analysis).
- Analyze the processes of change at the microscopic and macroscopic levels.
- Identify scientific evidence from various sources, such as the fossil record, comparative anatomy, and biochemical similarities, to demonstrate knowledge of theories about processes of biological evolution.

0008 Understand and apply knowledge of the characteristics and life functions of organisms.

- Identify the levels of organization of various types of organisms and the structures and functions of cells, tissues, organs, and organ systems.
- Analyze the strategies and adaptations used by organisms to obtain the basic requirements of life.
- Analyze factors (e.g., physiological, behavioral) that influence homeostasis within an organism.
- Demonstrate an understanding of the human as a living organism with life functions comparable to those of other life forms.

0009 Understand and apply knowledge of how organisms interact with each other and with their environment.

- Identify living and nonliving components of the environment and how they interact with one another.
- Recognize the concepts of populations, communities, ecosystems, and ecoregions and the role of biodiversity in living systems.
- Analyze factors (e.g., ecological, behavioral) that influence interrelationships among organisms.
- Develop a model or explanation that shows the relationships among organisms in the environment (e.g., food web, food chain, ecological pyramid).
- Recognize the dynamic nature of the environment, including how communities, ecosystems, and ecoregions change over time.
- Analyze interactions of humans with their environment.
- Explain the functions and applications of the instruments and technologies used to study the life sciences at the organism and ecosystem levels.

SUBAREA III—PHYSICAL SCIENCE

0010 Understand and apply knowledge of the nature and properties of energy in its various forms.

- Describe the characteristics of and relationships among thermal, acoustical, radiant, electrical, chemical, mechanical, and nuclear energies through conceptual questions.
- Analyze the processes by which energy is exchanged or transformed through conceptual questions.
- Apply the three laws of thermodynamics to explain energy transformations, including basic algebraic problem solving.
- Apply the principle of conservation as it applies to energy through conceptual questions and solving basic algebraic problems.

0011 Understand and apply knowledge of the structure and properties of matter.

- Describe the nuclear and atomic structure of matter, including the three basic parts of the atom.
- Analyze the properties of materials in relation to their chemical or physical structures (e.g., periodic table trends, relationships, and properties) and evaluate uses of the materials based on their properties.
- Apply the principle of conservation as it applies to mass and charge through conceptual questions.
- Analyze bonding and chemical, atomic, and nuclear reactions (including endothermic and exothermic reactions) in natural and man-made systems and apply basic stoichiometric principles.
- Apply kinetic theory to explain interactions of energy with matter, including conceptual questions on changes in state.
- Explain the functions and applications of the instruments and technologies used to study matter and energy.

0012 Understand and apply knowledge of forces and motion.

- Demonstrate an understanding of the concepts and interrelationships of position, time, velocity, and acceleration through conceptual questions, algebra-based kinematics, and graphical analysis.
- Demonstrate an understanding of the concepts and interrelationships of force (including gravity and friction), inertia, work, power, energy, and momentum.
- Describe and predict the motions of bodies in one and two dimensions in inertial and accelerated frames of reference in a physical system, including projectile motion but excluding circular motion.
- Analyze and predict motions and interactions of bodies involving forces within the context of conservation of energy and/or momentum through conceptual questions and algebra-based problem solving.
- Describe the effects of gravitational and nuclear forces in real-life situations through conceptual questions.
- Explain the functions and applications of the instruments and technologies used to study force and motion in everyday life.

0013 Understand and apply knowledge of electricity, magnetism, and waves.

- Recognize the nature and properties of electricity and magnetism, including static charge, moving charge, basic RC circuits, fields, conductors, and insulators.
- Recognize the nature and properties of mechanical and electromagnetic waves (e.g., frequency, source, medium, spectrum, wave-particle duality).
- Describe the effects and applications of electromagnetic forces in real-life situations, including electric power generation, circuit breakers, and brownouts.
- Analyze and predict the behavior of mechanical and electromagnetic waves under varying physical conditions, including basic optics, color, ray diagrams, and shadows.

SUBAREA IV—EARTH SYSTEMS AND THE UNIVERSE

0014 Understand and apply knowledge of Earth's land, water, and atmospheric systems and the history of Earth.

- Identify the structure and composition of Earth's land, water, and atmospheric systems and how they affect weather, erosion, fresh water, and soil.
- Recognize the scope of geologic time and the continuing physical changes of Earth through time.
- Evaluate scientific theories about Earth's origin and history and how these theories explain contemporary living systems.
- Recognize the interrelationships between living organisms and Earth's resources and evaluate the uses of Earth's resources.

