2016–2017 NC Final Exams of Earth and Environmental Science, Physical Science, Physics, and Chemistry

North Carolina Assessment Specifications

Purpose of the Assessments

 NC Final Exams were developed to replace locally developed assessments, providing teachers and principals with a common measure for all students state-wide during a given testing window. NC Final Exam scores (along with any other relevant end-of-course or end-of-grade assessment scores) will be used in the Educational Value Added Assessment System (EVAAS) to produce student growth measures.

 North Carolina Final Exams for High School Science courses will measure students' academic progress in the NC *Essential Standards*, adopted by the North Carolina State Board of Education in February 2010.

 NC State Board of Education policy GCS-A-016 directs schools to use the results from all course-specific NC Final Exams as a minimum of 20% of the student's final course grade.

 NC Final Exams will not be used for school and district accountability under the READY Accountability Model or for Federal reporting purposes.

Developing Assessments

 North Carolina educators were recruited and trained to write new items for the NC Final Exams. The diversity among the item writers and their knowledge of the current standards was addressed during recruitment. Trained North Carolina educators also review items and suggest improvements, if necessary. The use of North Carolina educators to develop and review items strengthens the instructional validity of the items.

 For an in-depth explanation of the test development process see State Board policy GCS-A-013 reference the *Test Development Process: Item, Selection and Form Development* (Updated May 2016).

Curriculum and Assessment Cycle

 February 2010: North Carolina State Board of Education adoption of the NC *Essential Standards*.

 2012–13: Operational administration of the Measures of Student Learning: Common Exams.

 2013–14: Redesign and subsequent first operational administration of the NC Final Exams.

 2014–15: Second operational administration of the NC Final Exams.

 2015–16: Third operational administration of the NC Final Exams.

 2016–17: Fourth operational administration of the NC Final Exams.

Prioritization of Standards

 Members of the Test Development section of the North Carolina Department of Public Instruction (NCDPI) invited teachers to collaborate and develop recommendations for a prioritization of the standards indicating the relative importance of each standard, the anticipated instructional time, and the appropriateness of the standard for multiple-choice item formats.

 Tables 1–4 describe the range of total items that will appear on the NC Final Exams in High School Science courses (i.e., Earth and Environmental, Physical Science, Physics, and Chemistry). All High School Science NC Final Exams contain multiple-choice items.

*Table 1. Test Specification Weights for the **Earth and Environmental** Science NC Final Exam*

NC *Essential Standards*	Range of Total Items
Earth in the Universe	
EEn.1.1	11% to 16%
Earth Systems, Structures, and Processes	
EEn.2.1	11% to 17%
EEn.2.2	11% to 17%
EEn.2.3	4% to 10%
EEn.2.4	7% to 12%
EEn.2.5	4% to 10%
EEn.2.6	7% to 10%
EEn.2.7	14%-19%
EEn.2.8	9%-14%
Total	100%

*Table 2. Test Specification Weights for the **Physical Science** NC Final Exam*

NC *Essential Standards*	Range of Total Items
Forces and Motion	
PSc.1.1	2% to 7%
PSc.1.2	9% to 14%
Matter: Properties and Change	
PSc.2.1	11% to 17%
PSc.2.2	23% to 31%
PSc.2.3	2% to 7%
Energy: Conservation and Transfer	
PSc.3.1	7% to 10%
PSc.3.2	14%-19%
PSc.3.3	9%-14%
Total	100%

*Table 3. Test Specification Weights for the **Physics** NC Final Exam*

NC *Essential Standards*	Range of Total Items
Forces and Motion	
Phy.1.1	7% to 12%
Phy.1.2	7% to 12%
Phy.1.3	7% to 12%
Energy: Conservation and Transfer	
Phy.2.1	12% to 17%
Phy.2.2	7% to 12%
Phy.2.3	14% to 19%
Interactions of Energy and Matter	
Phy.3.1	12% to 17%
Phy.3.2	9% to 14%
Total	100%

