Illinois Licensure Testing System

STUDY GUIDE

Science: Chemistry (106)

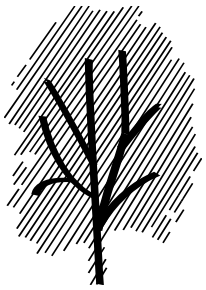
Illinois State Board of Education

An Equal Opportunity/Affirmative Action Employer
Printed by the Authority of the State of Illinois

IL-SG-FLD106-05

TABLE OF CONTENTS

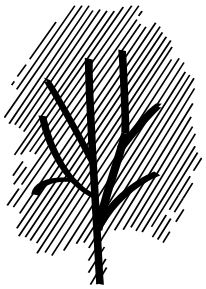
Readers should be advised that this study guide, including many of the excerpts used herein, is protected by federal copyright law.



General Information About the Illinois Licensure 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 Licensure 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 licensure 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 ILTS 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 ILTS 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: CHEMISTRY TEST OBJECTIVES

I. Science and Technology
II. Life Science
III. Physical Science
IV. Earth Systems and the Universe
V. Matter, Structure, and Practical Knowledge
VI. Stoichiometry and Chemical Reactions

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.

0018 Understand and apply knowledge of basic scientific and mathematical skills, safe laboratory practices, and issues of public concern related to the field of chemistry.

- Apply appropriate mathematical skills (e.g., algebraic operations, graphing, statistics, scientific notation) and technology to collect, analyze, and report data and to solve problems in chemistry.
- Select appropriate experimental procedures and equipment for the measurement and determination of chemical reactions and properties.
- Recognize safety practices in the chemistry laboratory, including the characteristics and purposes of chemical hygiene plans.
- Evaluate the role of chemistry in daily life, including ways in which basic research and the development of new technology affect society.

0019 Understand and apply knowledge of periodic relationships and the nature of matter.

- Demonstrate knowledge of the chemical constitution of matter as elements, compounds, and mixtures.
- Distinguish between physical and chemical changes.
- Demonstrate knowledge of basic techniques used to separate substances based on differences in properties.
- Analyze the periodic nature of the elements and the relationship between their electron configuration and the periodic table.
- Connect the chemical and physical properties of elements to electron configuration.
- Demonstrate proficiency at naming compounds and writing formulas.

0020 Understand and apply knowledge of the development and central concepts of atomic theory and structure, including the quantum mechanical model.

- Recognize the central concepts of atomic theory and atomic structure.
- Demonstrate knowledge of the historical progression in the development of the theory of the atom, including the contributions of Dalton, Thomson, Rutherford, and Bohr.
- Describe the energy of an electron in an atom or ion in terms of the four quantum numbers.
- Demonstrate a qualitative knowledge of the role of probability in the description of an orbital's size and shape.
- Analyze the properties of an atomic nucleus that affect its stability.
- Apply strategies for writing and balancing equations for nuclear reactions (e.g., fission, fusion, radioactivity and bombardment).

0021 Understand and apply knowledge of the formation of bonds and the geometry and properties of the resulting compounds.

- Analyze electron behavior in the formation of various types of bonds (e.g., ionic, covalent) and the polarity of compounds in terms of shape and electronegativity differences.
- Apply the concepts of Lewis structures, valence-shell electron-pair repulsion, and hybridization to describe molecular geometry and bonding.
- Demonstrate knowledge of the general features and properties of compounds of metals, nonmetals, and transition elements and the materials derived from them.
- Describe the hybridization of the central atom based on the geometry of coordination compounds.

0022 Understand and apply knowledge of the kinetic molecular theory and the nature and properties of molecules in the gaseous, liquid, and solid states.

- Demonstrate knowledge of the basic principles of the kinetic molecular theory.
- Explain the properties of solids, liquids, and gases and changes of state in terms of the kinetic molecular theory and intermolecular forces.
- Apply various laws related to the properties and behavior of ideal gases (e.g., combined gas laws, ideal gas law, Dalton's law of partial pressures, Graham's law of diffusion) to solve problems.
- Demonstrate an understanding of the differences between real and ideal gases.
- Interpret phase diagrams and use them to explain the transitions between solids, liquids, and gases.
- Classify unknown solids as molecular, metallic, ionic, and covalent network solids according to their physical and chemical properties.

