
**NEW YORK STATE TEACHER
CERTIFICATION EXAMINATIONS™**

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

June 2003

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Subarea

	Selected-Response	Range of Objectives
I.	Foundations of Scientific Inquiry	0001–0007
II.	Space Systems	0008–0012
III.	Atmospheric Systems	0013–0018
IV.	Geological Systems	0019–0022
V.	Water Systems	0023–0025
	Constructed-Response	
VI.	Geological Systems: Constructed-Response Assignment	0019–0022

NEW YORK STATE TEACHER CERTIFICATION EXAMINATIONS™

FIELD 08: EARTH SCIENCE TEST FRAMEWORK

Foundations of Scientific Inquiry
Space Systems
Atmospheric Systems
Geological Systems
Water Systems
Geological Systems: Constructed-Response Assignment

The New York State earth science educator has the knowledge and skills necessary to teach effectively in New York State public schools. The earth science teacher is a skilled problem solver who understands the historical development of ideas in science and the connections among science, mathematics, and technology. The earth science teacher knows how to access, generate, process, and transfer information using appropriate technologies and can apply knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions. Most importantly, the earth science teacher understands the process of scientific inquiry and applies scientific concepts, principles, and theories to pose questions, seek answers, and communicate explanations of natural phenomena.

SUBAREA I—FOUNDATIONS OF SCIENTIFIC INQUIRY

0001 Understand the general relationships and common themes that connect mathematics, science, and technology.

For example:

- analyzing similarities among systems in mathematics, science, and technology (e.g., magnitude and scale, equilibrium and stability, optimization)
- applying concepts and theories from mathematics, biology, chemistry, and physics to an earth science system
- analyzing the use of earth science, mathematics, and other sciences in the design of a technological solution to a given problem
- using a variety of software (e.g., spreadsheets, graphing utilities, statistical packages, simulations) and information technologies to model and analyze problems in mathematics, science, and technology

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0002 Understand the historical and contemporary contexts of the earth sciences and their application to everyday life.

For example:

- analyzing the significance of key events in the history of the earth sciences (e.g., the development of solar system models, the discovery of a galactic universe, the development of the plate tectonics model)
- recognizing the impact of society on the study of the earth sciences (e.g., increasing commercial demand for more accurate meteorological analyses; growing populations in earthquake-prone regions; expanding markets for oil, gas, and other nonrenewable resources)
- assessing the implications for society of earth science phenomena in a variety of regions (e.g., volcanoes, earthquakes, erosion, rising sea levels)
- analyzing Earth's hazards (e.g., earthquakes, volcanoes, hurricanes, tornadoes, drought) and their effects upon humans to develop plans for emergency preparedness
- recognizing the applications of earth-science-related technology to everyday life (e.g., GPS, weather satellites, cellular communication)

0003 Understand the process of scientific inquiry and the role of observation and experimentation in explaining natural phenomena.

For example:

- analyzing processes by which scientific knowledge develops
- assessing the appropriateness of a specified experimental design to test a given hypothesis
- assessing the role of communication among scientists in promoting scientific progress

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0004 Understand the processes of gathering, organizing, reporting, and interpreting scientific data; and apply this understanding in the context of earth science investigations.

For example:

- evaluating the appropriateness of a given method or procedure for collecting data for a specified purpose
- selecting an appropriate and effective graphic representation (e.g., graph, table, diagram) for organizing, analyzing, and reporting given data
- applying procedures and criteria for reporting investigative procedures and data
- analyzing relationships between factors (e.g., cyclic, inverse, direct, linear) as indicated by data

0005 Understand types and uses of natural resources, the effects of human activities on the environment, and the need for stewardship to preserve the environmental integrity of Earth systems.

For example:

- demonstrating an understanding of the uses and importance of natural resources
- recognizing methods of locating and obtaining natural resources
- assessing the positive and negative effects of human activities (e.g., mining, waste disposal) on Earth's environment
- evaluating strategies for dealing with environmental concerns (e.g., buying and selling carbon credits)

0006 Understand how to create, use, and interpret physical and mathematical models (e.g., maps, charts, graphs, diagrams, equations) commonly used in earth science.

For example:

- evaluating the appropriateness of alternative models for conveying given information from earth science
- demonstrating an understanding of the methods by which given physical and graphic models are created
- classifying different types of maps (e.g., topographic, star charts, weather) used in earth science and analyzing the information conveyed by each type of map
- interpreting diagrams relating to earth science (e.g., cross-sections, seismic wave graphs)

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0007 Understand equipment and materials used in earth science investigations, and apply procedures for their proper and safe use.