0015 Understand and apply knowledge of the dynamic nature of Earth.

- Analyze and explain large-scale dynamic forces, events, and processes that affect Earth's land, water, and atmospheric systems, including conceptual questions about plate tectonics, El Niño, drought, and climatic shifts.
- Identify and explain Earth processes and cycles and cite examples in real-life situations, including conceptual questions on rock cycles, volcanism, and plate tectonics.
- Analyze the transfer of energy within and among Earth's land, water, and atmospheric systems, including the identification of energy sources of volcanoes, hurricanes, thunderstorms, and tornadoes.
- Explain the functions and applications of the instruments and technologies used to study the earth sciences, including seismographs, barometers, and satellite systems.

0016 Understand and apply knowledge of objects in the universe and their dynamic interactions.

- Describe and explain the relative and apparent motions of the sun, the moon, stars, and planets in the sky.
- Recognize properties of objects (e.g., comets, asteroids) within the solar system and their dynamic interactions.
- Recognize the types, properties, and dynamics of objects external to the solar system (e.g., black holes, supernovas, galaxies).

0017 Understand and apply knowledge of the origins of and changes in the universe.

- Identify scientific theories dealing with the origin of the universe (e.g., big bang).
- Analyze evidence relating to the origin and physical evolution of the universe (e.g., microwave background radiation, expansion).
- Compare the physical and chemical processes involved in the life cycles of objects within galaxies.
- Explain the functions and applications of the instruments, technologies, and tools used in the study of the space sciences, including the relative advantages and disadvantages of Earth-based versus space-based instruments and optical versus nonoptical instruments.

SUBAREA V—PHYSICS SKILLS, MOTION, FORCES, AND WAVES

0018 Understand and apply the knowledge and skills needed to practice physics and understand the broad applicability of its principles to real-world situations.

- Demonstrate knowledge of the safe and proper use of equipment and materials commonly used in physics classrooms and laboratories.
- Design appropriate laboratory investigations to study the principles and applications of physics.
- Demonstrate knowledge of the uses of basic equipment to illustrate physical principles and phenomena.
- Use mathematical concepts, strategies, and procedures, including graphical and statistical methods and differential and integral calculus, to derive and manipulate formal relationships between physical quantities.
- Demonstrate an understanding of the growth of physics knowledge from a historical perspective.
- Recognize examples of the applicability of physics in daily life, including career opportunities and avocations in physics and technology.

0019 Understand and apply knowledge of planar motion.

- Analyze the relationship between vectors and physical quantities and perform a variety of vector algebra operations.
- Use algebra and calculus methods to determine the rectilinear displacement, velocity, and acceleration of particles and rigid bodies, given initial conditions.
- Use algebra and calculus methods to determine the angular displacement, velocity, and acceleration of rigid bodies in a plane, given initial conditions.
- Use algebra and calculus methods to determine the displacement, velocity, and acceleration of particles and rigid bodies undergoing periodic motion, given initial conditions.
- Analyze and solve problems involving the relationships of linear and angular displacement, velocity, and acceleration.
- Analyze and solve problems involving periodic motion and uniform circular motion.

0020 Understand and apply knowledge of force, momentum, and energy as they apply to planar motion.

- Apply Newton's laws of motion to analyze and solve problems involving translational, rotational, and periodic motion.
- Apply the law of universal gravitation to solve problems involving free fall, projectile motion, and planetary motion.
- Analyze and solve problems involving the relationships between linear quantities and their rotational analogues.
- Solve problems involving the conservation of linear and angular momentum.
- Use the relationship between work and energy, in algebraic and calculus forms, to solve problems involving the motions of physical systems acted upon by conservative and nonconservative forces.

0021 Understand and apply knowledge of the nature, properties, and behavior of mechanical waves.

- Apply the relationships among wave speed, wavelength, period, and frequency to analyze and solve problems related to wave propagation.
- Analyze the interference and reflection of waves and wave pulses.
- Describe and analyze the nature, production, and transmission of sound waves in various uniform media.
- Describe how the perception of sound depends on the physical properties of sound waves.

0022 Understand and apply knowledge of the nature, properties, and behavior of electromagnetic radiation.

- Classify the regions of the electromagnetic spectrum relative to their frequency or wavelength.
- Analyze and predict the behavior of various types of electromagnetic radiation as they interact with matter.
- Analyze and predict the behaviors of light, including interference, reflection, diffraction, polarization, and refraction.
- Use ray diagrams to analyze systems of lenses and mirrors.

