Georgia High School Graduation Tests

Test Content Descriptions for 2011

Based on Georgia Performance Standards

Science

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Revised May 2010

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Program Purpose

The Georgia High School Graduation Tests (GHSGT) measure whether Georgia High School students have mastered essential concepts and skills from the state-adopted curriculum deemed necessary to earn a diploma. Students earning a regular Georgia diploma must pass all four parts of the GHSGT and the Georgia High School Writing Assessment in addition to meeting other local and state graduation requirements.

Transition from QCC to GPS

The Georgia State Board of Education, in July 2004, approved Georgia Performance Standards (GPS) in science for use in all Georgia public schools. Committees of science educators from throughout Georgia met in October and November of 2004 to identify common standards, content, and skills and make recommendations about how the information should be assessed. In 2004 and 2005, teachers were trained on the GPS Science standards. In 2005 and 2006, the standards were implemented in grades 9-12 in Georgia public schools. The 2006 and 2007 Science GHSGT reflected the transition to the GPS from the former curriculum, the Georgia Quality Core Curriculum (QCC). First-time 11th grade test-takers took a transitional form of the Science GHSGT that was aligned to standards and content found in both the GPS and the QCC that students had an opportunity to learn whether they received instruction on the GPS or the QCC. Beginning in spring 2008, after the GPS science curriculum had been in use for three years, first-time 11th grade test-takers took a science graduation test based solely on the GPS.

The GPS Science graduation test assesses standards with cognitively rich items reflecting the range and depth of knowledge inherent in the GPS. A new cut score (passing) and a new scale score were set for the GPS version of the Science GHSGT and applied to the spring 2008 test.

A new graduation rule (160-4-2-.48) was approved in 2008 by the Georgia State Board of Education, changing the course requirements for science. The 2011 GPS-based graduation test in science will reflect the curriculum and the graduation requirements of Rule 160-4-2-.48. Some minor revisions will be made to the test based on feedback from the K-12 and higher education science experts throughout the state. The primary revisions are in Domain 3, Structures and Properties of Matter. This domain has been revised to include only fundamental concepts about atomic structure and properties of matter that students are exposed to in science courses included in the requirements of the 2008 graduation rule. These concepts are part of the foundation of science and recur in some manner in courses of the Georgia science graduation requirements.

GHSGT Content Descriptions

This document, ***GHSGT Science Test Content Descriptions for 2011***, describes the content domains and relative weights of the revised test. In the spring 2011 administration, it replaces the ***2008 Test Content Descriptions for Science*** for all first time test takers. The Content Descriptions acquaint Georgia educators, students, parents, and others with the content assessed by the GHSGT. They provide an overview of the five content domains and list the associated skills and concepts that students should understand and be able to apply. They also provide the GPS standards under which the information assessed within each domain is taught.

Reference Resource
The GHSGT in science allows students the use of a page of common equations and the Periodic Table, printed in the test booklets and available to the students during testing.

The ***GHSGT Science Test Content Descriptions for 2011*** refer to the GPS, which can be accessed at https://www.georgiastandards.org. Additional information about the GHSGT program can be found at http://www.gadoe.org/ci_testing.aspx?PageReq=CI_TESTING_GHSGT.

Science Domains

- **Cells and Heredity**
  Students of science must understand the importance of cells to all living things. Cells are made up of many organelles, each with a specific function in cell processes such as reproduction and homeostasis. DNA stores and transmits cellular information making it possible for traits to change or be passed on to other generations. Students demonstrate understanding by identifying, analyzing, and explaining various cell structures and relating these structures to their functions. Students also relate cell structure to the complexity of organisms and systems and their ability to survive. Assessment of this domain focuses on students' abilities to understand specialized cell parts, to analyze elements in living cells, and to compare diffusion and osmosis. Assessments focus on concepts not specific laws, on essential elements and processes, on genetic terms and expressions at a chemical level, and practical applications of genetics.

