
ILLINOIS LICENSURE TESTING SYSTEM

FIELD 112 SCIENCE: ENVIRONMENTAL SCIENCE TEST FRAMEWORK

November 2003

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Science and Technology
Life Science
Physical Science
Earth Systems and the Universe
The Physical and Living Environment
Environmental Issues

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.

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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.

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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 level.

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.

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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 level.

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.

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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.

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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.

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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 non-optical instruments.

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SUBAREA V—THE PHYSICAL AND LIVING ENVIRONMENT

0018 Understand and apply knowledge of the cycling of matter and flow of energy through the biotic and abiotic components of various ecosystems.

- Describe how the laws of thermodynamics apply to habitats, individual organisms, and community dynamics.
- Analyze the flow of energy from the sun on a global scale and its effects on climate and the distribution of ecosystems.
- Analyze the flow of energy through diverse ecosystems.
- Apply knowledge of the hydrologic cycle to explain its effects on natural systems and human society.
- Analyze the phosphorous, sulphur, nitrogen, and carbon dioxide/oxygen cycles and their effects at the local, regional, and global levels.
- Recognize the impact of biodiversity on the cycling of matter and the flow of energy.

0019 Understand and apply knowledge of the interactions and interdependence of Earth's biotic and abiotic systems.

- Analyze the interactions of biotic and abiotic factors in the environment and the interrelatedness of organisms to each other and to their environment.
- Analyze how population dynamics, principles of natural selection, and human activity determine the biodiversity and distribution of organisms in various environments.
- Analyze ways in which the environment has been changed by natural occurrences (e.g., catastrophic events, species migrations, disease epidemics, climate change), differentiating between short- and long-term effects.
- Analyze how changes in the physical and chemical characteristics of the lithosphere, atmosphere, and hydrosphere affect ecosystems.

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0020 Understand and apply knowledge of how social, cultural, political, and economic systems affect local, regional, and global environments.

- Analyze how social, cultural, political, and economic processes impact the environment and alter the use and management of resources.
- Analyze the effects of international competition and trade on local, regional, and global environments.
- Identify ways in which the environment has been changed by human intervention (e.g., introduction of exotics, water purification).
- Apply knowledge of the procurement and use of renewable (e.g., alternative energy, water) and nonrenewable (e.g., minerals, fossil fuels) resources to explain the ecological consequences of varying strategies for managing resources.
- Evaluate the ecological implications of various land use patterns and urban development.
- Identify natural resource conservation (e.g., source reduction, recycling) and management methods (e.g., solid waste, bioremediation) and sustainable practices that have been proposed or implemented.

SUBAREA VI—ENVIRONMENTAL ISSUES

0021 Understand and apply knowledge of the societal, economic, and cultural influences on environmental research and the environmental decision-making process.

- Apply research and analytical skills to investigate environmental issues in a social, political, and economic context.
- Evaluate the validity of information sources related to environmental issues by identifying bias and boundaries of evidence.
- Analyze how differing values (e.g., political, cultural, economic) influence decisions regarding environmental issues.
- Recognize the historical basis for positions regarding environmental rights and responsibilities.
- Evaluate proposed or implemented citizen actions with respect to their influence on achieving and/or maintaining a mutually beneficial relationship between humans and the environment.
- Identify strategies for recognizing, evaluating, and clarifying personal value positions related to specific environmental issues and their associated solutions.

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0022 Understand and apply knowledge of trends in national and global societies related to environmental quality, resource management, health issues, and environmental awareness.

- Analyze the effects of human population growth and distribution on local and global environments.
- Analyze the effects of economic development and industrialization on environmental quality and resource management.
- Analyze ways that resource management methods and technology can be used to accommodate population trends and industrial development.
- Recognize the relationship between environmental literacy and the ability to make informed decisions regarding environmental issues.
- Analyze the health effects of hazardous substances (e.g., mercury, dioxin, asbestos) in the environment.

0023 Understand and apply knowledge of the scientific strategies and criteria used to investigate environmental questions and evaluate environmental studies.

- Demonstrate knowledge of how to design scientific investigations of environmental phenomena.
- Demonstrate an understanding of the use and evaluation of models (e.g., algebraic, geometric, computer) to interpret environmental phenomena.
- Recognize procedures for the use of equipment and technologies necessary to conduct safe and appropriate studies of environmental phenomena.
- Analyze criteria used to evaluate sources of environmental information.
- Recognize degrees of bias in claims derived from scientific studies used in advertising and marketing strategies.

0024 Understand and apply knowledge of Illinois, United States, and world environmental history.

- Identify significant historical environmental events in Illinois, the United States, and the world.
- Analyze how given scientific discoveries have influenced environmental policy and public attitudes.
- Identify state, national, and world agencies that are involved in establishing or enforcing environmental regulations and policies.
- Identify significant national and global policies (e.g., Clean Water Act, Wilderness Act) on environmental issues.

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0025 Understand and apply knowledge of the actual and potential effects of local, state, national, and global policies on environmental issues.

- Compare and contrast the prevention and correction of health-threatening environmental problems by individuals and by governments.
- Analyze the arguments for and against various pollution-control policies and conservation measures.
- Analyze the environmental consequences of government energy policies.
- Evaluate the political and economic difficulties confronting ecosystem protection and pollution control in industrialized and nonindustrialized countries.