



## GACE® Science Assessment *Test at a Glance*

Updated September 2017

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

Assessment Name	Science
Grade Level	6–12
Test Code	Test I: 024 Test II: 025 Combined Test I and Test II: 524
Testing Time	Test I: 2 hours and 10 minutes Test II: 2 hours and 10 minutes Combined Test I and Test II: 4 hours and 20 minutes
Test Duration	Test I: 2.5 hours Test II: 2.5 hours Combined Test I and Test II: 5 hours
Test Format	Computer delivered
Number of Selected-response Questions	Test I: 80 Test II: 80 Combined Test I and Test II: 160
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 <b><i>Guide to Taking a GACE Computer-delivered Test.</i></b>
Number of Constructed-response Questions	Test I: 0 Test II: 0 Combined Test I and Test II: 0

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## About this Assessment

The GACE Science assessment is designed to measure the professional knowledge of prospective teachers of secondary school Science in the state of Georgia.

This assessment includes two tests. You may take either test individually or the full assessment in a single session. 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

Each test in 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 the tests in this assessment on the following pages.

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## Test I Subareas

Subarea	Approx. Percentage of Test
I. Scientific Inquiry, Processes, Technology, and Society	30%
II. Physical Science	70%

## Test I 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 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
  - Consistent with evidence
  - Based on reproducible evidence
  - Unifying concepts and processes, such as systems, models, constancy and change, equilibrium, form and function
  - Peer review
- C. Understands the major historical developments of science
  - Accepted principles and models develop over time
  - Major developments in science, such as atomic theory and plate tectonics
  - Contributions of major historical figures such as Darwin and Newton
- D. Understands the processes involved in scientific data collection and manipulation
  - Common units of measurement (metric and English), including unit conversion and prefixes such as milli- and kilo-

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- Laboratory notebook practices
  - Scientific notation and significant figures in collected data
  - Organization, presentation, and communication of data, using appropriate tools
  - Basic data and error analysis, including determining mean, accuracy, precision, and sources of error
- E. Understands how to interpret and draw conclusions from data presented in tables, graphs, maps, and charts
- Trends in data
  - Relationships between variables
  - Predictions based on data
  - Drawing valid conclusions based on data
- F. Understands the procedures for correct preparation, storage, use, and disposal of laboratory materials
- Appropriate and safe use of materials, such as chemicals and lab specimens
  - Safe disposal of materials
  - Appropriate storage
  - Preparations for classroom or field use of materials, such as preparing solutions and staining slides
- G. Understands how to use standard equipment in the laboratory and the field
- Appropriate and safe use of equipment such as Bunsen burner, glassware, and microscopes
  - Appropriate storage of equipment such as pH probes and dissection equipment
  - Maintenance and calibration of equipment such as microscopes and balances
  - Preparation for classroom or field use, such as prelaboratory setup, classroom demonstrations, and field research
- H. Understands safety and emergency procedures in the laboratory
- Location and use of standard safety equipment such as eyewash stations and showers
  - Laboratory safety rules for students
  - Appropriate apparel and conduct in the laboratory
  - Emergency procedures for events such as fires, chemical spills, and injuries

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

The beginning 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
  - 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
  - Chemical properties of household products
  - Communication (e.g., wireless devices, GPS, satellites)
  - Science principles applied in commonly used consumer products such as batteries, lasers, polarized sunglasses, and fiber optic cables
  - Water purification
  - Common agricultural practices, such as the use of insecticides, herbicides, and genetically modified crops
  - DNA evidence in criminal investigations
- D. Understands the impact of science on public health issues
  - Nutrition, disease, and medicine
  - Biotechnology, such as genetic engineering

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- 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 Science teacher:

A. Understands the organization of matter

- Elements, compounds, and mixtures
- Molecules, atoms, ions, and subatomic particles
- Basic properties of solids, liquids, and gases

B. Understands the basic structure of the atom

- Atomic models
- Atomic structure, including nucleus, electrons, protons, and neutrons
- Atomic number, atomic mass, and isotopes
- Electron arrangements
- Radioactive decay processes and half-life
- Fission and fusion

C. Understands basic concepts and relationships involving energy and matter

- Conservation of energy
- Conservation of matter in chemical systems
- Kinetic and potential energy
- Conversions between different forms of energy, such as thermal, chemical, electrical, and mechanical
- Chemical and physical properties/changes
- Temperature scales, such as Celsius, Fahrenheit, and Kelvin
- Conduction, convection, and radiation

D. Understands the states of matter and factors that affect phase changes

- Basic assumptions of the kinetic theory of matter, such as the particles are in constant motion and the average speed of gas particles is related to temperature
- Ideal gas laws
- Phase transitions and the energy changes involved, such as heat of vaporization and heat of sublimation