- **Ecology and Biodiversity**
  Students of science must understand the concept of interdependence among organisms, especially with regard to the flow of matter and energy within ecosystems. Students must understand biome types as they relate to the climate, geography, and vegetation of given areas, but not simply locate biome types on maps. In addition, it is important for students to analyze the causes and effects of pollution, possible solutions, and preventative measures, understand and evaluate change over time and relate natural selection to changes in organisms. Students will examine the role of natural selection in the success of species. Assessment in this domain focuses on students identifying, analyzing, and evaluating relationships among organisms, populations, communities, ecosystems, and biomes. Further, students must recognize that modern ideas about evolution provide a scientific explanation for the history of life on Earth as described by the fossil record.

- **Structure and Properties of Matter**
  Knowledge of atomic structure and the relationship between the motion of atoms and the states of matter is fundamental to understanding concepts in courses included in the 2008 science graduation requirements. Assessment in this domain includes knowledge about the locations of subatomic particles, the effects of changes in the number or arrangement of subatomic particles in elements, and the characteristics of different elements and substances. Students examine atoms with different numbers of neutrons and protons and use the first 20 elements of the Periodic Table to examine atomic mass and atomic number. Students also compare and contrast the atomic and molecular motion of solids, liquids, gases, and plasmas.

- **Energy Transformations**
  Students of science must understand the various forms in which energy exists and how it may be transformed from one form to another as well as determine (calculate) the heat gain or loss of a substance. Students must distinguish the characteristics of radioactivity as it relates to radioactive decay and be able to describe fission and fusion. Questions assess conceptual understanding of energy transformation, nuclear energy and radioactivity.

- **Forces, Waves, and Electricity**
  Students of science must understand the relationship of force, mass, and motion through Newton's Laws of Motion. Assessment in this domain focuses on students' abilities to apply the concepts of inertia and gravitational force, velocity and acceleration, waves, magnetism, and electricity. Students demonstrate understanding of these concepts in several ways including calculating velocity, acceleration, and amount of work. Students analyze factors affecting the transfer of energy by heat, light, sound, or mechanical waves including reflection, refraction, interference, and diffraction. Students apply knowledge of magnetism and electricity as they relate to the movement of electrical charges in electromagnets and simple motors.

Characteristics of Science

The Georgia Performance Standards in Science require that content be taught in conjunction with process skills identified as the Characteristics of Science. The phrase characteristics of science refers to the process skills used in the learning and practice of science, such as testing a hypothesis, record keeping, using correct safety procedures, using appropriate tools and instruments, applying math and technology, analyzing data, interpreting results, and communicating scientific information. It also refers to understanding how science knowledge grows and changes and the processes that drive those changes. Characteristics of Science items are integrated across the four content domains.

Overview of Characteristics of Science

Students apply skills used in explaining and understanding the characteristics of science including comprehension, application, synthesis, evaluation, and the weighing of evidence.

- Students examine new experiments that may reinforce or alter scientific understandings and suggest alternate explanations of scientific evidence.
- Students apply knowledge of safety practices and identify appropriate laboratory techniques for a given situation.
- Students choose procedures for investigation of scientific problems.
- Students compare and analyze data using tables and graphs.
- Students determine reasonable conclusions based on presented data.
- Students evaluate reasonableness of conclusions after considering research methods and other scientific knowledge.
- Students determine the most appropriate method for recording or organizing data.
- Students solve scientific problems by substituting values into formulas, using dimensional analysis, or using simple algebra.
- Students evaluate written reports of laboratory findings, scientific accounts, and supporting data.
- Students determine appropriate data to support scientific claims.
- Students recognize that scientific principles are universally applicable, discovered through experiment or observation, and subject to change.
- Students understand the necessity of continuously evaluating current theories.
- Students recognize that new hypotheses often require new experiments.
- Students comprehend the importance of controls in scientific experiments.
- Students explain why estimated and calculated answers to numerical problems may differ.
- Students evaluate the effects of possible measurement errors in calculations.