SUBAREA VI—HEAT, ELECTRICITY, MAGNETISM, AND MODERN PHYSICS

0023 Understand and apply knowledge of the principles of thermodynamics.

- Apply basic concepts of heat and temperature as they relate to temperature measurement and temperature-dependent properties of matter.
- Apply the laws of thermodynamics to problems involving temperature, work, heat, energy, and entropy.
- Demonstrate knowledge of the kinetic-molecular theory and apply it to describe thermal properties and behaviors of solids, liquids, and gases.
- Analyze and solve problems involving energy, temperature, heat, and changes of state.

0024 Understand and apply knowledge of static and moving electric charges.

- Predict the interactions between electric charges.
- Interpret electric field diagrams and predict the influence of electric fields on electric charges.
- Determine the electric potential due to a charge distribution and calculate the work involved in moving a point charge through a potential difference.
- Determine the electric field due to a charge distribution and calculate the force on a point charge located in that electric field.
- Describe the flow of charge through different media and interpret circuit diagrams.
- Analyze AC and DC circuits composed of basic circuit elements.

0025 Understand and apply knowledge of the principles of magnetism and induced electric fields.

- Analyze the motion of a charged particle in a magnetic field and determine the force on a current-carrying conductor in a magnetic field.
- Analyze the characteristics of magnetic fields produced by straight and coiled current-carrying conductors.
- Describe and analyze the processes of electromagnetic induction.
- Demonstrate an understanding of the operating principles of electric generators, motors, and transformers.
- Identify applications of magnets and magnetic fields in technology and daily living.

0026 Understand and apply knowledge of the basic concepts and applications of modern physics.

- Demonstrate knowledge of a quantum model of atomic structure (e.g., the Bohr model), including the relationship between changes in electron energy levels and atomic spectra.
- Describe types, properties, and applications of radioactivity and the effects of radioactivity on living organisms.
- Balance particle equations and solve radioactive decay problems involving half-life, energy, mass, and charge.
- Describe the quantum mechanical nature of the interaction between radiation and matter.
- Describe the wave-particle duality of radiation and matter.
- Describe the quantum mechanical electron properties of conductors, semiconductors, and insulators.
- Apply the concepts of special relativity as they relate to time, space, and mass.

SCIENCE: PHYSICS PRACTICE TEST QUESTIONS

The periodic table provided with this test can be found on page 2-24.

1. Use the graph below to answer the question that follows.



Key	
.....	Carbon dioxide concentration in atmosphere
—	Temperature

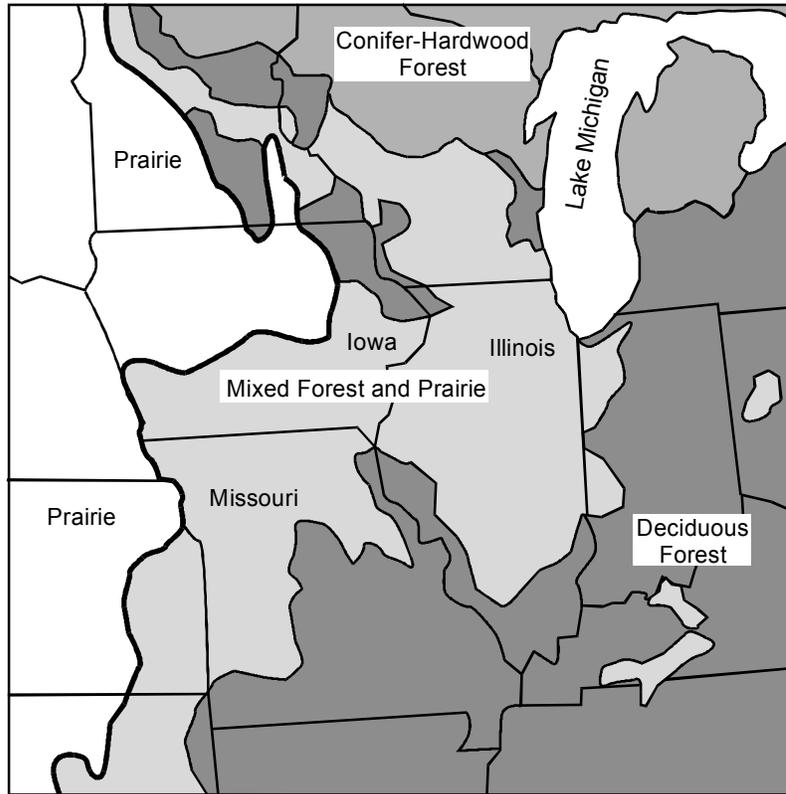
The graph above shows the variation in the concentration of carbon dioxide in the atmosphere over the past 160,000 years and the average global temperature change during that same period. Which of the following is the best logical conclusion that can be drawn relying exclusively on these two data sets?