*Table 4. Test Specification Weights for the **Chemistry** NC Final Exam*

NC *Essential Standards*	Range of Total Items
Matter: Properties and Change	
Chm.1.1	11% to 17%
Chm.1.2	14% to 19%
Chm.1.3	4% to 10%
Energy: Conservation and Transfer	
Chm.2.1	14% to 19%
Chm.2.2	14% to 19%
Interactions of Energy and Matter	
Chm.3.1	7% to 12%
Chm.3.2	12% to 17%
Total	100%

Cognitive Rigor

NC Final Exams items in High School Science were aligned to the Essential Standards using the Revised Bloom's Taxonomy (RBT).

Types of Items and Supplemental Materials

 All NC Final Exams in High School Science will contain four-response-option multiple-choice items.

 Students taking the Physical Science, Physics, and Chemistry NC Final Exams must be provided with a reference table and a scientific calculator. Earth and Environmental Science NC Final Exam should only be provided a scientific calculator.

 A complete list of the supplemental test materials (i.e., *NC Final Exams Materials List*) may be reviewed at the NCDPI/Accountability Services website.

 Released items are available on the NCDPI/Accountability Services website. Released items may be used by school systems to help acquaint students with items. The released items may not reflect the breadth of the standards assessed and/or the range of item difficulty found on the NC Final Exam. These materials must not be used for personal or financial gain. The released items are also available to schools through NCTest, the NCDPI's online assessment platform.

 Schools must ensure every student participating in an online assessment for the North Carolina Testing Program completes the Online Assessment Tutorial for the associated assessment at least once at the school before test day. The tutorial provides students the opportunity to practice the mechanics of navigating through the testing platform, to become familiar with the tools, and to respond to the sample items. Refer to the Refer to the *North Carolina Test Coordinators' Policies and Procedures Handbook* (PDF pages 14, 42, 103) for additional information for additional information.

Testing Structure and Test Administration Time

 The NC Final Exams in High School Science contain a total of 45 multiple-choice items. Included in the total item counts are embedded multiple-choice field test items that will not count toward the students score but will be used for purposes of developing items for future test forms.

NC Final Exam 2016–17	Number of Operational Items	Number of Field Test Items*	Total Number of Items
Earth and Environmental	40 multiple-choice	5 multiple-choice	45
Physical Science	40 multiple-choice	5 multiple-choice	45
Physics	40 multiple-choice	5 multiple-choice	45
Chemistry	40 multiple-choice	5 multiple-choice	45

*Field test items will not count toward the students score but will be used for purposes of developing items for future test forms.

 Students will be given 120 minutes to answer all items.

 Appendices A-D show the number of operational items for each clarifying objective for the 2016–17 exams. Note that future coverage of objectives could vary within the constraints of the content category weights in *Tables 1–4*.

Test Cycle and Delivery Mode

The NC Final Exams are administered to students enrolled in fall and spring courses. A list of course codes that align with the 2016–17 NC Final Exams (i.e., *Course Codes that Align with the NC Final Exams*) is available on the NCDPI/Accountability Services website.

 The NC Final Exams are administered through NCTest, the NCDPI's online assessment platform. Paper editions are available.

 The NC Final Exams are only provided in English. Native language translation versions are not available.

Appendix A
Earth and Environmental Science NC Final Exam 2016–17
Number of Operational Items by Clarifying Objective

The following table shows the number of operational (scored) test items for each clarifying objective. Note that future coverage of objectives could vary within the constraints of the test specification weights in *Tables 1–4*. Some objectives not designated with tested items (i.e., "–") may be a prerequisite objective, may be tested within the context of another objective or may be included as an embedded field test item.