Associated GPS

SCSh1 (b, c)	SCSh2 (a, b, c)	SCSh3 (b, d, e, f)	SCSh4 (a)
SCSh5 (a, b, e)	SCSh6 (a, b, c)	SCSh7 (a, b, c, d, e)	SCSh8 (a)

Science

Domain 1: Cells and Heredity (approximately 26% of the test)

Overview of the Domain

- Students describe the structures of cells and the structure and function of their components.
    - Students examine the similarities and differences between prokaryotic and eukaryotic cells.
- Students explain the process of inheritance of genetic traits.
    - Students differentiate between DNA and RNA, recognizing the role of each in heredity.
    - Students demonstrate understanding of Mendel's Laws in genetic inheritance and variability.
    - Students discuss the use of DNA technology in the fields of medicine and agriculture.
- Students analyze the similarities and differences between organisms of different kingdoms.
- Students compare and contrast viruses with living organisms.

Associated Concepts and Skills

Assessment of this domain focuses on the following:

- describing the roles of cell organelles in the following:
    - information feedback
    - motility
    - obtaining, storing, and using energy
    - protein construction
    - reproduction
    - transport of material
    - waste disposal
- differentiating the functions of the macromolecules:
    - carbohydrates
    - lipids
    - nucleic acids
    - proteins
- understanding differences between DNA and RNA
- describing how DNA stores and transmits information
- understanding Mendel's Laws as they apply to variability between generations and cell division
- understanding how DNA technology is used today in medicine and agriculture, including but not limited to:
    - environmental factors in mutation
    - genotype and phenotype
- understanding the relationships between single-celled and multi-celled organisms, on a broad, conceptual level
- differentiating how organisms from different kingdoms obtain, transform, and transport, energy and/or material
- recognizing the differences between a cell's organization and reproduction and a virus
- examining the evolutionary basis of modern classification systems

Associated GPS

SB1 (a, c) SB2 (a, b, c, f) SB3 (a, c)

Science

Domain 2: Ecology and Biodiversity (approximately 17% of the test)

Overview of the Domain

- Students analyze dependence of organisms on each other and the flow of energy and matter in an ecosystem.
    - Students evaluate relationships between organisms, populations, communities, ecosystems, and biomes.
    - Students describe the flow of matter and energy through an ecosystem by organizing the components of food chains and webs.
- Students evaluate the role of natural selection in the development of the theory of evolution.
    - Students will investigate the theory of evolution and how it pertains to the biological history of earth.
    - Students use the fossil record and molecular evidence to trace the history of life.

Associated Concepts and Skills

Assessment of this domain focuses on the following:

- understanding the identifying characteristics of major biomes of the world on a conceptual level, rather than identifying them on maps
- describing predator/prey, producer/consumer, parasite/host, scavenging, or decomposing relationships among organisms
- understanding and analyzing the physical conditions (food, space, water, air, and shelter) necessary for organisms to survive in an environment
- understanding that the amount of matter remains constant as it flows through an ecosystem
- explaining the flow of energy through an ecosystem and that energy may change from one form to another
- using diagrams to interpret the interactions of organisms within food chains and webs
- determining the role of different organisms in food chains and webs
- comparing the history of life in the following terms
    - biodiversity
    - ancestry
    - rate of evolution
- evaluating the scientific evidence that supports the theory of evolution
    - fossil record
    - biochemistry
- analyzing the effect of natural selection on species
- understanding biological resistance as a modern example of biological evolution
- using cladograms to illustrate how shared characteristics can be used to reveal degrees of relatedness
- recognize what comparisons of molecular structure suggest about evolutionary relationships

Associated GPS

SB4 (a, b1) SB5 (b, c, d, e)

Domain 3 has been revised to include only fundamental concepts about atomic structure and properties of matter that students are exposed to in science courses included in the requirements of the 2008 graduation rule. These concepts are part of the foundation of science and recur in some manner in courses of the Georgia science graduation requirements.