- A. Increased global temperatures correlate with increases in atmospheric carbon dioxide, suggesting a connection between the two phenomena.
- B. Increased atmospheric carbon dioxide promotes a general warming of the global climate through its role as a greenhouse gas.
- C. Increased global temperatures increase the production of carbon dioxide from a variety of natural sources, including photosynthesis and erosion of carbonate rocks.
- D. Increased carbon dioxide concentrations in the atmosphere are not related to the warming in the global climate.

2. Which of the following is a fundamental challenge in the design of complex systems?
- A. Feedback mechanisms in complex systems decrease the overall stability of the system.
 - B. The more parts and connections that a complex system has, the more ways the system can fail.
 - C. The cost of designing complex systems is excessive.
 - D. The construction of complex systems is time consuming.
3. Newton's laws are considered laws and not theories because:
- A. they describe natural phenomena with unvarying uniformity under certain conditions.
 - B. they can be used to explain the outcome of natural phenomena.
 - C. over time, theories become laws.
 - D. they are all true for all frames of reference discovered so far.
4. Major breakthroughs in science and technology during the nineteenth century were primarily the result of:
- A. inventions designed to solve a specific problem.
 - B. basic research into the workings of the physical and natural world.
 - C. accidental discoveries made when conducting research on other topics.
 - D. grant-funded research projects seeking to reach a particular goal.
5. For an unordered system, such as a mixture of salt and pepper, to become more ordered, which of the following is required?
- A. the addition of heat
 - B. an increase in the size of the system
 - C. the expenditure of energy
 - D. a decrease in the pressure in the system

6. Ribosomes are involved in which of the following cellular processes?
- A. maintaining structural integrity
 - B. transporting waste
 - C. digesting nutrients
 - D. synthesizing proteins
7. There are four characteristic phenotypes for a feather color trait in parrots. The phenotypes exhibited by the parrots depend on two genes that assort independently. A cross between an individual of genotype AABb and an individual of genotype aaBb would result in which of the following phenotypic ratios?
- A. 3:1
 - B. 9:3:3:1
 - C. 1:2:1
 - D. 2:1:1
8. A pitcher plant traps insects in a pitcher-shaped leaf from which the insect cannot escape. This strategy is best described as an evolutionary adaptation that:
- A. discourages insect predation.
 - B. provides the plant with complex carbohydrates.
 - C. attracts insect-eating pollinators.
 - D. helps the plant survive in a nutrient-poor environment.
9. In order to maintain homeostasis, mammals require significantly higher metabolic rates per gram of body weight than fish. This is primarily because mammals have:
- A. more complex circulatory systems.
 - B. internal thermoregulation.
 - C. water-conserving excretory systems.
 - D. proportionally larger hearts.

10. Use the map below to answer the question that follows.



The map above shows vegetation in the Midwest prior to the 1800s. Which of the following factors was critical in determining the extent of prairie in this region?

- A. soil type
- B. character of bedrock
- C. precipitation
- D. temperature

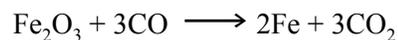
11. When hydrochloric acid reacts with calcium carbonate in a flask, the flask becomes noticeably warm to the touch. Which of the following best describes why this occurs?

- A. The high rate at which the chemical reaction occurs generates infrared radiation.
- B. The number of protons in the products is greater than the number of protons in the reactants.
- C. The friction produced by the agitation of the reactants creates thermal energy.
- D. The bond energies of the reactants are greater than the bond energies of the products.

12. A ball rolls down an incline and then across a flat, smooth surface until it stops. Which of the following best describes why the ball comes to a stop?

- A. The ball's acceleration is balanced by its inertia.
- B. Gravity no longer affects the ball's mass.
- C. The ball's kinetic energy is changed into potential energy.
- D. Frictional forces overcome the ball's inertia.