0023 Understand and apply knowledge of the interactions of particles in solution and the properties of solutions.

- Describe the solution process, including the effects of temperature and pressure on the solubility of solids, liquids, and gases.
- Analyze the qualitative colligative properties of solutions, including the practical applications of these properties to technological problems.
- Demonstrate knowledge of how to prepare solutions of specific concentrations, including molality, molarity, normality, mole fraction, and percent by weight.
- Select appropriate solvents for the dissolution or purification of solid compounds.

0024 Understand and apply knowledge of the concepts and principles of chemical equations and stoichiometry.

- Classify types of chemical reactions and balance equations to describe chemical reactions.
- Use mass and mole relationships in an equation to solve stoichiometric problems (including percent yield and limiting reactants).
- Use gas laws and solution concentrations to solve stoichiometric problems (including percent yield and limiting reactants).
- Demonstrate proficiency at converting between percent composition and the formulas of compounds (including both empirical and molecular formulas).

0025 Understand and apply knowledge of the concepts and principles of acid-base chemistry.

- Compare the Arrhenius, Brønsted-Lowry, and Lewis concepts of acids and bases.
- Recognize the relationship between acid and base strength, pH, and molecular structure.
- Explain the characteristics of buffered solutions in terms of chemical equilibrium of weak acids.
- Demonstrate an understanding of how to prepare a standardized solution or a buffer of a specified pH, given the Ka of various acids and a standardized NaOH solution.
- Design and analyze the results of an acid-base titration (which may include selecting an appropriate indicator or interpreting a titration curve).

0026 Understand and apply knowledge of thermodynamics and their applications to chemical systems.

- Recognize the relationships among enthalpy, entropy, Gibbs free energy, and the equilibrium constant.
- Evaluate the thermodynamic feasibility of various reactions and calculate energy changes during chemical reactions.
- Analyze the thermodynamics and kinetic dynamics that move a reversible reaction to a position of chemical equilibrium.
- Apply Le Chatelier's principle to analyze reversible reactions.

0027 Understand and apply knowledge of electrochemistry.

- Demonstrate an understanding of oxidation/reduction reactions and their relationship to standard reduction potentials.
- Demonstrate an understanding of electrolysis reactions.
- Balance redox reactions.
- Demonstrate knowledge of devising and building electrochemical cells.

0028 Understand and apply knowledge of the mechanisms of chemical reactions and the theory and practical applications of reaction rates.

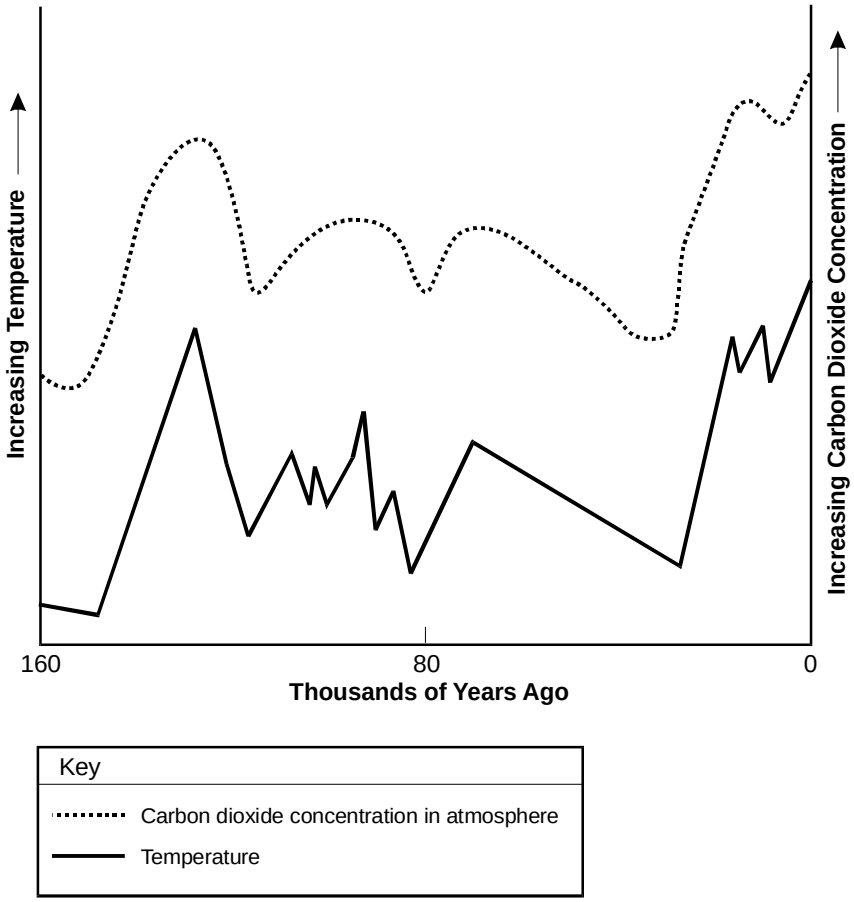
- Recognize the basics of collision and transition-state theories and the significance of the Arrhenius equation.
- Explain how various factors (e.g., temperature, catalysts) influence reaction rates.
- Analyze experimental data involving reaction rates, concentration, and/or time to determine kinetic parameters (e.g., reaction order, rate constants, activation energy).
- Demonstrate an understanding of the relationship of rate laws to reaction mechanisms.

