NEW YORK STATE TEACHER CERTIFICATION EXAMINATIONS™

FIELD 162: EARTH SCIENCE

TEST DESIGN AND FRAMEWORK

June 2018

Authorized for Distribution by the New York State Education Department

This test design and framework document is designed to provide information about the content and format of a test for the New York State Teacher Certification Examinations™ (NYSTCE®) program. Education faculty and administrators at teacher preparation institutions may also find the information in this framework useful as they discuss the test with candidates. All test components may differ from those presented here. Furthermore, review of this framework, in whole or in part, does not guarantee an increased likelihood of success on any of the New York State Teacher Certification Examinations. The NYSTCE program is subject to change at the sole discretion of the New York State Education Department, and any changes will fully supersede the information presented in this document. As a reminder, candidates are responsible for contacting their certification officer(s) regarding any changes to the New York State Teacher Certification Examinations.

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FIELD 162: EARTH SCIENCE

TEST DESIGN

This test consists of selected-response items measuring content knowledge and one extended constructed-response item measuring pedagogical content knowledge. The constructed-response item is scenario-based and requires candidates to describe an instructional strategy to guide all students in achieving a specific learning goal, assess student understanding, and identify students' strengths and needs.

The selected-response items count for 80% of the total test score and the constructed-response item counts for 20% of the total test score, as indicated in the table that follows. Each selected-response item counts the same toward the total test score. The percentage of the total test score derived from the constructed-response item is also indicated in the table that follows.

The total testing time is 195 minutes. Candidates are free to set their own pace during the test administration. The following estimates were used to determine the total test time:

- The selected-response items are designed with the expectation of a response time up to 135 minutes.
- The constructed-response item is designed with the expectation of a response time up to 60 minutes.

Further information regarding the content of each competency can be found in the test framework.

Competency	Selected-Response		Constructed-Response	
	Approximate Number of Items	Approximate Percentage of Test Score	Number of Items	Approximate Percentage of Test Score
0001 Space Systems	18	16%	--	--
0002 Earth Materials and the History of Earth	18	16%	--	--
0003 Geologic Systems	18	16%	--	--
0004 Water, Weather, and Climate	18	16%	--	--
0005 Human Impacts and Sustainability	18	16%	--	--
0006 Pedagogical Content Knowledge	--	--	1	20%
Total	**90**	**80%**	**1**	**20%**

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Space Systems
Earth Materials and the History of Earth
Geologic Systems
Water, Weather, and Climate
Human Impacts and Sustainability
Pedagogical Content Knowledge

The New York State Earth science teacher has the knowledge and skills necessary to teach effectively in New York State schools. The Earth science teacher understands and applies current education research on how students learn science. The Earth science teacher demonstrates mastery of the content and concepts of Earth science, is a skilled problem solver, and demonstrates strong mathematics and literacy skills. The Earth science teacher applies the three-dimensional approach (i.e., disciplinary core ideas, crosscutting concepts, science and engineering practices) to science instruction in order to explain phenomena, solve real-world problems, and make informed decisions. The Earth science teacher has a broad understanding of the disciplinary core ideas in Earth science and the crosscutting concepts between science disciplines. In addition, the Earth science teacher understands science and engineering practices and applies scientific concepts, principles, and theories to develop and use models; plan and carry out investigations; analyze and interpret data; engage in argument from evidence; and obtain, evaluate, and communicate scientific and technical information from a variety of source types. The Earth science teacher knows, demonstrates, and implements policies and procedures to ensure laboratory safety and ethical practices.

As used in this document, the term "research-based" refers to those practices that have been shown to be effective in improving learner outcomes through systematic observation or experiment, rigorous data analysis, ability to replicate results, and publication in a peer-reviewed journal.