Science

Domain 3: Structure and Properties of Matter (approximately 14 % of the test)

Overview of the Domain

Knowledge of the structure and properties of matter is essential for understanding of concepts of physics, physical science, earth systems, environmental science, or chemistry. For example, in physics, the understanding of atomic structure is fundamental to form a clear explanation of why some elements decay radioactively. In chemistry, the understanding of atomic structure is necessary for the identification of substances based on chemical and physical properties or the prediction of formulas for stable ionic compounds. In earth systems, the understanding of atomic structure is basic to the description of how the decay of radioactive isotopes is used to determine the age of rocks, Earth, and solar system. In environmental science, the understanding of atomic structure is necessary to correctly describe the effects and potential implications of pollution and resource depletion on the environment at the local and global levels (e.g. air and water pollution, solid waste disposal, depletion of the stratospheric ozone, global warming, and land uses). For the purposes of the GHSGT, items in this domain will be limited to the following.

- Students describe atoms, understanding the structure of an atom in terms of:
  - atomic mass and atomic number
  - elements (atoms with different numbers of protons)
  - isotopes (atoms with different numbers of neutrons)
  - proton (positive charge), neutron (neutral), and electron (negative charge) locations
- Students examine the phases of matter and the related atomic and molecular motion

Associated Concepts and Skills

Assessment of this domain focuses on the following:

- understanding that atoms are composed of a nucleus surrounded by a cloud of electrons
- understanding that the nucleus of a typical atom is composed of protons and neutrons
- understanding that the atomic mass of an atom is concentrate in the nucleus of the atom
- identifying the atomic number, and atomic mass of the first 20 elements on the Periodic Table
- recognizing the difference between atomic mass and atomic number
- identifying the effect of differing numbers of neutrons in atoms of the same element, primarily in the context of radioactive isotopes
- understanding that as temperature increases, the motion of the atoms increases
- describing a solid as a composition of particles closely situated in position giving a definite shape and definite volume and that little motion occurs between particles as compared to other phases of matter
- describing a liquid as a composition of particles free to move, giving a definite volume but not a definite shape and that particles have a greater range of motion as compared to solids
- describing a gas as a composition of particles that move more than the particles of either a solid or a liquid, giving no definite volume or shape, and colliding more randomly than the particles of solids and liquids
- understanding that phase changes require a gain or loss of energy

These concepts are necessary to develop a complete understanding of the following standards:

Associated GPS SPS1 (a1, a2, a3, a4) SPS5 (a) SC3 (a, c, d) SC6 (a)

Science

Domain 4: Energy Transformations (approximately 17% of the test)

Overview of the Domain

- Students understand radioactivity.
    - Students describe half-lives of elements.
    - Students distinguish between the characteristics of each type of radioactive decay.
    - Students differentiate between fission and fusion.
- Students analyze energy transformations and the flow of energy in systems.
- Determine the heat capacity of a substance using mass, specific heat, and temperature.

Associated Concepts and Skills

Assessment of this domain focuses on the following:

- describing the process of radioactive decay in which the unstable nucleus of a radioactive isotope spontaneously decays
- calculating the amount of a radioactive substance that will remain after one half-life
- analyzing graphs, tables, and other displays of data to determine the length of a half-life or the amount of material remaining after one half-life
- comparing stopping distances for different type of radioactive decay processes
- describing in general the processes of fission and fusion
- describing the two forms of energy encountered during a given single energy transformation, including chemical, heat, light, electrical, and mechanical predicting the effect of adding or removing heat on the temperature of a substance
- comparing the capacity of different substance to change temperature as a result of absorbing or releasing energy
- calculating heat capacity using mass, specific heat and temperature

Associated GPS

SPS3 (a, b, c) SPS7 (a, c) SP2 (a, b) SP3 (a, b, f)

Science

Domain 5: Forces, Waves, and Electricity (approximately 26% of the test)

Overview of the Domain

- Students understand the relationships between force, mass, and motion.
    - Students calculate velocity and acceleration.
    - Students apply Newton's Laws of Motion.
    - Students relate falling objects to the force of gravity.
    - Students understand the difference between mass and weight.
- Students describe the properties of waves.
    - Students understand that all waves transfer energy.
    - Students associate frequency and wavelength with the energy transferred by electromagnetic and mechanical waves.
    - Students explain differences and similarities between electromagnetic and mechanical waves.
    - Students understand the concepts and can identify examples of reflection, refraction, interference, and diffraction.
    - Students analyze the effects of different mediums on the speed of sound.
- Students understand the properties of electricity and magnetism.
    - Students describe magnetism and electrical charges in the context of electricity, magnetism, electromagnets, and simple motors.
    - Students describe the flow of electrons in DC circuits.