0029 Understand and apply knowledge of major aspects of organic chemistry.

- Identify the functional group classification and nomenclature of organic compounds and the general characteristics and reactions of each group.
- Demonstrate an understanding of the concepts and mechanisms of substitution, addition, elimination, and other reactions of organic molecules.
- Demonstrate knowledge of appropriate separation, purification, and identification schemes for organic molecules (e.g., chromatography, spectroscopy).
- Recognize the general structure, properties, and uses of organic polymers, pharmaceuticals, pesticides, and other practical products.
- Demonstrate an understanding of the structure, properties, and function of common biological molecules (carbohydrates, lipids, proteins, and nucleic acids) and how these biomolecules are involved in life processes.
- Recognize the general features of three-dimensional structures, bonding, molecular properties, and reactivity of organic molecules.

The periodic table provided with this test can be found on page 2-23.

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



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:

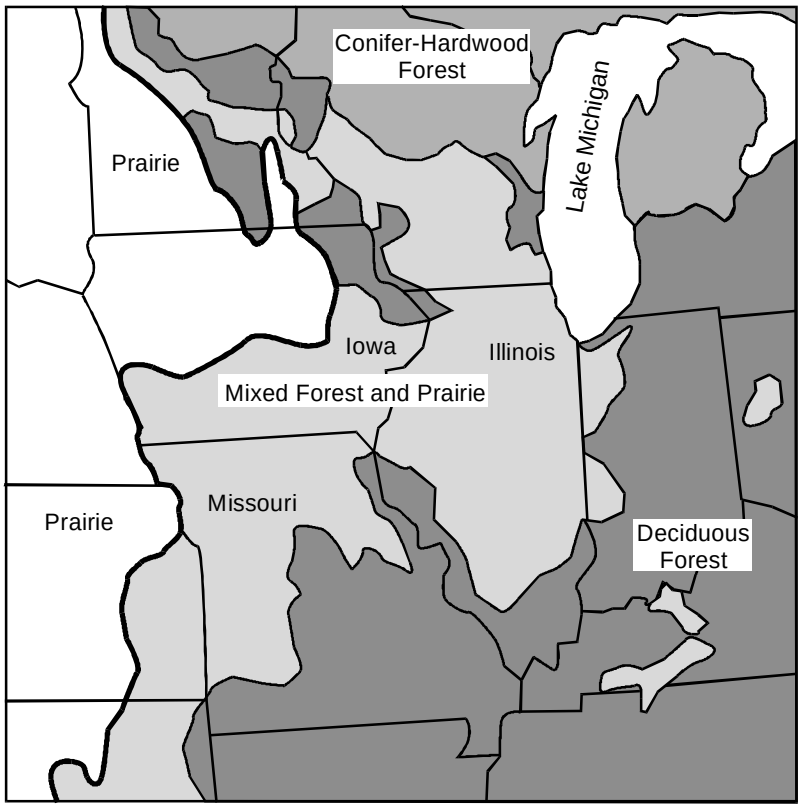
   A. more complex circulatory systems.

   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.**

$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

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. $\frac{(200)(3)}{(28)(160)}$ g

