



GACE® Middle Grades Science Assessment *Test at a Glance*

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See the GACE® Middle Grades Science Assessment Study Companion for practice questions and preparation resources.

Assessment Name	Middle Grades Science
Grade Level	4–8
Test Code	014
Testing Time	2 hours and 10 minutes
Test Duration	2.5 hours
Test Format	Computer delivered
Number of Selected-response Questions	80
Question Format	The test consists of a variety of short-answer questions such as selected-response questions, where you select one answer choice or multiple answer choices (depending on what the question asks for), questions where you enter your answer in a text box, and other types of questions. You can review the possible question types in the <i>Guide to Taking a GACE Computer-delivered Test.</i>
Number of Constructed-response Questions	0

About this Assessment

The GACE Middle Grades Science assessment is designed to measure the professional knowledge of prospective teachers of science in middle schools in the state of Georgia.

The testing time is the amount of time you will have to answer the questions on the test. Test duration includes time for tutorials and directional screens that may be included in the test.

The questions in this assessment assess both basic knowledge across content areas and the ability to apply principles.

The total number of questions that are scored is typically smaller than the total number of questions on the test. Most tests that contain selected-response questions also include embedded pretest questions, which are not used in calculating your score. By including pretest questions in the assessment, ETS is able to analyze actual test-taker performance on proposed new questions and determine whether they should be included in future versions of the test.

Content Specifications

This assessment is organized into content **subareas**. Each subarea is further defined by a set of **objectives** and their **knowledge statements**.

- The objectives broadly define what an entry-level educator in this field in Georgia public schools should know and be able to do.
- The knowledge statements describe in greater detail the knowledge and skills eligible for testing.
- Some tests also include content material at the evidence level. This content serves as descriptors of what each knowledge statement encompasses.

See a breakdown of the subareas and objectives for this assessment on the following pages.

Test Subareas

Subarea	Approx. Percentage of Test
I. Scientific Inquiry, Processes, Technology, and Society	20%
II. Physical Science	30%
III. Life Science	30%
IV. Earth and Space Science	20%

Test Objectives

Subarea I: Scientific Inquiry, Processes, Technology, and Society

Objective 1: Understands the nature of scientific inquiry and processes, including the collection and analysis of data

The beginning Middle Grades Science teacher:

- A. Understands methods of scientific inquiry and design
 - Identifying problems based on observations
 - Forming and testing hypotheses
 - Development of theories, models, and laws
 - Experimental design, including independent and dependent variables, controls, and sources of error
 - Process skills including observing, comparing, inferring, categorizing, generalizing, and concluding
- B. Understands the history and nature of scientific knowledge
 - Subject to change and consistent with evidence
 - Based on reproducible evidence
 - Unifying concepts and processes such as systems, models, constancy and change, equilibrium, and form and function
 - Accepted principles and models develop over time
 - Major developments in science such as atomic theory and genetics
 - Contributions of major historical figures such as Darwin and Newton
- C. Understands the processes involved in collecting and analyzing scientific data
 - Common units of measurement (metric and English) including unit conversion and prefixes such as milli and kilo
 - Organization and presentation of data

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- Trends in data
 - Relationships between variables such as direct/indirect
 - Predictions and valid conclusions based on data
 - Basic data and error analysis, including determining mean, accuracy, precision, and sources of error
- D. Understands the procedures for safe and correct use of laboratory and field materials and equipment
- Appropriate and safe preparation, use, storage, and disposal of materials such as chemicals and lab specimens
 - Appropriate and safe use of equipment such as glassware and microscopes
 - Preparations for demonstrations, activities, or field use
 - Basic use and maintenance of equipment such as microscopes and balances
 - Use of standard safety equipment such as eyewash stations and shower
 - Laboratory safety rules for students
 - Appropriate apparel and conduct in the laboratory
 - Emergency procedures for events such as fires, chemical spills, and injuries

Objective 2: Understands the relationship of science and technology to society and the environment

The beginning Middle Grades Science teacher:

- A. Understands that science and technology impact the environment and society
- Acid rain
 - Air and water pollution
 - Greenhouse gases
 - Ozone layer depletion
 - Waste disposal and recycling
 - Green chemistry
 - Irrigation
 - Reservoirs and levees
 - Depletion of aquifers
 - Loss of biodiversity
- B. Understands major issues associated with energy production and the management of natural resources
- Renewable and nonrenewable energy resources
 - Conservation, recycling, and sustainability

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- Pros and cons of power generation based on various sources such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power
 - Issues associated with the use and extraction of Earth's resources; e.g., mining, land reclamation, and deforestation
- C. Understands applications of science and technology in daily life and public health
- Chemical properties of household products
 - Communication technologies; e.g., wireless devices, GPS, satellites
 - Basic science principles applied in commonly used consumer products such as batteries and sunglasses
 - Water purification
 - Common agricultural practices, such as the use of herbicides, insecticides, and genetically modified crops.
 - Medical technologies, such as medical imaging, X rays, and radiation therapy

Subarea II: Physical Science

Objective 1: Understands the organization of matter, the atomic model, and relationships involving energy and matter