13. Use the chemical equation below to answer the question that follows.

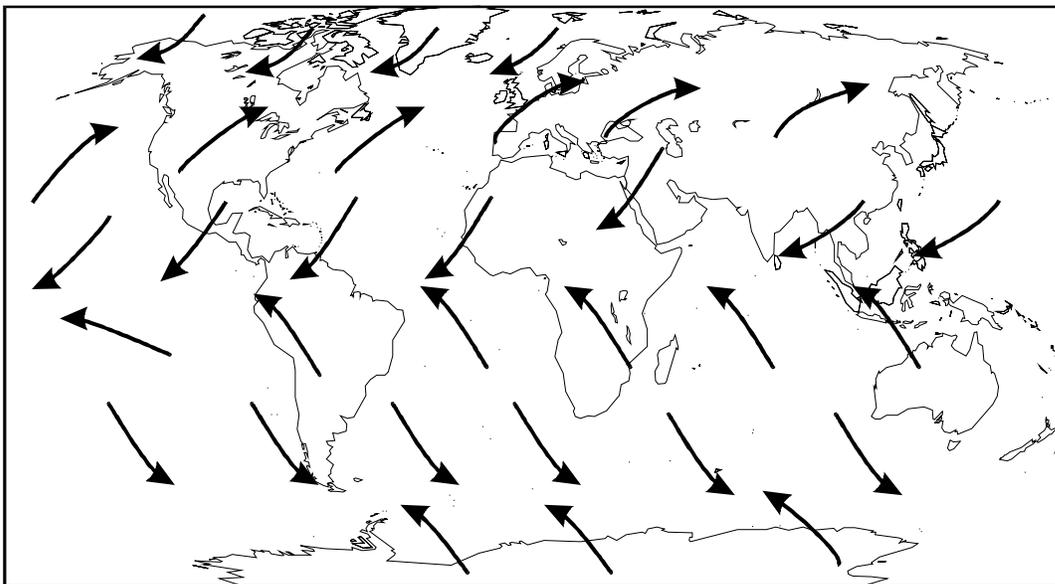


Which of the following formulas represents the approximate number of grams of CO required to react completely with 200 g of Fe_2O_3 ?

- A. $\frac{(200)(3)}{(28)(160)} \text{ g}$
- B. $\frac{(200)(3)(28)}{160} \text{ g}$
- C. $\frac{(200)(28)}{(3)(160)} \text{ g}$
- D. $\frac{160}{(200)(28)(3)} \text{ g}$

14. Two trains pass each other. One train is going 70 km/h toward the east; the other train is traveling 50 km/h toward the west. A passenger on the eastbound train walks toward the back of the train at 5 km/h. Relative to the walking passenger, what is the speed of the westbound train?
- A. 75 km/h
 - B. 115 km/h
 - C. 120 km/h
 - D. 125 km/h
15. An object that becomes charged by frictional contact with another object gains electric charge as a result of:
- A. the repulsion of positive charges in one object by the positive charges in the other object.
 - B. magnetic fields produced by the relative motion of electrons and protons.
 - C. the induction of charge in both objects by the generation of heat energy.
 - D. the transfer of electrons from the surface of one object to the surface of the other object.
16. The composition of soils in Illinois is primarily the result of:
- A. the sediments covering the region from the Pleistocene glaciations.
 - B. the abundance of granitic bedrock in the state.
 - C. the various kinds of vegetation in the region.
 - D. the climatic zones found within the state.

17. Use the map below to answer the question that follows.

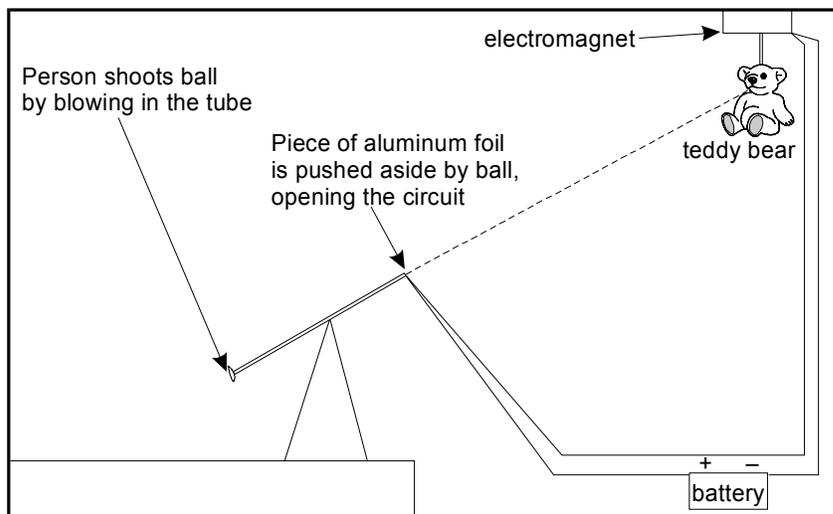


As shown in the map above, major air currents in the Northern Hemisphere are always deflected toward the right, while in the Southern Hemisphere they are always deflected to the left. Which of the following causes this deflection?