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COMPETENCY 0001—SPACE SYSTEMS

Performance Expectations

The New York State Earth science teacher understands and applies the disciplinary core ideas of astronomy. The teacher applies knowledge of the universe, solar system, stars, and planets to analyze complex phenomena resulting from the interaction of the different components of the universe and solar system. The teacher connects the evidence for a particular phenomenon with the research and technology that were involved in gathering the evidence and effectively evaluates evidence to determine whether it supports a stated hypothesis or conclusion. The teacher applies relevant laws, principles, and mathematics and computational representations to analyze astronomical phenomena. The teacher applies knowledge of the formation of Earth in the larger context of the evolution of the solar system. In addition, the teacher understands how to plan and safely carry out scientific investigations, understands the process of engineering design in refining a solution to a problem, interprets scientific information, and evaluates specific claims made about scientific phenomena related to space systems.

Performance Indicators

a. demonstrates knowledge of current theories of the origin and evolution of the solar system and universe and supporting evidence, such as light spectra, motion of distant galaxies, and composition of all types of matter in the universe

b. applies knowledge of the role of gravity on the position and motion of all objects in the solar system and universe (e.g., Newton's law of gravitation, Kepler's laws), including the use of mathematical representations

c. demonstrates knowledge of different types of stars and galaxies; stellar life cycles, including that of the Sun; nucleosynthesis; mechanisms that allow energy from the Sun to reach Earth and factors that affect the Sun's radiation (e.g., solar flares); and the use of models such as the Hertzsprung-Russell (H-R) diagram

d. analyzes data, methods, and technologies used to determine and infer the size, scale, proportion, structure, and motions of objects in the solar system and universe

e. analyzes how the relative motions and interactions of the Sun, Earth, and Moon result in the observed patterns of phases of the Moon, eclipses, and tides

f. demonstrates knowledge of how Earth's revolution and tilt result in seasonal changes

g. demonstrates knowledge of the celestial sphere model and how Earth's orbit and rotation produce the apparent motions of the stars, Sun, Moon, and planets as viewed from Earth and evidence of Earth's rotation

h. analyzes and interprets evidence about the formation, evolution, and early geologic history of Earth and the evolution of the biosphere

i. demonstrates knowledge of the engineering design process as related to space systems, including criteria, modeling, use of technology and mathematical thinking, and applications to real-world situations; and evaluates an engineering design or solution, taking into account a range of constraints, including cost, safety, reliability, and aesthetics, and considering social, cultural, and environmental impacts

j. demonstrates knowledge of how to plan, construct, and safely and ethically carry out investigations about space systems (e.g., modeling galaxy separation as the universe expands, using computer simulations to construct explanations of apparent motions of celestial objects, making solar observations using appropriate equipment and methods)

k. analyzes and draws inferences from scientific and technical texts and graphics; interprets graphs and data; applies mathematical and computational thinking in analyzing data; and evaluates the hypotheses, data, analyses, and conclusions in a scientific or technical text related to space systems

COMPETENCY 0002—EARTH MATERIALS AND THE HISTORY OF EARTH

Performance Expectations

The New York State Earth science teacher understands and applies the disciplinary core ideas of geology. The teacher applies knowledge of atomic structure to explain the physical and chemical properties of Earth materials. The teacher analyzes the processes of the rock cycle by applying knowledge of the properties and formation of sedimentary, igneous, and metamorphic rocks. The teacher interprets geologic cross sections and stratigraphic sequences by applying the principles of stratigraphy. The teacher understands how rock strata, fossils, and other evidence are used in determining the history of Earth. The teacher solves radiometric dating problems by analyzing the half-lives of radioactive elements. The teacher understands how to plan and safely carry out scientific investigations, understands the process of engineering design in refining a solution to a problem, interprets scientific information, and evaluates specific claims made about scientific phenomena related to Earth materials and the history of Earth. In addition, the teacher applies knowledge of the safe and proper use of equipment and materials in school science investigations.

Performance Indicators

a. analyzes the properties of Earth materials, such as minerals, radioactive elements, and water, and the underlying arrangement and properties of the atoms that compose them

b. demonstrates knowledge of common minerals associated with the major mineral groups and the characteristics used to classify minerals (e.g., hardness, cleavage and fracture, color, crystal form, luster, specific gravity, Bowen's reaction series)

c. recognizes common rocks (e.g., granite, basalt, limestone, shale, gneiss, schist) based on their origin and their distinct patterns of composition and texture

d. analyzes the major processes that drive the rock cycle; the transformations that occur as a result of the rock cycle; and the characteristics and properties of sedimentary, igneous, and metamorphic rocks