B. $\frac{(200)(3)(28)}{160}$ g

C. $\frac{(200)(28)}{(3)(160)}$ g

D. $\frac{160}{(200)(28)(3)}$ 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:

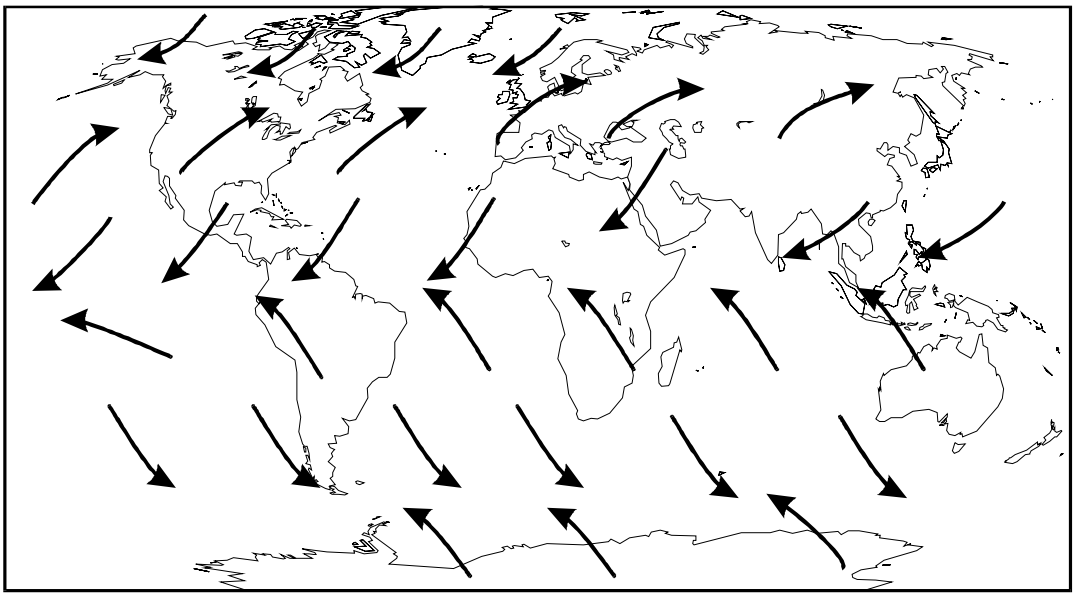
    A. the sediments covering the region from the Pleistocene glaciations.

    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. The development of the Haber process played a central role in which of the following events of the twentieth century?

A. the use of nuclear fuel for energy production

B. the production of plastics with a wide variety of properties

C. the vast increase in agricultural production

D. the development of microcomputer technology

22. Element *X* reacts with chlorine gas to produce the ionic compound XCl_2. Which of the following electron configurations for element *X* is consistent with this chemical property?

A. $1s^2 2s^2 2p^6 3s^2 3p^1$

B. $1s^2 2s^2 2p^6 3s^2 3p^2$

C. $1s^2 2s^2 2p^6 3s^1$

D. $1s^2 2s^2 2p^6 3s^2$

23. Which of the following ratios is most important with respect to the stability of a nucleus?

A. neutrons : electrons

B. protons : electrons

C. neutrons : protons

D. nucleons : nonnucleons

24. What is the relative rate of diffusion of sulfur dioxide gas to bromine gas at the same pressure and temperature?

A. 0.401:1

B. 0.633:1

C. 1.58:1

D. 2.50:1

25. A sample of solid iodine crystals has been contaminated by solid NaCl crystals. To purify the iodine, a process of dissolving, filtering, collecting the filtrate, and allowing the solvent to evaporate will be carried out. Which of the following would be the most appropriate solvent for this purification process?

A. C_6H_{14}

B. HCl

C. H_2O

D. C_2H_5OH

26. Magnesium and hydrochloric acid react according to the equation below.

$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$

If 1.0 g of Mg is reacted with 10.0 mL of 6.0 *M* HCl, what volume of hydrogen gas will be produced at 25°C and 1.0 atm? (R = 0.0821 L•atm/mol•K)

A. 0.062 L

B. 0.73 L

C. 1.0 L

D. 1.5 L

27. **Use the information below to answer the question that follows.**

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

K_c = 0.0182 at 698 K for the reaction above. Which of the following correctly describes the relationship between the initial rate of the forward reaction and the initial rate of the reverse reaction if the initial concentration of HI is 0.5 *M* and the initial concentrations of H_2 and I_2 are 0.1 *M* each?

A. $\frac{\text{Rate}_{\text{forward}}}{\text{Rate}_{\text{reverse}}} > 1$

B. $\frac{\text{Rate}_{\text{forward}}}{\text{Rate}_{\text{reverse}}} < 1$

C. $\frac{\text{Rate}_{\text{forward}}}{\text{Rate}_{\text{reverse}}} = 1$

D. $\frac{\text{Rate}_{\text{forward}}}{\text{Rate}_{\text{reverse}}} = K_c$

28. If an electric current is passed through molten sodium chloride using two electrodes, which substance will be produced at the cathode?

