National Evaluation Series

Test Framework

Earth and Space Science (825)

December 2024

Multiple Choice

Subarea	Range of Objectives	Approximate Percentage of Test Score
I. Earth's Place in the Universe	0001–0002	10%
II. Earth's Systems: Geosphere	0003–0005	20%
III. Earth's Systems: Hydrosphere, Atmosphere, Weather, and Climate	0006–0008	30%
IV. Earth and Human Activity	0009–0011	20%
Total	0001–0011	**80%**

Open Response

Subarea	Range of Objectives	Approximate Percentage of Test Score
V. Integration of Knowledge and Understanding		
Key Scientific Concepts	0012	10%
Application of Science Practices	0013	10%
Total	0012–0013	**20%**

MATTER AND ITS INTERACTIONS

0001: Analyze the structure of the universe.

- Interpret evidence for the Big Bang theory (e.g., red shift, cosmic microwave background radiation, hydrogen-helium ratio).
- Demonstrate knowledge of the types and characteristics of objects in the universe (e.g., nebulae, galaxies, black holes, quasars, pulsars).
- Demonstrate knowledge of the formation and characteristics of stars; the relationship between the life span of a star and the processes occurring in stars that produce elements (e.g., nuclear fusion, nucleosynthesis); and energy transfer within the Sun and between the Sun and Earth.
- Apply knowledge of data, methods, and technologies (e.g., optical and radio telescopes, space probes, spectroscopy) used to understand the size, structure, and motions of objects in the universe.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the structure of the universe, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0002: Demonstrate knowledge of the solar system and the interactions of Earth, the Moon, and the Sun.

- Demonstrate knowledge of the formation and early history of the solar system and the location and characteristics of objects within the solar system (e.g., planets, comets, asteroids, moons).
- Apply knowledge of Newton's and Kepler's laws and how orbits may change due to the gravitational effects from, or collisions with, other objects.
- Analyze how interactions between Earth and the Sun produce the cyclical pattern of seasons, Earth's tilt, and differences in the intensity of sunlight throughout the year.
- Analyze how a planet's distance from the Sun creates conditions conducive for life (i.e., habitable zone).
- Analyze how the interactions between Earth, the Moon, and the Sun produce lunar phases, eclipses, and tides.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the solar system and the interactions of Earth, the Moon, and the Sun, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

EARTH'S SYSTEMS: GEOSPHERE

0003: Apply knowledge of the geologic history of Earth.

- Demonstrate knowledge of how Earth has changed on the global scale since Earth's origin; key events in Earth's history (e.g., formation of Earth's crust and oceans, emergence of life and formation of oxygen-rich atmosphere, mass extinctions, continental glaciations); the causes of those events; and their consequences for Earth's geosphere, hydrosphere, atmosphere, and biosphere.
- Apply knowledge of the geologic timescale, absolute and relative dating, fossilization processes, and the fossil record, including the use of index fossils.
- Apply the principles of stratigraphy (e.g., law of original horizontality, principle of superposition, principle of crosscutting relationships), including in the interpretation of the geologic history of rock strata.
- Demonstrate knowledge of Earth's surface features, including their formation, how they have changed over time, and the forces that continue to impact them.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the geologic and biological history of Earth, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0004: Analyze plate tectonics.

- Demonstrate knowledge of the structure and composition of Earth's interior and of the methods and technology used to collect evidence of Earth's interior.
- Demonstrate knowledge of the mechanisms that drive the convection that cycles the Earth's crust and of the direction of movement of heat, energy, and matter through Earth's interior (e.g., outward flow of energy, gravitational movement of denser materials).
- Demonstrate knowledge of the theory of plate tectonics, the evidence of past and current movements of the crust (e.g., distribution of fossils and rocks, past climatic zones, continental shapes, seafloor structures), and the spatial and temporal scale of plate tectonic activity.
- Analyze interactions of tectonic plates (e.g., seafloor spreading, subduction of oceanic plates due to relative densities of rocks, collision of continental plates) and their effects (e.g., melting, crystallization, weathering, deformation).
- Analyze the geologic and topographic features that result from plate boundary interactions and other tectonic processes (e.g., seamounts, ocean trenches, rift valleys, intrusions, mid-ocean ridges, mountain building, active volcanic chains, hot spots).
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to plate tectonics, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0005: Apply knowledge of Earth materials.