- A. the frictional drag on the atmosphere as Earth orbits the sun
- B. the differences in atmospheric heating and wind flow caused by the proportion of land to water
- C. the movement of Earth's spherical surface around its axis of rotation
- D. the existence of semistable pressure systems in the middle and upper levels of the atmosphere

18. Which of the following is used to determine the location and magnitude of an earthquake?
- A. the frequency and amplitude of earthquake waves recorded at a seismograph station
 - B. the size and direction of incoming earthquake waves recorded at two different seismograph stations
 - C. the arrival times and amplitudes of earthquake waves at three separate seismograph stations
 - D. the arrival times of three different kinds of earthquake waves at a seismograph station
19. Which of the following best explains why only one side of the moon is visible from Earth?
- A. The moon does not rotate on its axis during its orbit of Earth.
 - B. The moon rotates at the same rate as Earth rotates.
 - C. The periods of the moon's rotation and revolution are the same.
 - D. The moon's axis of rotation is parallel to the plane of its orbit.
20. Which of the following is the major advantage of using space-based telescopes, rather than Earth-based telescopes, to observe extremely distant objects in the universe?
- A. There is no distortion from gas and dust in the atmosphere.
 - B. They are closer to the objects being viewed.
 - C. There is no light pollution to disrupt x-ray and radio-wave signals.
 - D. They are easier to maintain in the low-gravity, dust-free conditions of space.

21. Use the diagram below to answer the question that follows.



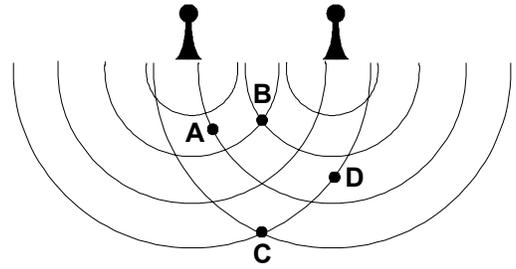
The diagram shows a blowgun aimed to shoot a small ball at a teddy bear. The teddy bear is suspended by an electromagnet. When the ball leaves the blowgun, the electromagnetic circuit is opened and the teddy bear is released. This apparatus is most useful for demonstrating:

- A. the conservation of mechanical energy.
- B. the quadratic nature of displacement versus time for free fall.
- C. the conservation of linear momentum.
- D. the independence of vertical and horizontal components of motion.

22. A wheel rotates around an axis through the center of the wheel. A point on the wheel has an initial displacement of 30.0° , an initial angular speed of $15.0^\circ/\text{s}$, and a constant angular acceleration of $10.0^\circ/\text{s}^2$. What is the angular displacement of the point after 4.0 seconds?

- A. 130°
- B. 170°
- C. 220°
- D. 250°

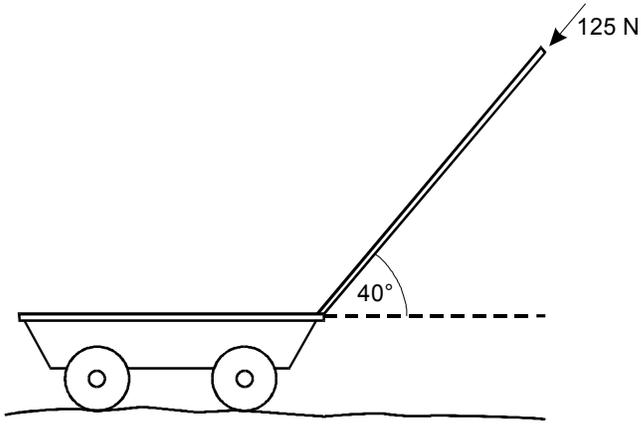
23. Use the diagram below to answer the question that follows.



The diagram represents the wave fronts of two sound waves. The waves are in phase and have the same frequency. At which point on the diagram is the sound loudest?

- A. A
- B. B
- C. C
- D. D

Use the information below to answer the two questions that follow.



A garden cart of mass 22 kg is pushed on level ground with a handle that makes an angle of 40° with the horizontal. A force of 125 N is applied along the direction of the handle as shown.

24. Neglecting friction, what is the acceleration of the garden cart?
- A. 3.7 m/s^2
 - B. 4.4 m/s^2
 - C. 4.8 m/s^2
 - D. 5.7 m/s^2
25. What is the normal force exerted by the ground on the garden cart?
- A. $1.0 \times 10^2 \text{ N}$
 - B. $1.4 \times 10^2 \text{ N}$
 - C. $2.2 \times 10^2 \text{ N}$
 - D. $3.0 \times 10^2 \text{ N}$

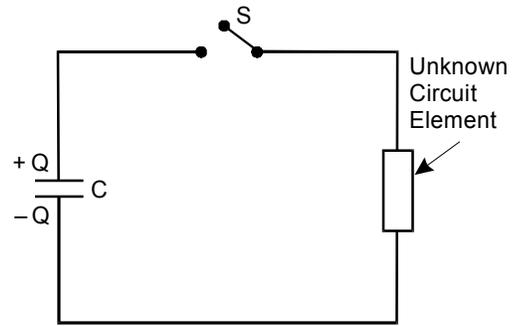
26. A razor blade is placed halfway into a monochromatic laser beam. The image when the beam strikes a screen shows that the shadow is actually a series of alternating light and dark bands. This result is due to which of the following wave phenomena?