Earth and Environmental Clarifying Objectives	Number of Operational Items per Objective
Explain the Earth's role as a body in space.	
EEn.1.1.1—Explain the Earth's motion through space, including precession, nutation, the barycenter, and its path about the galaxy.	1
EEn.1.1.2—Explain how the Earth's rotation and revolution about the Sun affect its shape and is related to seasons and tides.	2
EEn.1.1.3—Explain how the sun produces energy which is transferred to the Earth by radiation.	1
EEn.1.1.4—Explain how incoming solar energy makes life possible on Earth.	1
Explain how processes and forces affect the lithosphere.	
EEn.2.1.1—Explain how the rock cycle, plate tectonics, volcanoes, and earthquakes impact the lithosphere.	3
EEn.2.1.2—Predict the locations of volcanoes, earthquakes, and faults based on information contained in a variety of maps.	–
EEn.2.1.3—Explain how natural actions such as weathering, erosion (wind, water and gravity), and soil formation affect Earth's surface	2
EEn.2.1.4—Explain the probability of and preparation for geohazards such as landslides, avalanches, earthquakes and volcanoes in a particular area based on available data.	–
Understand how human influences impact the lithosphere.	
EEn.2.2.1—Explain the consequences of human activities on the lithosphere (such as mining, deforestation, agriculture, overgrazing, urbanization, and land use) past and present.	3
EEn.2.2.2—Compare the various methods humans use to acquire traditional energy sources (such as peat, coal, oil, natural gas, nuclear fission, and wood).	2
Explain the structure and processes within the hydrosphere.	
EEn.2.3.1—Explain how water is an energy agent (currents and heat transfer).	1
EEn.2.3.2—Explain how ground water and surface water interact.	3

Evaluate how humans use water.	
EEn.2.4.1—Evaluate human influences on freshwater availability.	2
EEn.2.4.2—Evaluate human influences on water quality in North Carolina's river basins, wetlands and tidal environments.	1
Understand the structure of and processes within our atmosphere.	
EEn.2.5.1—Summarize the structure and composition of our atmosphere	2
EEn.2.5.2—Explain the formation of typical air masses and the weather systems that result from air mass interactions.	1
EEn.2.5.3— Explain how cyclonic storms form based on the interaction of air masses.	–
EEn.2.5.4— Predict the weather using available weather maps and data (including surface, upper atmospheric winds, and satellite imagery).	–
EEn.2.5.5—Explain how human activities affect air quality.	1
Analyze patterns of global climate change over time.	
EEn.2.6.1—Differentiate between weather and climate.	–
EEn.2.6.2—Explain changes in global climate due to natural processes.	1
EEn.2.6.3—Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation).	2
EEn.2.6.4—Attribute changes to Earth's systems to global climate change (temperature change, changes in pH of ocean, sea level changes, etc.).	1
Explain how the lithosphere, hydrosphere, and atmosphere individually and collectively affect the biosphere.	
EEn.2.7.1—Explain how abiotic and biotic factors interact to create the various biomes in North Carolina.	1
EEn.2.7.2—Explain why biodiversity is important to the biosphere.	2
EEn.2.7.3—Explain how human activities impact the biosphere.	3
Evaluate human behaviors in terms of how likely they are to ensure the ability to live sustainably on Earth.	
EEn.2.8.1—Evaluate alternative energy technologies for use in North Carolina.	1
EEn.2.8.2—Critique conventional and sustainable agriculture and aquaculture practices in terms of their environmental impacts.	1
EEn.2.8.3—Explain the effects of uncontrolled population growth on the Earth's resources.	1
EEn.2.8.4—Evaluate the concept of "reduce, reuse, recycle" in terms of impact on natural resources.	1

Appendix B
Physical Science NC Final Exam 2016–17
Number of Operational Items by Clarifying Objective

The following table shows the number of operational (scored) test items for each clarifying objective. Note that future coverage of objectives could vary within the constraints of the test specification weights in *Tables 1–4*. Some objectives not designated with tested items (i.e., "–") may be a prerequisite objective, may be tested within the context of another objective or may be included as an embedded field test item.