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E. Understands applications of energy and matter relationships

- Matter cycling (carbon, nitrogen, water)
- Energy flow in ecosystems
- Convection currents in the atmosphere, ocean, and mantle
- Conservation of mass in the rock cycle
- Chemical and physical changes in rocks
- Impact of solar radiation on Earth and life
- Energy transformations in living systems, such as photosynthesis and cellular respiration

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

The beginning Science teacher:

A. Understands how to name simple compounds and write their chemical formulas

- Interpreting chemical formulas
- Naming compounds based on formula
- Writing formulas based on name
- Structural formulas, such as electron dot and Lewis structures

B. Understands types of chemical interactions

- Covalent bonding
- Ionic bonding
- Metallic bonding
- Intermolecular forces such as hydrogen bonding

C. Understands the mole concept and its applications

- Avogadro's number
- Molar mass
- Percent composition

D. Understands the organization of the periodic table and can use it to predict trends in physical and chemical properties

- Elements arranged in groups and periods
- Atomic number, atomic mass, and isotopic abundance
- Symbols of the elements
- Trends in physical properties based on position of elements on the periodic table

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- Trends in chemical reactivity based on position of elements on the periodic table
- E. Understands basic concepts involved in chemical reactions
- Balancing equations of simple chemical reactions
  - Simple stoichiometric calculations based on balanced equations
  - Endothermic and exothermic reactions
  - Factors that affect reaction rates, such as concentration, temperature, pressure, catalysts/enzymes, and activation energy
  - Factors that affect reaction equilibrium, including Le Chatelier's principle
  - Types of reactions, such as combustion, single or double replacement, decomposition, synthesis, and oxidation/reduction
- F. Understands simple acid-base chemistry
- Properties of acids and bases
  - pH scale
  - Neutralization
  - Acid-base indicators, such as phenolphthalein, pH paper, and litmus paper
- G. Understands different types of solutions
- Dilute and concentrated
  - Saturated, unsaturated, and supersaturated
  - Solvent and solute
  - Concentration terms such as molarity
  - Preparation of solutions of varying concentrations
- H. Understands factors affecting the solubility of solids, liquids, and gases and the dissolving process
- Effect of temperature, pressure, particle size, and agitation on the rate of dissolving
  - Effect of temperature and pressure on solubility, including solubility curves
  - Polar versus nonpolar solvents and solutes
  - Dissociation of ionic compounds such as salts in water (e.g., ionization, electrolytes)
  - Precipitation
  - Freezing point depression
  - Osmotic pressure



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

The beginning Science teacher:

- A. Understands how to describe motion in one and two dimensions
  - Speed and velocity
  - Acceleration
  - Displacement
  - Linear momentum
  - Vector and scalar quantities
- B. Understands Newton's three laws of motion
  - First law: inertia
  - Second law:  $F = ma$
  - Third law: action-reaction forces
- C. Understands the concepts of mass, weight, and gravity
  - Distinction between mass and weight
  - Gravitational attraction
  - Acceleration due to gravity
- D. Understands how to analyze motion and forces
  - Friction
  - Collisions and conservation of linear momentum
  - Circular motion
  - Center of mass
  - Conservation of energy
  - Work, energy, and power
  - Projectile motion
  - Inclined planes
  - Periodic motion, including pendulums, oscillating springs, planetary orbits, and satellites
  - Basic fluid mechanics, including buoyancy, density, and pressure
- E. Understands simple machines
  - Mechanical advantage
  - Types of simple machines, such as the wedge, screw, and lever
  - Concept of torque

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- F. Understands the electrical nature of common materials
- Electric charges
  - Electrostatic force (attraction and repulsion, Coulomb's law)
  - Conductivity, conductors, and insulators
- G. Understands basic electrical concepts
- Direct current (DC) and alternating current (AC)
  - Current, resistance, voltage, and power
  - Ohm's law ( $V = IR$ )
  - Basic series and parallel circuits
  - Voltage sources, such as batteries and generators
- H. Understands the basic properties of magnetic fields and forces
- Magnetic materials
  - Magnetic forces and fields, including magnetic poles, attractive and repulsive forces
  - Electromagnets
- I. Understands the electromagnetic spectrum
- Nature of light, including wave properties and photons
  - Visible spectrum and color
  - Electromagnetic spectrum, such as visible, ultraviolet, infrared, microwave, and gamma
- J. Understands the basic characteristics and types of waves
- Transverse and longitudinal
  - Frequency, amplitude, wavelength, speed, and energy
- K. Understands basic wave phenomena
- Reflection, refraction, diffraction, and dispersion
  - Absorption and transmission
  - Interference, scattering, and polarization
  - Total internal reflection
  - Doppler effect
- L. Understands basic optics
- Mirrors
  - Lenses and their applications, such as the human eye, microscope, and telescope
  - Prisms