e. demonstrates knowledge of Earth's layered structure and composition, the motions and energy sources of Earth's interior, and the use of seismological tools and data to investigate Earth's interior

f. demonstrates knowledge of the geologic time scale; the fossil record (e.g., emergence, evolution, and disappearance of organisms); the processes involved in fossilization; and how rocks, fossils, and other evidence are used to establish the relative ages of major events in Earth's history

g. demonstrates knowledge of relative dating by applying the principles of stratigraphy (e.g., original horizontality, superposition, crosscutting relationships, law of inclusions, unconformities, uniformitarianism), the correlation of rock layers from distant locations, and the theory and application of radiometric dating techniques

h. demonstrates knowledge of the engineering design process as related to Earth materials and the history of Earth, including criteria, modeling, use of technology and mathematical thinking, and applications to real-world situations; and evaluates an engineering design or solution, taking into account a range of constraints, including cost, safety, reliability, and aesthetics, and considering social, cultural, and environmental impacts

i. demonstrates knowledge of how to plan, construct, and safely and ethically carry out investigations about the properties of Earth materials and the history of Earth (e.g., identifying various minerals by their characteristics, examining fossilized specimens in reference to the fossil record, simulating radioactive decay, analyzing half-lives)

j. analyzes and draws inferences from scientific and technical texts and graphics; interprets graphs and data; applies mathematical and computational thinking in analyzing data; and evaluates the hypotheses, data, analyses, and conclusions in a scientific or technical text related to the properties of Earth materials and the geologic time scale

k. demonstrates knowledge of appropriate resources regarding the safe and proper use of scientific equipment and materials (e.g., inventory, handling, storage, disposal), including accurately interpreting provided information; applies knowledge of guidelines for the proper use of materials and scientific equipment in field, laboratory, and classroom settings; and understands proper procedures for maintaining safety and responding to accidents and injuries during school science investigations

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COMPETENCY 0003—GEOLOGIC SYSTEMS

Performance Expectations

The New York State Earth science teacher understands and applies knowledge of geologic systems, including analyzing the relationship between earthquakes, volcanism, and plate tectonics. The teacher applies knowledge of the theory of plate tectonics by explaining the mechanisms that drive plate motions, by connecting the theory to the various types of evidence that support it, and by predicting the landforms and geologic events associated with specific plate interactions. The teacher understands the processes by which rocks break down and soils form and the erosional and depositional processes that change Earth's surface. The teacher connects the cycling of elements to the physical and biological processes that move elements through the atmosphere, lithosphere, hydrosphere, and biosphere. In addition, the teacher understands how to plan and safely carry out scientific investigations, understands the process of engineering design in refining a solution to a problem, interprets scientific information, and evaluates specific claims made about scientific phenomena related to geologic systems.

Performance Indicators

a. demonstrates knowledge of the theory and mechanisms of plate tectonics; the evidence supporting it; the effects that tectonic plate motions have on the configuration of the continents, the evolution of major landforms, and the formation of the geologic features of the ocean basins; and the spatial and temporal scales associated with plate tectonic activity

b. analyzes interactions along plate boundaries and the results of these interactions (e.g., volcanism, mountain building, intrusions, mid-ocean ridges)

c. analyzes the causes of earthquakes, the use of seismological tools and data in investigating earthquakes and locating earthquake epicenters, and the relationship of earthquake activity to the movements of tectonic plates

d. analyzes the physical and chemical breakdown of rocks (i.e., weathering) and the process of soil formation under different climate conditions

e. analyzes the connections between erosion and deposition; the different agents that cause erosion and deposition (e.g., wind action, glaciation, running water); and the ways in which these processes alter river systems, coastlines, deserts, and glaciated regions

f. analyzes models of the cycling of carbon, nitrogen, and water through the atmosphere, lithosphere, hydrosphere, and biosphere

g. demonstrates knowledge of the engineering design process as related to geologic systems, including criteria, modeling, use of technology and mathematical thinking, and applications to real-world situations; and evaluates an engineering design or solution, taking into account a range of constraints, including cost, safety, reliability, and aesthetics, and considering social, cultural, and environmental impacts

h. demonstrates knowledge of how to plan, construct, and safely and ethically carry out investigations about geologic systems (e.g., investigating through modeling forces that form landforms, faults, and volcanoes; exploring erosion by testing running water's effects on a pile of soil; simulating the steps of the carbon cycle)

i. analyzes and draws inferences from scientific and technical texts and graphics, including maps; interprets graphs and data; applies mathematical and computational thinking in analyzing data; and evaluates the hypotheses, data, analyses, and conclusions in a scientific or technical text related to Earth's geologic systems