The beginning Middle Grades Science teacher:

A. Understands the organization of matter

- Elements, compounds, and mixtures
- Atoms, molecules, and ions
- Basic properties of solids, liquids, and gases.
- Atomic structure, including nucleus, electrons, protons, and neutrons
- Atomic number, atomic mass, isotopes
- Electron arrangements
- Nature of radioactive substances
- Fission and fusion

Understands basic concepts and relationships involving energy and matter

- Conservation of energy and conservation of matter
- Kinetic and potential energy
- Conversions between different forms of energy, such as thermal, chemical, and electrical
- Chemical and physical properties/changes
- Phase transitions and the energy changes involved such as heat of vaporization

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- Basic assumptions of the kinetic molecular theory
 - Temperature scales such as Celsius, Fahrenheit, and Kelvin
 - Conduction, convection, and radiation
 - Applications of energy and matter relationships in life and Earth/space science

Objective 2: Understands chemistry, including the periodic table, compounds, formulas, bonding, reactions, and solutions

The beginning Middle Grades Science teacher:

- A. Understands types of bonding and composition and the formulas of simple compounds
 - Covalent and ionic bonding
 - Naming simple compounds based on formula and writing formulas based on name
- B. Understands the organization of the periodic table and can use it to predict trends in physical and chemical properties
 - Symbols of the elements
 - Arrangement of elements on the table
 - Atomic number and atomic mass
 - Trends in physical and chemical properties of elements such as metals and nonmetals, based on their position on the table
- C. Understands basic concepts involved in chemical reactions
 - Balancing equations of simple chemical reactions
 - Types of reactions such as combustion, single or double replacement, and oxidation
 - Energy consumed or produced in reactions (endothermic and exothermic reactions)
 - Factors that affect reaction rates such as concentration, temperature, pressure, and catalysts
 - The basic concept of reaction equilibrium
- D. Understands acid-base chemistry
 - Chemical and physical properties of acids and bases
 - pH scale
 - Neutralization
 - Acid-base indicators, such as phenolphthalein, pH paper, and litmus paper
- E. Understands solutions and solubility
 - Dilute, concentrated, saturated, unsaturated, and supersaturated solutions

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- Understands that solutions can vary by concentration
 - Effect of temperature, pressure, particle size, and agitation on the rate of dissolving
 - Effect of temperature and pressure on solubility
 - Dissociation of ionic compounds such as salts in water; e.g., ionization, electrolytes
 - Conceptual understanding of freezing point depression

Objective 3: Understands physics, including mechanics, electricity and magnetism, and wave properties

The beginning Middle Grades Science teacher:

A. Understands basic concepts in mechanics

- Describe motion in terms of speed, velocity, acceleration, and displacement
- Newton's laws of motion
- Gravitational attraction and acceleration due to gravity
- Distinguish between mass and weight
- Friction
- Work, energy, and power
- Analyze motion and forces in applications such as inclined planes and projectile motion
- Periodic motion including pendulums, oscillating springs, planetary orbits, and satellites
- Conservation of momentum and collisions
- Simple machines such as the wedge, screw, and lever
- Forces and physical properties involving fluids including buoyancy, density, and pressure

B. Understands basic concepts in electricity and magnetism

- Electrostatic attraction and repulsion
- Conductivity, conductors, and insulators
- Direct current (DC) and alternating current (AC)
- Relationship among current, resistance, voltage, and power
- Basic series and parallel circuits
- Voltage sources such as batteries and generators
- Magnetic attractive and repulsive force and magnetic poles
- Magnetic materials and electromagnets

C. Understands concepts involving waves and optics

- Nature of light and the electromagnetic spectrum including visible, ultraviolet, infrared, microwave, and gamma
- Transverse and longitudinal waves
- Mechanical waves, such as sound waves
- Wave properties, such as frequency, amplitude, wavelength, speed, and energy
- Wave phenomena, such as reflection, refraction, diffraction, interference, and scattering
- Sound properties, such as pitch/frequency, loudness/intensity, and resonance
- The Doppler effect
- Mirrors and prisms
- Lenses and their applications, such as the human eye, microscope, and telescope

Subarea III: Life Science

Objective 1: Understand the structure of cells and cellular processes, basic genetics, and the mechanisms of evolution

The beginning Middle Grades Science teacher:

A. Understands the basic structure and function of cells and their organelles

- Structure and function of cell membranes
- Structure and function of animal and plant cell organelles
- Levels of organization; e.g., cells, tissues, organs, organ systems
- Major features of common animal cell types
- Prokaryotes and eukaryotes
- Cell cycle
- Mitosis, meiosis, cytokinesis

B. Understands the basic biochemistry of life

- Cellular respiration
- Photosynthesis
- Biological molecules such as DNA, carbohydrates, proteins, lipids, and enzymes

C. Understands basic genetics

- Structure and function of DNA and RNA
- Chromosomes, genes, alleles

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- Dominant and recessive traits
 - Mendelian inheritance, including genotype, phenotype, use of Punnett squares, and pedigrees