A. sodium metal

B. sodium ions

C. chlorine molecules

D. chloride ions

29. **Use the information below to answer the question that follows.**

The following data were collected during the room temperature decomposition of chlorine oxide according to the reaction $2ClO(g) \longrightarrow Cl_2(g) + O_2(g)$.

Time (s)	[ClO] (*M*)
2.24	5.79×10^{-3}
4.00	4.77×10^{-3}

What would be the rate of appearance of oxygen gas during this reaction?

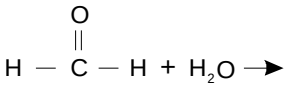
A. 2.90×10^{-4} *M*/s

B. 5.80×10^{-4} *M*/s

C. 1.02×10^{-3} *M*/s

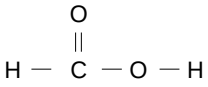
D. 1.16×10^{-3} *M*/s

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

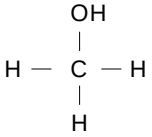


Which of the following molecules would be the primary product of the reaction shown above?

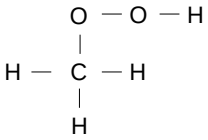
A.



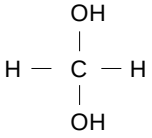
B.



C.



D.



PERIODIC TABLE OF THE ELEMENTS

1 **IA**																	18 **VIIIA**
1 **H** 1.01	2 **IIA**											13 **IIIA**	14 **IVA**	15 **VA**	16 **VIA**	17 **VIIA**	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 23.0	12 **Mg** 24.3	3 **IIIB**	4 **IVB**	5 **VB**	6 **VIB**	7 **VIIB**	8	9 **VIIIB**	10	11 **IB**	12 **IIB**	13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 39.9
19 **K** 39.1	20 **Ca** 40.1	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	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	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.	C	Understand and apply knowledge of basic scientific and mathematical skills, safe laboratory practices, and issues of public concern related to the field of chemistry.
22.	D	Understand and apply knowledge of periodic relationships and the nature of matter.
23.	C	Understand and apply knowledge of the development and central concepts of atomic theory and structure, including the quantum mechanical model.
24.	C	Understand and apply knowledge of the kinetic molecular theory and the nature and properties of molecules in the gaseous, liquid, and solid states.
25.	A	Understand and apply knowledge of the interactions of particles in solution and the properties of solutions.
26.	B	Understand and apply knowledge of the concepts and principles of chemical equations and stoichiometry.
27.	B	Understand and apply knowledge of thermodynamics and their applications to chemical systems.
28.	A	Understand and apply knowledge of electrochemistry.
29.	A	Understand and apply knowledge of the mechanisms of chemical reactions and the theory and practical applications of reaction rates.
30.	D	Understand and apply knowledge of major aspects of organic chemistry.

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 Licensure 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 license 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

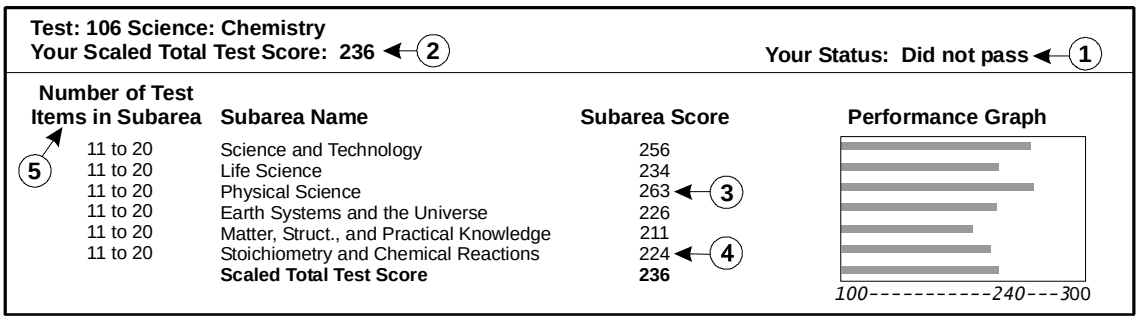
- Subarea scores are presented on the same scale as the total test score.
- Subarea scores contain different numbers of questions and are weighted differently in the computation of the total test score; therefore, the average of the subarea scaled scores generally will not equal the scaled total test 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: Chemistry test score report is provided below.



According to the above sample, the examinee did not pass the Science: Chemistry 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 Stoichiometry and Chemical Reactions 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.