For example:

- identifying the principles upon which given instruments (e.g., telescope, spectroscope, compass) are based
- demonstrating knowledge and applications of basic safety procedures in laboratory and field situations

SUBAREA II—SPACE SYSTEMS

0008 Understand the structure, composition, and features of Earth, the Moon, and the Sun.

For example:

- demonstrating an understanding of the physical characteristics of Earth (e.g., diameter, tilt of axis, distance from the Sun) and how they can be determined
- identifying characteristics of the Sun (e.g., nucleogenesis)
- relating surface features of Earth's moon (e.g., maria, craters, mountains) to events in the history of the Moon
- recognizing the importance of density in the formation of the internal structure of Earth, the Moon, and the Sun

0009 Understand the interactions among the components of the Earth, Moon, and Sun system (including energy transmission and absorption).

For example:

- demonstrating an understanding of the consequences of Earth's relative position and motion with respect to the Sun (e.g., length of day, change of seasons, length of year)
- relating Earth's coordinate system (e.g., latitude and longitude) to astronomical observations
- analyzing the consequences of the relative positions and motions of Earth, the Moon, and the Sun (e.g., phases of the Moon, tides, eclipses)
- demonstrating an understanding that the Sun is the major source of energy for Earth's surface
- analyzing the Sun's activity (e.g., sunspots, solar flares) and its possible effects on Earth

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0010 Understand the scale and organization of the solar system, the role of gravity in the solar system, and characteristics of the bodies within the solar system.

For example:

- analyzing characteristics of the planets (e.g., size, density, inferred interior structure, surface temperature)
- analyzing the apparent motion of celestial objects to infer solar system models (i.e., geocentric and heliocentric)
- recognizing physical and mathematical models (e.g., Newton's and Kepler's laws) that describe objects in the solar system and their real and apparent motions

0011 Understand the properties, motions, and life cycles of stars and the methods and technology used to study them.

For example:

- comparing and contrasting types of telescopes (e.g., optical, radio, infrared, ultraviolet) and the ways in which they are used to acquire information on star characteristics
- comparing and contrasting types of stars (e.g., pulsars, Cepheid variables) and their characteristics
- using the Hertzsprung-Russell (H-R) diagram to analyze the life cycle of stars
- analyzing stellar life cycles to understand the formation and initial development of the solar system

0012 Understand evidence regarding the origin, age, size, structure, scale, and motions of the universe, the Milky Way galaxy, and the solar system.

For example:

- analyzing evidence for the location of the solar system within the Milky Way galaxy
- analyzing historical methods of inferring the size, structure, and motions of the galaxy and the solar system (e.g., star observations and counts)
- analyzing the evidence for current theories of the origin and evolution of Earth, the solar system, and the universe (e.g., Big Bang, inflation)
- analyzing types of evidence used to infer scales of the solar system, the Milky Way galaxy, and the universe (e.g., in relation to relative size and distance)
- recognizing the historical, present, and future role of technology and exploration in obtaining knowledge about the universe

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

SUBAREA III—ATMOSPHERIC SYSTEMS

0013 Understand the composition, structure, and properties of Earth's atmosphere and the mechanisms and effects of energy transfer involving the Earth-atmosphere system.

For example:

- comparing and contrasting properties of the atmosphere (e.g., density, composition, temperature) from Earth's surface through the thermosphere and understanding the significance of changes in these properties
- analyzing how various wavelengths of solar radiation (e.g., ultraviolet, visible light, infrared) are affected as the radiation enters and passes through the atmosphere and is absorbed and re-radiated from Earth's surface
- analyzing the processes by which energy is transferred to and within the atmosphere (e.g., radiation, convection, conduction)
- analyzing global wind patterns in terms of latitudinal and altitudinal variations in insolation and the Coriolis effect

0014 Understand the properties of water, conditions in the atmosphere that result in phase changes, and the energy relationships of phase changes to cloud formation and precipitation.

For example:

- relating the physical properties of water (e.g., high specific heat, surface tension) to the chemical structure and properties of water molecules
- analyzing energy changes involved in the transition between phases of water (e.g., latent heat)
- analyzing atmospheric conditions under which fog and clouds with various characteristics form (e.g., adiabatic temperature changes, dew point, atmospheric stability)
- understanding conditions under which precipitation forms and predicting the type of precipitation that will fall to Earth's surface under given conditions

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0015 Understand characteristics of weather systems and local weather, the relationship between them, and the methods and instruments used to collect and display weather data.

For example:

- interpreting symbols used on weather maps and analyzing the methods used to generate weather maps (e.g., computer models)
- analyzing types and characteristics of air masses, their movements, and the kinds of fronts that form between air masses
- analyzing the relationship between the jet stream and weather
- analyzing the horizontal and vertical movements of surface air in high-pressure and low-pressure systems
- analyzing the effects of the relationship between land and water on weather (e.g., lake-effect snow, land and sea breezes)
- demonstrating an understanding of the use of weather instruments (e.g., thermometer, barometer, psychrometer) for collecting given types of weather data

0016 Understand the impact of weather on humans and the principles and technology of weather forecasting.

For example:

- analyzing the use of weather models in forecasting
- predicting weather in a given location based on one or more weather maps
- evaluating the role of computers, satellites, and radars in weather forecasting
- analyzing types and effects of hazardous weather to determine appropriate precautions and demonstrating an understanding of the role of weather services in issuing weather alerts
- analyzing the impact of weather on humans in different climatic regions

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0017 Understand the locations and characteristics of Earth's major climatic regions and analyze factors that affect local climate and the relationship between weather and climate.