- Apply knowledge of the formation and characteristics of common rocks and minerals and methods used to identify common rock-forming minerals (e.g., hardness, cleavage).
- Demonstrate knowledge of processes that drive the rock cycle and the formation and characteristics of sedimentary, igneous, and metamorphic rocks.
- Apply knowledge of the processes of mechanical, chemical, and biological weathering and of soil formation, including factors that affect the rate at which rocks weather.
- Demonstrate knowledge of the processes of erosion by various agents (e.g., wind, water, glaciers) and factors that affect erosion rates and patterns.
- Apply knowledge of depositional processes and the topographic features (e.g., beaches, dunes, mesas, valleys, moraines) that are formed by various agents of weathering, erosion, and deposition.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to Earth materials, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

EARTH'S SYSTEMS: HYDROSPHERE, ATMOSPHERE, WEATHER, AND CLIMATE

0006: Demonstrate knowledge of the hydrologic cycle and water systems.

- Demonstrate knowledge of the chemical and physical properties of water, how these properties affect Earth materials and surface processes, and changes of state and associated energy changes of water.
- Apply knowledge of the hydrologic cycle, processes that move water through the cycle (e.g., energy of the Sun, Earth's gravity, condensation, evaporation, transpiration) and factors that affect the distribution of water over space and time (e.g., temperature fluctuations, glaciations).
- Demonstrate knowledge of types and characteristics of surface-water reservoirs (e.g., oceans, lakes, streams, glaciers) and groundwater reservoirs (e.g., aquifers, water table) and factors that affect the movement of water through these systems (e.g., gradient, topography, porosity, permeability).
- Demonstrate knowledge of the physical and chemical characteristics of ocean water, the causes and characteristics of ocean waves, the characteristics of ocean layers and zones (e.g., benthic, pelagic), and ocean circulation and currents (e.g., thermohaline circulation, surface currents), including factors that influence currents.
- Apply knowledge of the interaction of the hydrosphere with other Earth systems (e.g., weathering, ocean absorption and retention of heat, clouds, albedo effect), including how one change to Earth's hydrosphere can create feedback loops.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the hydrologic cycle and water systems, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0007: Analyze the atmosphere and atmospheric processes.

- Analyze the composition and layered structure of the atmosphere, the properties of each layer, and reasons for differences in these properties.
- Analyze how various wavelengths of radiation are affected as they enter and pass through the atmosphere and are absorbed by and radiated from Earth's surface.
- Demonstrate knowledge of the how composition of the atmosphere affects absorption of radiation from Earth's surface and heats the atmosphere (i.e., natural greenhouse effect).
- Apply knowledge of the sources of atmospheric energy (e.g., insolation, terrestrial radiation, latent heat of water) and the processes by which energy is transferred to and within the atmosphere (e.g., radiation, convection, conduction).
- Demonstrate knowledge of factors responsible for the generation of winds (e.g., uneven heating), global wind patterns, and prevailing wind speed and direction (e.g., Coriolis effect, barriers, elevation).
- Apply knowledge of the interaction of the atmosphere with other Earth systems (e.g., erosion, climate, weather patterns), including how one change to Earth's atmosphere can create feedback loops.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the atmosphere and atmospheric processes, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0008: Demonstrate knowledge of weather and climate, including regional phenomena.

- Demonstrate knowledge of the differences between weather and climate.
- Apply knowledge of types and characteristics of low- and high-pressure zones and air masses, their formation and patterns of movements, and the kinds of fronts that form as a result of air-mass interactions.
- Demonstrate knowledge of factors that affect regional weather (e.g., influence of ocean temperature, ocean currents, land–ocean contrast, position of jet streams, topography), including factors and conditions that lead to severe weather.
- Demonstrate knowledge of the relationship of patterns of air-mass interactions and other factors and conditions to the formation of local weather (e.g., fog, clouds, inversions, different types of precipitation).
- Apply knowledge of the characteristics and distribution of current major climatic regions.
- Demonstrate knowledge of factors that affect regional climates over different time scales (e.g., flow of energy into and out of Earth's systems, latitude, wind patterns, topography), the relationship of climate and weather, and the causes of past changes in climate (e.g., Milankovitch cycles).
- Demonstrate knowledge of the application of weather and climate models and data, instruments and methods that are used to gather weather and climate data (e.g., Earth-observing satellites, tree-ring data, ice cores), and the interpretation of weather maps and symbols.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to weather and climate, including regional phenomena, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

EARTH AND HUMAN ACTIVITY

0009: Apply knowledge of geochemical cycles, natural resources, and sources of energy.