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M. Understands the basic characteristics and phenomena of sound

- Pitch/frequency and loudness/intensity
- Sound wave production, air vibrations, and resonance
- Application of the Doppler effect to sound

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## Test II Subareas

Subarea	Approx. Percentage of Test
I. Life Science	60%
II. Earth and Space Science	40%

## Test II Objectives

### Subarea I: Life Science

*Objective 1: Understands the structure of cells and basic cellular processes, including genetics*

The beginning 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 and scale (molecules, cells, tissues, organs, organ systems)
  - Major features of common animal cell types
  - Prokaryotes and eukaryotes
- B. Understands key aspects of cell reproduction and division
  - Cell cycle
  - Mitosis
  - Meiosis
  - Cytokinesis
- C. Understands the basic biochemistry of life
  - Cellular respiration (aerobic and anaerobic)
  - Photosynthesis
  - Structure and function of biological molecules, such as DNA, carbohydrates, proteins, lipids, and enzymes
- D. Understands basic genetics
  - Structure and function of DNA and RNA
  - Chromosomes, genes, and alleles
  - Dominant and recessive traits

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- Mendelian inheritance, including genotype, phenotype, use of Punnett squares, and pedigrees
  - Mutations, chromosomal abnormalities, and common genetic disorders

*Objective 2: Understands mechanisms of evolution, characteristics of organisms, and principles of ecology*

The beginning Science teacher:

A. Understands the theory and key mechanisms of evolution

- Mechanisms of evolution
- Isolation mechanisms and speciation
- Supporting evidence, including the fossil record, comparative genetics, and homologous structures

B. Understands the elements of the hierarchical classification scheme

- Classification schemes
- Characteristics of bacteria, animals, plants, fungi, and protists
- Characteristics of viruses

C. 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
- Tropisms: responses to stimuli

D. 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 the circulatory system
- Control systems, such as the nervous system and the endocrine system
- Movement and support systems, including the skeletal and muscular systems
- Reproduction and development
- Immune system

E. Understands population dynamics

- Growth curves and carrying capacity
- Behavior, such as territoriality

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- Intraspecific relationships, such as mating systems, social systems, and competition

F. Understands community ecology

- Niche
- Species diversity
- Interspecific relationships, such as predator-prey and parasitism

G. 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 II: Earth and Space Science**

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

The beginning 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 of minerals and their formation processes

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

- Erosion and sedimentation
- Chemical and physical weathering
- Characteristics of soil
- Porosity and permeability

C. Understands Earth's basic structure and internal processes

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

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D. Understands plate tectonic theory

- Folding and faulting
- Processes at plate boundaries, such as seafloor spreading
- Basic characteristics of various types of volcanoes
- Basic characteristics of earthquakes, including seismic waves and triangulation

E. Understands historical geology

- Principle of uniformitarianism
- Basic principles of relative age dating, including superposition, stratigraphic correlation, and fossil succession
- Absolute (radiometric) dating
- Geologic time scale (era and periods)
- 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 atmosphere, including water cycle, bodies of water, weather, and climate*

The beginning 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
- Tides, waves, and currents
- Estuaries, barrier islands, islands, reefs, and atolls
- Polar ice, icebergs, and glaciers
- Lakes, ponds, and wetlands
- Streams, rivers, and river deltas

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- Groundwater, water table, wells, aquifers, geysers, and springs
- C. Understands the basic structure and composition of Earth's atmosphere
- Layers
  - Composition of atmosphere
  - Atmospheric pressure and temperature
- D. Understands basic concepts of weather development
- Relative humidity
  - Dew point
  - 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
- E. 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 jet streams
  - 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
  - Effects of natural phenomena, such as volcanic eruptions and solar radiation variations
  - El Niño, La Niña, and monsoons

*Objective 3: Understands astronomy, including solar system, stars, and other features of the universe*

The beginning Science teacher:

- A. Understands the major features of the solar system
- Structure of the solar system
  - Effects of motion and gravity
  - Characteristics of the Sun, Moon, and planets
  - Characteristics of asteroids, meteoroids, comets, and dwarf/minor planets
  - Theories of the origin of the solar system



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B. 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
- Time zones
- Effect of solar wind on Earth

C. Understands major features of the universe

- Galaxies
- Characteristics of stars and their life cycles
- Dark matter
- Theories of the origin of the universe
- Technology and measurement techniques used to investigate the universe, such as telescopes, spectroscopes, and probes