COMPETENCY 0004—WATER, WEATHER, AND CLIMATE

Performance Expectations

The New York State Earth science teacher analyzes factors that affect water's movement through different parts of the hydrologic cycle and the physical processes that drive the hydrologic cycle. The teacher recognizes the characteristics and processes of freshwater systems. The teacher demonstrates knowledge of ocean circulation, ocean waves, the physical and chemical properties of ocean water, and the ocean's role in the climate system and weather. The teacher understands atmospheric processes and the structure of the atmosphere as a foundation for analyzing the climate system, weather phenomena, and Earth's energy balance. The teacher applies knowledge of Earth's energy balance and the biosphere to explain the physical and biological attributes that define Earth's different climate regions. In addition, the teacher understands how to plan and safely carry out scientific investigations, understands the process of engineering design in refining a solution to a problem, interprets scientific information, and evaluates specific claims made about scientific phenomena related to Earth's water systems and weather and climate.

Performance Indicators

a. analyzes the movement of water through the hydrologic cycle; the processes and changes in state of water; and the roles of energy (e.g., latent heat), density, and gravity in driving the cycling of water

b. analyzes characteristics and processes of freshwater systems (i.e., lakes, wetlands, rivers, groundwater aquifers, and glaciers) and the factors affecting the movement of water in these systems

c. demonstrates knowledge of thermohaline and wind-driven circulation of ocean waters, the properties of waves, the layered structure of oceans, ocean chemistry, and the role of oceans in the climate system (e.g., absorbing and releasing heat, specific heat, oceanic-atmospheric oscillations)

d. demonstrates knowledge of the structure, layering, composition, and physical and chemical properties of the atmosphere, including its effects on Earth's energy balance

e. analyzes variables that cause different types of weather, including the motions and complex interactions of air masses at frontal boundaries; the effects of geographic features on weather; and the characteristics and development of hurricanes, tornadoes, and other forms of severe weather

f. demonstrates knowledge of weather forecasting, including the use of computer models, the tools used to track weather systems, weather variables and their complex relationships (e.g., temperature, pressure, wind, relative humidity, dew point, adiabatic temperature change, atmospheric instability), and the symbols used to designate weather conditions on synoptic weather maps

g. analyzes variables in the climate system (e.g., energy imbalances at different latitudes, the Coriolis effect, prevailing wind patterns, topography, ocean temperatures, vegetation, feedbacks, reflectivity) and their effects on climate

h. demonstrates knowledge of Earth's different climate regions, factors that determine regional climates (e.g., latitude, elevation, proximity to large bodies of water, orographic effect, oceanic circulation), and the biological characteristics of different climate regions

i. analyzes evidence of factors that have caused global temperature changes in the past and uses geoscience data (e.g., levels of greenhouse gases) and results from global climate models to make evidence-based predictions of short- and long-term regional or global climate change and impacts to Earth systems

j. demonstrates knowledge of the engineering design process as related to Earth's water systems, weather, and climate, including criteria, modeling, use of technology and mathematical thinking, and applications to real-world situations; and evaluates an engineering design or solution, taking into account a range of constraints, including cost, safety, reliability, and aesthetics, and considering social, cultural, and environmental impacts

k. demonstrates knowledge of how to plan, construct, and safely and ethically carry out investigations about Earth's water systems, weather, and climate (e.g., analyzing raw weather data to create a forecast, using models and computer simulations to explore physical factors that influence climate, correlating the climate of different regions with the adaptive features of plants and animals)

l. analyzes and draws inferences from scientific and technical texts and graphics, including maps; interprets graphs and data; applies mathematical and computational thinking in analyzing data; and evaluates the hypotheses, data, analyses, and conclusions in a scientific or technical text related to Earth's water systems, weather, and climate