D. Understands the theory and key mechanisms of evolution

- Mechanisms of evolution including natural selection
- Isolation mechanisms and speciation
- Supporting evidence, including the fossil record and homologous

Objective 2: Understands characteristics of organisms and principles of ecology

The beginning Middle Grades Science teacher:

A. Understands the elements of the hierarchical classification scheme

- Basic taxonomy
- Characteristics of bacteria, animals, plants, fungi, and protists

B. Understands the major structures of plants and their functions

- Characteristics of vascular and nonvascular plants
- Structure and function of roots, leaves, and stems
- Asexual and sexual reproduction
- Uptake and transport of nutrients and water
- Responses to stimuli and homeostasis

C. Understands the basic anatomy and physiology of animals, including the human body

- Response to stimuli and homeostasis
- Systems that exchange with the environment, including respiratory, excretory, and digestive systems
- Internal transport and exchange, including circulatory system
- Control systems, such as the nervous system and the endocrine systems
- Movement and support, including the skeletal and muscular systems
- Reproductive system
- Reproductive patterns and life cycles of common organisms
- Immune system

D. Understands basic population dynamics

- Growth curves and carrying capacity
- Intraspecific relationships such as mating systems, social systems, and competition

E. Understands basic community ecology

- Niche and habitat
- Interspecific relationships, such as predator-prey and parasitism

F. Understands ecosystems

- Biomes
- Stability and disturbances, such as glaciation, climate change, and succession
- Energy flow, such as trophic levels and food webs
- Biogeochemical cycles, including water, nitrogen, and carbon cycles and biotic/abiotic interaction

Subarea IV: Earth and Space Science

Objective 1: Understands geology, including Earth's structure, rocks, minerals, plate tectonics, and historical geology

The beginning Middle Grades Science teacher:

A. Understands the types and basic characteristics of rocks and minerals and their formation processes

- The rock cycle
- Characteristics of sedimentary, igneous, and metamorphic rocks and their formation processes
- Characteristics and function of minerals

B. Understands the processes involved in erosion, weathering, and deposition of Earth's surface materials and soil formation

- Erosion and deposition
- Chemical and physical weathering
- Characteristics of soil
- Porosity and permeability
- Runoff and infiltration

C. Understands Earth's basic structure and internal processes

- Earth's layers, such as the crust, mantle, and core
- Earth's shape and size
- Geographical features
- Earth's magnetic field

D. Understands plate tectonic theory and evidence

- Plate boundary interactions

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- Continental drift, lithospheric plates, seafloor spreading, magnetic reversals
 - Characteristics of volcanoes
 - Characteristics of earthquakes, including seismic waves

E. Understands historical geology

- Principle of uniformitarianism
- Basic principles of relative age dating, including superposition and fossil succession
- Geologic time scale
- Fossil record as evidence of the origin and development of life, including fossilization methods, mass extinctions, ice ages, and meteor impacts

Objective 2: Understands the hydrosphere and the atmosphere, and astronomy

The beginning Middle Grades Science teacher:

A. Understands the water cycle

- Evaporation and condensation
- Precipitation
- Runoff and infiltration
- Transpiration
- Properties of water that affect Earth systems such as density, changes on freezing, high heat capacity, and solvent properties

B. Understands the characteristics and processes of Earth's oceans and other bodies of water

- Distribution and location of Earth's water
- Seawater composition
- Coastline topography and topography of ocean floor such as estuaries, barrier islands, and reefs
- Tides, waves, and currents
- Polar ice, icebergs, and glaciers
- Lakes, ponds, and wetlands
- Streams, rivers, and river deltas
- Groundwater, water table, wells, aquifers, geysers, and springs

C. Understands the basic composition of Earth's atmosphere and basic concepts of weather

- Layers and composition of the atmosphere
- Atmospheric pressure and temperature
- Relative humidity and dew point

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- Wind
 - Cloud types and formation
 - Types of precipitation
 - Air masses, fronts, storms, and severe weather such as hurricanes and tornadoes
 - Development and movement of weather patterns
- D. Understands the major factors that affect climate and seasons
- Effects of latitude, geographical location, and elevation
 - Effects of atmospheric circulation, such as trade winds and the jet stream
 - Effects of ocean circulation
 - Characteristics and locations of climate zones, such as the Tropics and the Arctic
 - Effect of the tilt of Earth's axis on seasons
- E. Understands the major features of the solar system
- Structure of the solar system
 - The laws of motion and gravity
 - Characteristics of the Sun, Moon, and planets
 - Characteristics of asteroids, meteoroids, comets, and dwarf/minor planets
 - Theories of origin of the solar system
- F. Understands the interactions of the Earth-Moon-Sun system
- Effect on seasons
 - Effect on tides
 - Earth's rotation and orbital revolution around the Sun
 - Phases of the Moon
 - Solar and lunar eclipses
- G. Understands major features of the universe
- Galaxies
 - Characteristics of stars and their life cycles
 - Theories about the origin of the universe
 - Contributions of space exploration and technology to our understanding of the universe