Associated Concepts and Skills

Assessment of this domain focuses on the following:

- using the following formulas to solve for velocity and acceleration:

  velocity: $V = \frac{d}{t}$ where d = distance, t = time

  final velocity: $V_f = V_0 + at$

  acceleration: $a = \frac{V_f - V_o}{t}$

- applying knowledge of Newton's Laws of Motion to given situations
- understanding that gravity causes objects to accelerate as they fall
- understanding factors that affect the force of gravity on an object
- explaining the difference between mass and weight
- calculating work using the formula $W=Fd$ (Work = force × distance)
- understanding that waves carry energy
- relating the frequency and wavelength to the energy carried by the waves
- understanding how frequency and wavelength are related
- understanding that electromagnetic waves do not require a medium
- understanding how electromagnetic waves differ in the amount of energy transferred based on position on the electromagnetic spectrum

- relating frequencies and wavelengths on the electromagnetic spectrum to technological advances such as microwaves and radio waves
- understanding how light interacts with lenses and mirrors
- using the terms absorption, reflection, refraction, interference, and diffraction to describe how waves (including sound waves) interact with obstacles, within mediums, and with other waves
- describing how the speed of sound varies with the type of medium and temperature of a medium
- relating magnetism and electricity
- explaining the relation between voltage, current and resistance
- describing electromagnets, including their uses in electric motors, generators, radio, television, and other technologies
- explaining how an electromagnet transforms electrical energy into mechanical energy

Associated GPS

SPS8 (a, b1, b2, b3, c, d)	SPS9 (a, b, c, d, e)	SPS10 (b1, b2, b3, c1, c2)	
SP4 (a, b, c, d)	SP1 (a, d, e, h)	SP3 (a)	SP5 (b, c, d)

APPENDIX A
REFERENCE RESOURCES

SCIENCE FACTS AND FORMULAS

Some of the questions in this test require you to solve problems. This page contains all the basic facts and formulas you will need to solve those problems. You may refer to this page as often as you wish while you take the test. Some questions may require information from the Periodic Table. This table can be found at the end of the test booklet.

Basic Facts

Acceleration due to gravity = 9.8 meters/second/second (9.8 m/s^2)
Weight = Mass (m) × Acceleration due to gravity (g) (W = mg)
Density = Mass/Volume
Volume of a Rectangular Solid = Length × Width × Height
1 newton = 1 kilogram·meter/second/second
1 joule = 1 newton·meter

Motion

Velocity: $V = \frac{d}{t}$ where d = distance, t = time

Velocity: $V_f = V_0 + at$, where V_0 = Initial Velocity, V_f = final velocity, a = Acceleration, and t = Time

Acceleration = Change in Velocity/Time Elapsed $a = \frac{V_f - V_o}{t}$

Force, Mechanical Advantage, Power, Work

Force = Mass × Acceleration ($F = ma$)

Heat lost or gained = mass × specific heat capacity × change in temperature ($Q = mc\Delta T$)

Work = Force × Distance ($W = Fd$)

Electricity

Voltage = Current × Resistance ($V = IR$)