Physical Science Clarifying Objectives	Number of Operational Items per Objective
Understand motion in terms of speed, velocity, acceleration, and momentum.	
PSc.1.1.1—Explain motion in terms of frame of reference, distance, and displacement.	–
PSc.1.1.2—Compare speed, velocity, acceleration and momentum using investigations, graphing, scalar quantities and vector quantities.	2
Understand the relationship between forces and motion.	
PSc.1.2.1—Explain how gravitational force affects the weight of an object and the velocity of an object in freefall.	3
PSc.1.2.2—Classify frictional forces into one of four types: static, sliding, rolling, and fluid.	1
PSc.1.2.3—Explain forces using Newton's three laws of motion.	1
Understand types, properties, and structure of matter.	
PSc.2.1.1—Classify matter as: homogeneous or heterogeneous; pure substance or mixture; element or compound; metals, nonmetals or metalloids; solution, colloid or suspension	1
PSc.2.1.2—Explain the phases of matter and the physical changes that matter undergoes.	2
PSc.2.1.3—Compare physical and chemical properties of various types of matter.	2
PSc.2.1.4—Interpret data presented in Bohr model diagrams and dot diagrams for atoms and ions of elements 1 through 18.	1
Understand chemical bonding and chemical interactions.	
PSc.2.2.1—Infer valence electrons, oxidation number, and reactivity of an element based on its location in the Periodic Table.	2
PSc.2.2.2—Infer the type of chemical bond that occurs, whether covalent, ionic or metallic, in a given substance.	2
PSc.2.2.3—Predict chemical formulas and names for simple compounds based on knowledge of bond formation and naming conventions.	1

PSc.2.2.4—Exemplify the law of conservation of mass by balancing chemical equations.	2
PSc.2.2.5—Classify types of reactions such as synthesis, decomposition, single replacement or double replacement.	2
PSc.2.2.6—Summarize the characteristics and interactions of acids and bases.	1
Understand the role of the nucleus in radiation and radioactivity.	
PSc.2.3.1—Compare nuclear reactions including alpha decay, beta decay and gamma decay; nuclear fusion and nuclear fission.	1
PSc.2.3.2—Exemplify the radioactive decay of unstable nuclei using the concept of half-life.	1
Understand types of energy, conservation of energy and energy transfer.	
PSc.3.1.1—Explain thermal energy and its transfer.	1
PSc.3.1.2—Explain the law of conservation of energy in a mechanical system in terms of kinetic energy, potential energy and heat.	1
PSc.3.1.3—Explain work in terms of the relationship among the applied force to an object, the resulting displacement of the object and the energy transferred to an object.	1
PSc.3.1.4—Explain the relationship among work, power and simple machines both qualitatively and quantitatively.	1
Understand the nature of waves.	
PSc.3.2.1—Explain the relationships among wave frequency, wave period, wave velocity and wavelength through calculation and investigation.	3
PSc.3.2.2—Compare waves (mechanical, electromagnetic, and surface) using their characteristics.	2
PSc.3.2.3—Classify waves as transverse or compressional (longitudinal).	1
PSc.3.2.4—Illustrate the wave interactions of reflection, refraction, diffraction, and interference.	–
Understand electricity and magnetism and their relationship.	
PSc.3.3.1—Summarize static and current electricity.	–
PSc.3.3.2—Explain simple series and parallel DC circuits in terms of Ohm's law.	2
PSc.3.3.3—Explain how current is affected by changes in composition, length, temperature, and diameter of wire.	–
Understand motion in terms of speed, velocity, acceleration, and momentum.	
PSc.3.3.4—Explain magnetism in terms of domains, interactions of poles, and magnetic fields.	2
PSc.3.3.5—Explain the practical applications of magnetism.	1

Appendix C
Physics NC Final Exam 2016–17
Number of Operational Items by Clarifying Objective

The following table shows the number of operational (scored) test items for each clarifying objective. Note that future coverage of objectives could vary within the constraints of the test specification weights in *Tables 1–4*. Some objectives not designated with tested items (i.e., "–") may be a prerequisite objective, may be tested within the context of another objective or may be included as an embedded field test item.