- Demonstrate knowledge of the cycling of elements (e.g., carbon, nitrogen) through Earth's geosphere, hydrosphere, atmosphere, and biosphere, as well as factors that affect the movement of those elements through each cycle.
- Demonstrate knowledge of key renewable and nonrenewable natural resources (e.g., soil, wood, minerals), their distribution as a result of natural processes, and how these resources have influenced human activity.
- Apply knowledge of the extraction, transport, and use of nonrenewable natural resources (e.g., precious metals, minerals, ores, fossil fuels) and of the effects of these processes on local, regional, and global environments.
- Evaluate renewable (e.g., wind, solar) and nonrenewable (e.g., fossil fuels, nuclear) sources of energy.
- Apply knowledge of the relationship of the management of natural resources and energy sources to biodiversity; economic, social, and environmental cost-benefit ratios; and the sustainability of human populations.
- Evaluate strategies for managing natural resources and energy sources effectively (e.g., conservation, recycling) and for minimizing negative impacts of developing and using these resources.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to geochemical cycles, natural resources, and sources of energy, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0010: Analyze the types of natural and human-influenced hazards and their impacts on human populations.

- Identify the types and characteristics of climatic fluctuations (e.g., El Niño-Southern Oscillation), natural hazards, and catastrophic events (e.g., earthquakes, tsunamis, volcanic eruptions, floods, tornadoes, hurricanes).
- Analyze the effects of natural hazards on human populations and societies (e.g., mortality, displacement of people, property damage, short- and long-term social disruption).
- Demonstrate knowledge of methods and technologies (e.g., strainmeters, Global Positioning System and weather satellites) used to forecast the location and likelihood of future natural hazards and catastrophic events.
- Demonstrate knowledge of factors (e.g., release of carbon dioxide, volcanic gases) that have resulted in atmospheric and climate changes and the use of global and regional climate models to forecast climate change.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to natural and human-influenced hazards, their impacts on human populations, and strategies for mitigating their effects, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0011: Analyze the effects of human activities on Earth systems and strategies for mitigating their effects.

- Analyze how human population sizes and consumption levels vary regionally and differentially affect Earth systems.
- Apply knowledge of how human activities and technologies can mitigate the impact on the environment of increases in human population and per capita consumption of natural resources.
- Analyze how human activities affect the lithosphere (e.g., erosion, fracking, pollution from mining) and strategies for monitoring, limiting, and mitigating these effects.
- Analyze how human activities affect the hydrosphere (e.g., water pollution, depletion of aquifers, destruction of wetlands) and strategies for monitoring, limiting, and mitigating these effects.
- Analyze how human activities affect the atmosphere (e.g., release of greenhouse gases, aerosols, soot, acid precipitation) and strategies for monitoring, limiting, and mitigating these effects.
- Apply knowledge of global climate change to determine potential future impacts to Earth systems and strategies for slowing climate change and mitigating its effects.
- Analyze how human activities affect the biosphere (e.g., loss of biodiversity, introduction of invasive species, changes in land use, degradation of air and water, ocean acidification) and strategies for monitoring, limiting, and mitigating these effects.
- Analyze how changes in one Earth system due to human activities may induce changes in other Earth systems (e.g., reduced albedo from atmospheric black carbon particles leads to a loss of sea ice, more open water, and increased atmospheric water vapor).
- Analyze strategies for limiting or mitigating the effects of catastrophic events on human communities.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the effects of human activities on Earth systems and strategies for mitigating their effects, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

INTEGRATION OF KNOWLEDGE AND UNDERSTANDING

0012: Prepare an organized, developed analysis of a key topic in Earth science related to Earth's Place in the Universe or Earth's Systems: Geosphere.

- Describe the key scientific concepts that relate to a given topic.
- Use a representative graph, formula, and/or diagram with all proper labels to model the presented topic.
- Discuss how a specific science and engineering practice (e.g., developing and using models, constructing explanations, designing solutions) could be used to help students understand phenomena related to the given topic.

0013: Prepare an organized, developed analysis of a key topic in Earth science related to Earth's Systems: Hydrosphere, Atmosphere, Weather, and Climate or Earth and Human Activity that emphasizes the application of science and engineering practices in a classroom setting.

- Form a testable scientific claim that addresses a given topic.
- Plan a scientific investigation, including safety considerations, to test the proposed claim, including identifying variables and controls.
- Describe a possible result provided by collected data and provide reasoning about how the collected data provide evidence that supports or refutes the tested claim.
- Discuss how a specific science and engineering practice (e.g., developing and using models, planning and carrying out investigations) could be used to help students make sense of phenomena related to the given topic.