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COMPETENCY 0005—HUMAN IMPACTS AND SUSTAINABILITY

Performance Expectations

The New York Earth science teacher demonstrates comprehensive knowledge of how humans interact with Earth systems. The teacher understands society's use of natural resources and factors that affect the sustainability of current resource-use strategies. The teacher understands the causes, characteristics, and prediction of natural hazards and how natural hazards are managed. The teacher analyzes the causes and consequences of air and water pollution and the modification of ecosystems through forestry and agricultural practices, the damming of rivers, and urban development. The teacher evaluates technological solutions designed to reduce the impacts of humans on natural systems. In addition, the teacher understands how to plan and safely carry out scientific investigations, understands the process of engineering design in refining a solution to a problem, interprets scientific information, and evaluates specific claims made about scientific phenomena related to human impacts and sustainability.

Performance Indicators

a. analyzes the availability, use, and management of renewable and nonrenewable natural resources, including freshwater, clean air, mineral resources, fossil fuels, and biological resources

b. demonstrates knowledge of the causes and characteristics of different types of natural hazards (e.g., earthquakes, volcanic eruptions, tsunamis, coastal erosion, droughts, floods, hurricanes, tornadoes), impacts of natural hazards on affected communities, the prediction of natural hazards, and the design of practical strategies to prevent loss of life and property from natural hazards

c. demonstrates knowledge of the human impacts on Earth systems, including air pollution, surface and groundwater pollution, deforestation, urbanization, desertification, soil erosion, damming of rivers, habitat destruction, and earthquakes, and evaluates methods and designs for monitoring and minimizing human impacts

d. analyzes evidence for how the availability of natural resources and changes in climate (e.g., changes in regional patterns of precipitation and temperature) have affected human populations

e. analyzes data and information on the relationships between Earth systems and how those relationships are being modified by human activities

f. demonstrates knowledge of the engineering design process as related to human impacts and sustainability, including criteria, modeling, use of technology and mathematical thinking, and applications to real-world situations; and evaluates an engineering design or solution, taking into account a range of constraints, including cost, safety, reliability, and aesthetics, and considering social, cultural, and environmental impacts

g. demonstrates knowledge of how to plan, construct, and safely and ethically carry out investigations about human impacts and sustainability (e.g., researching and correlating human settlement patterns with changes in regional climate, assessing the resilience of structures to earthquakes, examining deforestation in a region)

h. analyzes and draws inferences from scientific and technical texts and graphics; interprets graphs and data; applies mathematical and computational thinking in analyzing data; and evaluates the hypotheses, data, analyses, and conclusions in a scientific or technical text related to human impacts and sustainability

COMPETENCY 0006—PEDAGOGICAL CONTENT KNOWLEDGE

Performance Expectations

The New York State Earth science teacher effectively applies pedagogical content knowledge to design culturally relevant instruction to guide all students in achieving a specific learning goal using an effective three-dimensional approach (i.e., disciplinary core idea, crosscutting concept, science or engineering practice). The teacher also applies knowledge of current education research on how students learn science in order to develop safe and effective performance tasks that will guide all students, including diverse learners, in achieving a specific learning goal. The teacher appropriately assesses student knowledge and understanding and identifies potential and apparent student strengths and needs.

Performance Indicators

a. demonstrates knowledge of how to assess student readiness for a specific new learning goal related to an Earth science concept or science or engineering practice

b. applies knowledge of how to design culturally relevant instruction using appropriate and effective instructional strategies that connect students' prior understanding and real-world experiences to new knowledge for all students, including diverse learners

c. applies knowledge of how to design appropriate and effective three-dimensional instruction (i.e., disciplinary core ideas, crosscutting concepts, science or engineering practices) to support students in applying and developing understanding of Earth science concepts

d. applies knowledge of appropriate and effective researched-based strategies to guide all students to engage safely in Earth science concepts or science and engineering practices

e. applies knowledge of appropriate and effective assessment to evaluate and promote learning and growth for all students, including diverse learners