PERIODIC TABLE

PERIODS	GROUP 1 (Ia)	2 (IIa)	3	4	5	6	7	8	9	10	11	12	GROUP 13 (IIIa)	14 (IVa)	15 (Va)	16 (VIa)	17 (VIIa)	18 (VIIIa)
1	1 H Hydrogen 1.00797 1																	2 He Helium 4.0026 2
2	3 Li Lithium 6.941 2, 1	4 Be Beryllium 9.0122 2, 2											5 B Boron 10.811 2, 3	6 C Carbon 12.011 2, 4	7 N Nitrogen 14.0067 2, 5	8 O Oxygen 15.9994 2, 6	9 F Fluorine 18.998 2, 7	10 Ne Neon 20.183 2, 8
3	11 Na Sodium 22.9898 2, 8, 1	12 Mg Magnesium 24.312 2, 8, 2											13 Al Aluminum 26.9815 2, 8, 3	14 Si Silicon 28.086 2, 8, 4	15 P Phosphorus 30.9738 2, 8, 5	16 S Sulfur 32.064 2, 8, 6	17 Cl Chlorine 35.453 2, 8, 7	18 Ar Argon 39.948 2, 8, 8
4	19 K Potassium 39.102 2, 8, 8, 1	20 Ca Calcium 40.08 2, 8, 8, 2	21 Sc Scandium 44.956 2, 8, 9, 2	22 Ti Titanium 47.90 2, 8, 10, 2	23 V Vanadium 50.942 2, 8, 11, 2	24 Cr Chromium 51.996 2, 8, 13, 1	25 Mn Manganese 54.9380 2, 8, 13, 2	26 Fe Iron 55.847 2, 8, 14, 2	27 Co Cobalt 58.9332 2, 8, 15, 2	28 Ni Nickel 58.71 2, 8, 16, 2	29 Cu Copper 63.546 2, 8, 18, 1	30 Zn Zinc 65.37 2, 8, 18, 2	31 Ga Gallium 69.72 2, 8, 18, 3	32 Ge Germanium 72.59 2, 8, 18, 4	33 As Arsenic 74.9216 2, 8, 18, 5	34 Se Selenium 78.96 2, 8, 18, 6	35 Br Bromine 79.904 2, 8, 18, 7	36 Kr Krypton 83.80 2, 8, 18, 8
5	37 Rb Rubidium 85.47 2, 8, 18, 8, 1	38 Sr Strontium 88.905 2, 8, 18, 8, 2	39 Y Yttrium 88.905 2, 8, 18, 9, 2	40 Zr Zirconium 91.22 2,8,18, 10, 2	41 Nb Niobium 92.906 2,8,18,12,1	42 Mo Molybdenum 95.94 2,8,18,13,1	43 Tc Technetium (97) 2,8,18,13, 2	44 Ru Ruthenium 101.07 2,8,18,15,1	45 Rh Rhodium 102.905 2,8,18,16, 1	46 Pd Palladium 106.4 2,8,18,18,0	47 Ag Silver 107.868 2,8,18,18,1	48 Cd Cadmium 112.40 2,8,18,18,2	49 In Indium 114.82 2,8,18,18,3	50 Sn Tin 118.69 2,8,18,18,4	51 Sb Antimony 121.75 2,8,18,18,5	52 Te Tellurium 127.60 2,8,18,18,6	53 I Iodine 126.9045 2,8,18,18,7	54 Xe Xenon 131.30 2,8,18,18,8
6	55 Cs Cesium 132.905 2,8,18,18,8,1	56 Ba Barium 137.34 2,8,18,18,8,2	57-71 Lanthanide Series*	72 Hf Hafnium 178.49 2,8,18,32,10,2	73 Ta Tantalum 180.9488 2,8,18,32,11,2	74 W Tungsten 183.85 2,8,18,32,12,2	75 Re Rhenium 186.2 2,8,18,32,13,2	76 Os Osmium 190.2 2,8,18,32,14,2	77 Ir Iridium 192.2 2,8,18,32,15,2	78 Pt Platinum 195.09 2,8,18,32,16,2	79 Au Gold 196.967 2,8,18,32,18,1	80 Hg Mercury 200.59 2,8,18,32,18,2	81 Tl Thallium 204.37 2,8,18,32,18,3	82 Pb Lead 207.19 2,8,18,32,18,4	83 Bi Bismuth 208.9806 2,8,18,32,18,5	84 Po Polonium (209) 2,8,18,32,18,6	85 At Astatine (210) 2,8,18,32,18,7	86 Rn Radon (222) 2,8,18,32,18,8
7	87 Fr Francium (223) 2,8, 18, 32, 18 8, 1	88 Ra Radium (226) 2,8, 18, 32, 18 8, 2	89-103 Actinide Series*	104	105													

KEY

atomic number -	5
atomic symbol -	B
name of element -	Boron
atomic weight -	10.811
electron arrangement -	2, 3