Physics Clarifying Objectives	Number of Operational Items per Objective
Analyze the motion of objects.	
Phy.1.1.1—Analyze motion graphically and numerically using vectors, graphs and calculations.	2
Phy.1.1.2—Analyze motion in one dimension using time, distance, and displacement, velocity, and acceleration.	1
Phy.1.1.3—Analyze motion in two dimensions using angle of trajectory, time, distance, displacement, velocity, and acceleration.	1
Analyze systems of forces and their interaction with matter.	
Phy.1.2.1—Analyze forces and systems of forces graphically and numerically using vectors, graphs, and calculations.	2
Phy.1.2.2—Analyze systems of forces in one dimension and two dimensions using free body diagrams.	–
Phy.1.2.3—Explain forces using Newton's laws of motion as well as the universal law of gravitation.	1
Phy.1.2.4—Explain the effects of forces (including weight, normal, tension and friction) on objects.	–
Phy.1.2.5—Analyze basic forces related to rotation in a circular path (centripetal force).	1
Analyze the motion of objects based on the principles of conservation of momentum, conservation of energy and impulse.	
Phy.1.3.1—Analyze the motion of objects in completely elastic and completely inelastic collisions by using the principles of conservation of momentum and conservation of energy.	2
Phy.1.3.2—Analyze the motion of objects based on the relationship between momentum and impulse.	2
Understand the concepts of work, energy, and power, as well as the relationship among them.	
Phy.2.1.1—Interpret data on work and energy presented graphically and numerically.	2
Phy.2.1.2—Compare the concepts of potential and kinetic energy and conservation of total mechanical energy in the description of the motion of objects.	2
Phy.2.1.3—Explain the relationship among work, power and energy.	2

Analyze the behavior of waves.	
Phy.2.2.1—Analyze how energy is transmitted through waves, using the fundamental characteristics of waves: wavelength, period, frequency, amplitude, and wave velocity.	2
Phy.2.2.2—Analyze wave behaviors in terms of transmission, reflection, refraction and interference.	2
Phy.2.2.3—Compare mechanical and electromagnetic waves in terms of wave characteristics and behavior (specifically sound and light).	–
Analyze the nature of moving charges and electric circuits.	
Phy.2.3.1—Explain Ohm's law in relation to electric circuits.	1
Phy.2.3.2—Differentiate the behavior of moving charges in conductors and insulators.	–
Phy.2.3.3—Compare the general characteristics of AC and DC systems without calculations.	1
Phy.2.3.4—Analyze electric systems in terms of their energy and power.	4
Phy.2.3.5—Analyze systems with multiple potential differences and resistors connected in series and parallel circuits, both conceptually and mathematically, in terms of voltage, current and resistance.	1
Explain charges and electrostatic systems.	
Phy.3.1.1—Explain qualitatively the fundamental properties of the interactions of charged objects.	2
Phy.3.1.2—Explain the geometries and magnitudes of electric fields.	1
Phy.3.1.3—Explain how Coulomb's law relates to the electrostatic interactions among charged objects.	2
Phy.3.1.4—Explain the mechanisms for producing electrostatic charges including charging by friction, conduction, and induction.	2
Phy.3.1.5—Explain how differences in electrostatic potentials relate to the potential energy of charged objects.	–
Explain the concept of magnetism.	
Phy.3.2.1—Explain the relationship between magnetic domains and magnetism.	1
Phy.3.2.2—Explain how electric currents produce various magnetic fields.	2
Phy.3.2.3—Explain how transformers and power distributions are applications of electromagnetism.	1

Appendix D
Chemistry NC Final Exam 2016–17
Number of Operational Items by Clarifying Objective

The following table shows the number of operational (scored) test items for each clarifying objective. Note that future coverage of objectives could vary within the constraints of the test specification weights in *Tables 1–4*. Some objectives not designated with tested items (i.e., "–") may be a prerequisite objective, may be tested within the context of another objective or may be included as an embedded field test item.

