ILLINOIS LICENSURE TESTING SYSTEM

FIELD 108 SCIENCE: EARTH AND SPACE SCIENCE

TEST FRAMEWORK

November 2003

Illinois Licensure Testing System

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Science and Technology
Life Science
Physical Science
Earth Systems and the Universe
The Earth and Atmosphere
Astronomy

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 the 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—THE EARTH AND ATMOSPHERE

0018 Understand and apply knowledge of the geologic processes and structure of Earth.

- Relate the dynamic processes that occur in Earth's interior to their causes (e.g., thermal convection) and effects (e.g., earthquakes, volcanic eruptions).
- Identify the basic principles of plate tectonic theory, supporting evidence for the theory, and the mechanisms of plate dynamics.
- Relate the features and landforms of Earth's surface to the processes that shape them (e.g., uplift, erosion).
- Use a geologic column or block diagram to interpret the geologic history of a particular area.
- Demonstrate and explain strategies that are used to identify and classify rocks and minerals.
- Identify and describe characteristics of various rock types and minerals and how they are formed.

0019 Understand and apply knowledge of the historical evolution of Earth's features and life forms through geologic time.

- Recognize the scope of geologic time by distinguishing between the human time scale and the geologic time scale.
- Identify methods and technologies used to study Earth's history (e.g., relative and absolute dating techniques) leading to the divisions of geologic time.
- Analyze evidence for hypotheses and theories regarding Earth's origins and the evolution of Earth's features and life forms (e.g., paleontology, paleoclimatology, paleogeology).
- Describe how rock strata and fossils lead to inferences about geological environments and climatic conditions.

0020 Understand and apply knowledge of the transfer of energy and cycling of elements and compounds in Earth systems.

- Identify chemical reservoirs for various elements and compounds (e.g., carbon, nitrogen, water).
- Trace the cycle of various elements and compounds through the lithosphere, hydrosphere, biosphere, and atmosphere.
- Analyze the factors and interpret data that indicate the transfer of energy within and among Earth's land, water, and atmospheric systems (e.g., ocean currents and temperatures, surface albedo, atmospheric circulation).
- Describe the interrelationships among land, water, and atmospheric systems and how these relationships explain various natural processes, cycles, and events (e.g., weather and climate systems, El Niño events).
- Identify factors, including human activities, that affect the cycling of elements and compounds in Earth systems (e.g., volcanic eruptions, agriculture practices, logging, fossil fuels).

0021 Understand and apply knowledge of the structure and processes of the hydrosphere and atmosphere.

- Describe the physical and chemical nature of water and its influence on the lithosphere, hydrosphere, biosphere, and atmosphere.
- Demonstrate knowledge of the characteristics of oceans (e.g., currents, tides, nutrient availability) and freshwater systems (e.g., lakes, aquifers, glaciers).
- Analyze atmospheric data (e.g., temperature, barometric pressure, relative humidity, dew point) and how it correlates to weather patterns, climatic conditions, severe weather, and cloud development.
- Explain historic and current technologies and tools associated with data collection and interpretation of meteorologic and climatologic research and predictions.

0022 Understand and apply knowledge of interactions between humans and Earth systems.

- Identify the types and characteristics of Earth's renewable and nonrenewable resources and the methods employed to preserve or conserve them.
- Recognize the effects of human activities (e.g., development of urban areas, use of fossil fuels, production of ozone-depleting compounds) on the whole earth (e.g., global climate, water pollution, species destruction, erosion).
- Analyze how the use of natural resources affects human society economically, socially, and environmentally.
- Recognize the effects of Earth processes on human societies through time (e.g., flooding, earthquakes, volcanic eruptions).
- Analyze the use, quality, and scarcity of global freshwater resources, including protection and conservation measures.

SUBAREA VI—ASTRONOMY

0023 Understand and apply knowledge of the characteristics and formation of the planets and solar system.

- Analyze the effects of gravitational force in the solar system.
- Identify the general characteristics (e.g., atmospheric, geological, orbital data) of the sun, the planets, and their satellites.
- Identify the characteristics and orbital nature of comets, asteroids, and meteoroids.
- Recognize the scientific basis for understanding various atmospheric, solar, and celestial phenomena (e.g., eclipses, seasons, phases of the moon, relative and apparent motions of objects), meteors, and auroras.
- Recognize historical models of the solar system and the historical development of understanding about the solar system.

0024 Understand and apply knowledge of stellar evolution, characteristics of stars and galaxies, and the formation of the universe.

- Recognize characteristics of various star types, including all the stages and processes of stellar evolution.
- Analyze evidence regarding the chemical composition and physical characteristics of stellar and galactic objects.
- Evaluate the characteristics and supporting evidence for the various theories of cosmology and cosmogony.
- Recognize the historical progression of astronomy and the physical laws that govern it.

0025 Understand and apply knowledge of the history and methods of astronomy and space exploration.

- Demonstrate knowledge of the relationship between latitude and the apparent position and motion of celestial objects.
- Describe the various technologies used to observe and explore space (e.g., various types of telescopes, deep-space probes, artificial satellites) and the scientific laws that govern space flight.
- Recognize the scope and scale of astronomical time and distance.
- Recognize the historical technologies used to determine distance and time and their impact on civilization and progress.
- Describe the historic progression of space exploration and the technologies that made it possible.