- A. diffraction
- B. diffusion
- C. reflection
- D. refraction

27. A heat engine consists of a gas in a cylinder with a piston. When 78.4 J of heat are added to the gas it expands, moving the piston and lifting a mass of 2.00 kg a vertical distance of 0.500 meters. What percent of the heat is converted to work?

- A. 1.30%
- B. 5.10%
- C. 12.5%
- D. 33.3%

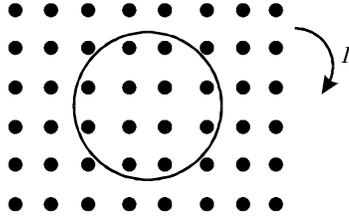
28. Use the diagram below to answer the question that follows.

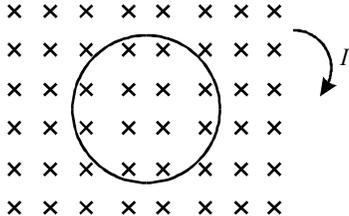


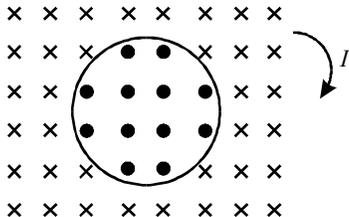
In the circuit above, the capacitor is initially charged. If the switch is closed, an alternating current will be produced if the unknown circuit element is:

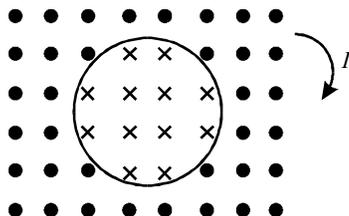
- A. a resistor.
- B. a diode.
- C. an inductor.
- D. a capacitor.

29. A conducting wire loop carries current in the clockwise direction. If an \times represents magnetic field lines pointing into the plane of the page, and a \bullet represents magnetic field lines pointing out of the page, which of the following diagrams best represents the direction of the magnetic field lines created by the current in the loop?

A. 

B. 

C. 

D. 

30. Use the diagram below to answer the question that follows.

$$n = 3 \quad \underline{\hspace{2cm}} \quad -1.51 \text{ eV}$$

$$n = 2 \quad \underline{\hspace{2cm}} \quad -3.40 \text{ eV}$$

$$n = 1 \quad \underline{\hspace{2cm}} \quad -13.6 \text{ eV}$$

The diagram shows the first three energy levels in the Bohr model of the hydrogen atom. What is the highest frequency of light in the spectrum of an atom transitioning among these three energy levels in terms of Planck's constant, h ?

- A. $\frac{12.1}{h} \text{ eV}$
- B. $\frac{13.6}{h} \text{ eV}$
- C. $\frac{15.1}{h} \text{ eV}$
- D. $\frac{18.5}{h} \text{ eV}$

PERIODIC TABLE OF THE ELEMENTS

18																																																																											
VIIIA																																																																											
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18																																									
IA		IIA		IIIB		IVB		VB		VIB		VII B		VIIIB		IX		X		XI		XII		IIIA		IVA		VA		VIA		VIIA		VIIIA																																									
1 H 1.01	2 He 4.00	3 Li 6.94	4 Be 9.01	11 Na 23.0	12 Mg 24.3	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98.9)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3	55 Cs 132.9	56 Ba 137.3	57-71 Lanthanide Series	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)	87 Fr (223)	88 Ra (226)	89-103 Actinide Series	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111	112	113	114	115	116	117	118

Lanthanide Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinide Series	89 Ac (227)	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Some of the elements 111 and above have been reported but not fully authenticated and named.

ANSWER KEY

This section contains the answers to the practice test questions in the previous section.

After you have worked through the practice test questions, check the answers given in this section to see which questions you answered correctly.