For example:

- inferring the climatic zone in which a given area is located based on temperature and precipitation data
- analyzing factors that affect the climate in a given region (e.g., insolation, water vapor, wind patterns, topography)
- analyzing the relationship between the climate of a region and its weather
- recognizing seasonal changes in weather in various world regions and analyzing factors that influence these changes (e.g., insolation, ocean current patterns)

0018 Understand the impact of human activities and natural processes on the atmosphere, theories about the long-range effects of human activities on global climate, and methods of controlling and minimizing these effects.

For example:

- identifying common air pollutants (e.g., sulfur dioxide, chlorofluorocarbons) and their sources and demonstrating an understanding of the effects of air pollutants and atmospheric chemical reactions involving these pollutants
- demonstrating an understanding of factors that affect local air pollutant concentrations (e.g., population density)
- analyzing theories of global climate change (e.g., greenhouse effect, glaciation)

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

SUBAREA IV—GEOLOGICAL SYSTEMS

0019 Understand geochemical systems, the processes of mineral and rock formation, and the characteristics of different types of minerals and rocks and the methods used to identify and classify them.

For example:

- demonstrating the ability to utilize a classification scheme (e.g., based on physical properties, crystal structure, chemical composition) to identify common rock-forming minerals
- analyzing the processes by which different kinds of rocks are formed (e.g., rock cycle)
- classifying a given rock as sedimentary, igneous, or metamorphic

0020 Understand the structure of Earth, the dynamic forces that shape its surface, theories and evidence of crustal movements, and the effects of crustal movements on landscapes.

For example:

- demonstrating an understanding of how Earth's internal structure can be inferred from the behavior of seismic waves
- relating lithospheric plate movements to circulation in the mantle
- analyzing evidence for seafloor spreading and plate tectonics (e.g., magnetic reversals)
- applying the theory of plate tectonics to explain ocean floor topography, landscape development, and geologic phenomena (e.g., volcanism, earthquakes) and to predict plate motions

0021 Understand weathering-erosional-depositional processes that change Earth's surface and the relation between these processes and landscape development.

For example:

- demonstrating an understanding of the processes of mechanical/ physical, chemical, and biological weathering and factors that affect the rate at which rocks weather and soils are produced
- demonstrating an understanding of the processes of erosion by various agents (e.g., wind, water, glaciers) and factors that affect erosion rates and patterns
- relating depositional patterns to the properties of the transported particles
- demonstrating an understanding of the processes by which given landscape features are formed

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0022 Understand characteristics of the major geologic time divisions and theories and supporting evidence regarding Earth's geologic history and the evolution of life.

For example:

- applying the principles of stratigraphy (e.g., principle of original horizontality, principle of superposition) to interpret diagrams of rock strata
- demonstrating an understanding of the principles, applications, and limits of radioactive dating
- comparing and contrasting the environmental conditions and characteristic fossils of the various geologic periods
- using stratigraphic and paleontological information to infer the geologic history of a given area
- applying the fossil record as evidence for evolutionary change

SUBAREA V—WATER SYSTEMS

0023 Understand the processes by which water moves through the hydrologic cycle, and use this knowledge to analyze local water budgets.

For example:

- analyzing the components of the hydrologic cycle (e.g., evaporation, runoff, transpiration, infiltration)
- evaluating the effects of various factors (e.g., vegetation, gradient, rock characteristics) on components of a local water budget
- analyzing the energy transformations that occur as water moves through the hydrologic cycle

**FIELD 08: EARTH SCIENCE
TEST FRAMEWORK**

0024 Understand the processes by which water moves on and beneath Earth's surface.

For example:

- analyzing the role of the hydrologic cycle in shaping Earth's surface
- analyzing the factors affecting the flow of water in streams (e.g., discharge, sediment load, cross-sectional shape)
- analyzing factors affecting the movement of groundwater (e.g., permeability, aquifers, gradient)
- analyzing a cross-sectional diagram of a water table and surrounding regolith and bedrock to predict the movement of groundwater and the behavior of wells
- analyzing the interactions between groundwater and surface water (e.g., springs, swamps, marshes)

0025 Understand the structure, composition, and properties of Earth's oceans and the causes and properties of currents and waves.

For example:

- analyzing the composition of seawater (e.g., elements, dissolved gases, salinity)
- analyzing the relationship between the physical properties of ocean water (e.g., temperature, pressure, density, light) and depth
- analyzing forces that affect ocean currents (e.g., Coriolis effect, wind, density)
- analyzing the effects of waves and changing sea levels on coastline formation

SUBAREA VI—GEOLOGICAL SYSTEMS: CONSTRUCTED-RESPONSE ASSIGNMENT

The content to be addressed by the constructed-response assignment is described in Subarea IV, Objectives 19–22.