Chemistry Clarifying Objectives	Number of Operational Items per Objective
Analyze the structure of atoms and ions.	
Chm.1.1.1—Analyze the structure of atoms, isotopes, and ions.	2
Chm.1.1.2—Analyze an atom in terms of the location of electrons	2
Chm.1.1.3—Explain the emission of electromagnetic radiation in spectral form in terms of the Bohr model.	1
Chm.1.1.4—Explain the process of radioactive decay by the use of nuclear equations and half-life.	1
Understand the bonding that occurs in simple compounds in terms of bond type, strength, and properties.	
Chm.1.2.1—Compare (qualitatively) the relative strengths of ionic, covalent, and metallic bonds.	1
Chm.1.2.2—Infer the type of bond and chemical formula formed between atoms.	1
Chm.1.2.3—Compare inter- and intra- particle forces.	1
Chm.1.2.4—Interpret the name and formula of compounds using IUPAC convention.	2
Chm.1.2.5—Compare the properties of ionic, covalent, metallic, and network compounds.	2
Understand the physical and chemical properties of atoms based on their position in the Periodic Table.	
Chm.1.3.1—Classify the components of a periodic table (period, group, metal, metalloid, nonmetal, transition).	–
Chm.1.3.2—Infer the physical properties (atomic radius, metallic and nonmetallic characteristics) of an element based on its position on the Periodic Table.	3
Chm.1.3.3—Infer the atomic size, reactivity, electronegativity, and ionization energy of an element from its position in the Periodic Table.	1
Understand the relationship among pressure, temperature, volume, and phase.	
Chm.2.1.1—Explain the energetic nature of phase changes.	1
Chm.2.1.2—Explain heating and cooling curves (heat of fusion, heat of vaporization, heat, melting point, and boiling point).	1

Chm.2.1.3—Interpret the data presented in phase diagrams.	1
Chm.2.1.4—Infer simple calorimetric calculations based on the concepts of heat lost equals heat gained and specific heat.	1
Chm.2.1.5—Explain the relationships between pressure, temperature, volume, and quantity of gas both qualitative and quantitative.	3
Analyze chemical reactions in terms of quantities, product formation, and energy.	
Chm.2.2.1—Explain the energy content of a chemical reaction.	1
Chm.2.2.2—Analyze the evidence of chemical change.	2
Chm.2.2.3—Analyze the law of conservation of matter and how it applies to various types of chemical equations (synthesis, decomposition, single replacement, double replacement, and combustion).	1
Chm.2.2.4—Analyze the stoichiometric relationships inherent in a chemical reaction.	2
Chm.2.2.5—Analyze quantitatively the composition of a substance (empirical formula, molecular formula, percent composition, and hydrates).	1
Understand the factors affecting rate of reaction and chemical equilibrium.	
Chm.3.1.1—Explain the factors that affect the rate of a reaction (temperature, concentration, particle size and presence of a catalyst).	1
Chm.3.1.2—Explain the conditions of a system at equilibrium.	2
Chm.3.1.3—Infer the shift in equilibrium when a stress is applied to a chemical system (Le Chatelier's Principle).	1
Understand solutions and the solution process.	
Chm.3.2.1—Classify substances using the hydronium and hydroxide ion concentrations.	1
Chm.3.2.2—Summarize the properties of acids and bases.	1
Chm.3.2.3—Infer the quantitative nature of a solution (molarity, dilution, and titration with a 1:1 molar ratio).	1
Chm.3.2.4—Summarize the properties of solutions.	–
Chm.3.2.5—Interpret solubility diagrams.	1
Chm.3.2.6—Explain the solution process.	1

Document History

Date	Comment	Revision Location	Revision Description
October 6, 2016	Original document posted	N/A	N/A
October 14, 2016	Revision	Appendix A (p. 5) EEn.2.1.1 Appendix A (p. 5) EEn.2.1.2	Edits to the Clarifying Objective and Number of Operational Items per Objective
		Appendix A (p. 6) EEn.2.5.3 Appendix A (p. 6) EEn.2.5.4	Edit to the Clarifying Objective
		Appendix D (p. 11) Chm.1.1.4	Edit to the Clarifying Objective