Question Number	Correct Response	Test Objective
1.	A	Understand and apply knowledge of science as inquiry.
2.	B	Understand and apply knowledge of the concepts, principles, and processes of technological design.
3.	A	Understand and apply knowledge of accepted practices of science.
4.	B	Understand and apply knowledge of the interactions among science, technology, and society.
5.	C	Understand and apply knowledge of the major unifying concepts of all sciences and how these concepts relate to other disciplines.
6.	D	Understand and apply knowledge of cell structure and function.
7.	A	Understand and apply knowledge of the principles of heredity and biological evolution.
8.	D	Understand and apply knowledge of the characteristics and life functions of organisms.
9.	B	Understand and apply knowledge of the characteristics and life functions of organisms.
10.	C	Understand and apply knowledge of how organisms interact with each other and with their environment.
11.	D	Understand and apply knowledge of the nature and properties of energy in its various forms.
12.	D	Understand and apply knowledge of the nature and properties of energy in its various forms.
13.	B	Understand and apply knowledge of the structure and properties of matter.
14.	B	Understand and apply knowledge of forces and motion.
15.	D	Understand and apply knowledge of electricity, magnetism, and waves.
16.	A	Understand and apply knowledge of Earth's land, water, and atmospheric systems and the history of Earth.
17.	C	Understand and apply knowledge of the dynamic nature of Earth.
18.	C	Understand and apply knowledge of the dynamic nature of Earth.

(continued on next page)

Question Number	Correct Response	Test Objective
19.	C	Understand and apply knowledge of objects in the universe and their dynamic interactions.
20.	A	Understand and apply knowledge of the origins of and changes in the universe.
21.	D	Understand and apply the knowledge and skills needed to practice physics and understand the broad applicability of its principles to real-world situations.
22.	B	Understand and apply knowledge of planar motion.
23.	B	Understand and apply knowledge of the nature, properties, and behavior of mechanical waves.
24.	B	Understand and apply knowledge of force, momentum, and energy as they apply to planar motion.
25.	D	Understand and apply knowledge of force, momentum, and energy as they apply to planar motion.
26.	A	Understand and apply knowledge of the nature, properties, and behavior of electromagnetic radiation.
27.	C	Understand and apply knowledge of the principles of thermodynamics.
28.	C	Understand and apply knowledge of static and moving electric charges.
29.	D	Understand and apply knowledge of the principles of magnetism and induced electric fields.
30.	A	Understand and apply knowledge of the basic concepts and applications of modern physics.

OVERVIEW

The score report indicates whether or not you passed the test and how you performed on each test subarea. The passing scores for the Illinois Certification Testing System were established by the Illinois State Board of Education based on recommendations from panels of Illinois educators. The passing score for each content-area test is designed to reflect the level of content knowledge and skills required to perform the job of an educator receiving an initial certificate in Illinois.

Passing Score

To pass a content-area test you must obtain a scaled total test score of 240 or above.

Total Test Score

The total test score is based on your performance on the entire test, specifically the number of multiple-choice questions you answered correctly.

Subarea Scores

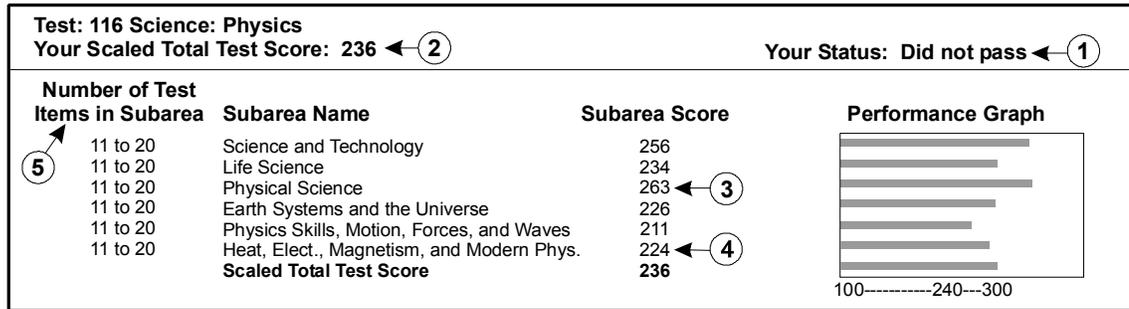
- Subarea scores are presented on the same scale as the total test score.
- Subarea scores contain different numbers of questions and are weighted differently in the computation of the total test score; therefore, the average of the subarea scaled scores generally will not equal the scaled total test score.
- Subarea scores will help you assess your areas of relative strength and weakness.

Reporting of Scores

Your results will be forwarded to the Illinois State Board of Education and to the Illinois institution(s) you indicate during the registration process. You should keep the score report you receive for your own records.

READING YOUR REPORT: A SAMPLE

A sample of a Science: Physics test score report is provided below.



According to the above sample, the examinee did not pass the Science: Physics test ①, because the examinee's total test score of 236 ② is below the passing score of 240.

The examinee did better on the Physical Science section ③ of the test than on the Heat, Electricity, Magnetism, and Modern Physics section ④. The examinee will need to retake the test and achieve a total test score of 240 or higher to pass the test. The score report indicates the number of items for each subarea on the test ⑤.