Effective October 15, 2012

505-3-.28 SCIENCE EDUCATION PROGRAM

(1) Purpose. This rule states field-specific content standards for approving programs that prepare individuals to teach broad field science and/or the science specialties of biology, chemistry, earth/space science, and physics in grades 6-12 and supplements requirements in Rule 505-3-.01, REQUIREMENTS AND STANDARDS FOR APPROVING PROFESSIONAL EDUCATION UNITS AND EDUCATOR PREPARATION PROGRAMS. The standards are based on National Science Teachers Association 2011 standards.

(2) Requirements.

(a) A GaPSC-approved professional education unit shall offer a preparation program described in program planning forms, catalogs, and syllabi addressing the following standards:

1. Standard 1: Content Knowledge. Effective teachers of science understand and articulate the knowledge and practices of contemporary science. They interrelate and interpret important concepts, ideas, and applications in their fields of certification. Secondary teachers are generally prepared with depth and breadth in the content of a given field. The major divisions of the natural sciences are biology, chemistry, the Earth and space sciences, and physics. All teachers certified in a given discipline should know, understand, and teach with the breadth of understanding reflected in the core competencies for that discipline. Specialists in a discipline should also have achieved the advanced competencies for that discipline and supporting competencies from related disciplines.

(i) Biology.

(I) Core Competencies. All teachers of biology should be prepared to lead students to understand:

I. Life processes in living systems including organization of matter and energy;

II. Similarities and differences among animals, plants, fungi, microorganisms, and viruses;

III. Ecological systems including the interrelationships and dependencies of organisms with each other and their environments;

IV. Population dynamics and the impact of population on its environment;

V. General concepts of genetics and heredity;

VI. Organizations and functions of cells and multi-cellular systems;

VII. Behavior of organisms and their relationships to social systems;

VIII. Regulation of biological systems including homeostatic mechanisms;

IX. Fundamental processes of modeling and investigating in the biological sciences;

X. Applications of biology in environmental quality and in personal and community health;

XI. Bioenergetics including major biochemical pathways;

XII. Molecular genetics and heredity and mechanisms of genetic modification; and

XIII. Molecular basis for evolutionary theory and classification.

(II) Advanced Competencies. In addition to these core competencies, teachers of biology as a primary field should be prepared to effectively lead students to understand:

I. Biochemical interactions of organisms and their environments;

II. Causes, characteristics and avoidance of viral, bacterial, and parasitic diseases;

III. Molecular genetics;

IV. Issues related to living systems such as genetic modification, uses of biotechnology, cloning, and pollution from farming;

V. Historical development and perspectives in biology including contributions of significant figures and underrepresented groups, and the evolution of theories in biology; and

VI. How to design, conduct, and report research in biology.

(III) Supporting Competencies. All teachers of biology should also be prepared to effectively apply concepts from other sciences and mathematics to the teaching of biology including basic concepts of:

I. Chemistry including general chemistry, biochemistry and basic laboratory techniques;

II. Physics including light, sound, optics, electricity, energy and order, and magnetism;

III. Earth and space sciences including energy and geochemical cycles, climate, oceans, weather, natural resources, and changes in the Earth; and

IV. Mathematics, including probability and statistics.

(ii) Chemistry.

(I) Core Competencies. All teachers of chemistry should be prepared to lead students to understand:

I. Fundamental structures of atoms and molecules;

II. Basic principles of ionic, covalent, and metallic bonding;

III. Periodicity of physical and chemical properties of elements;

IV. Laws of conservation of matter and energy;

V. Fundamentals of chemical kinetics, equilibrium, and thermodynamics;

VI. Kinetic molecular theory and gas laws;

VII. Mole concept, stoichiometry, and laws of composition;

VIII. Solutions, colloids, and colligative properties;

IX. Acids/base chemistry;

X. Fundamental oxidation-reduction chemistry, fundamental organic chemistry and biochemistry;

XI. Fundamental biochemistry;

XII. Nature of Science and the fundamental processes in chemistry;

XIII. Applications of chemistry in personal and community health and environmental quality;

XIV. Fundamentals of nuclear chemistry; and

XV. Historical development and perspectives in chemistry.

(II). Advanced Competencies. In addition to the core competencies, teachers of chemistry as a primary field should also be prepared to effectively lead students to understand:

I. Principles of electrochemistry;

II. Transition elements and coordination compounds;

III. Molecular orbital theory, aromaticity, metallic and ionic structures, and correlation to properties of matter;

IV. Advanced concepts in chemical kinetics, equilibrium, gas laws, and thermodynamics;

V. Lewis structures and molecular geometry;

VI. Advanced concepts in acid/base chemistry, including buffers;

VII. Major biological compounds and reactions;

VIII. Solvent system concepts;

IX. Chemical reactivity and molecular structure including electronic and steric effects;

X. Organic chemistry;

XI. Historical development and perspective in chemistry including synthesis, reaction, mechanisms, and aromaticity;

XII. Green chemistry and sustainability; and

XIII. How to design, conduct, and report research in chemistry.

(III) Supporting Competencies. All teachers of chemistry should be prepared to effectively apply concepts from other sciences and mathematics to the teaching of chemistry including:

I. Biology, including molecular biology, and ecology;

II. Earth science, including geochemistry, cycles of matter, and energetics of Earth systems;

III. Physics, including energy, electricity, and magnetism. Also including properties and function of waves, of motion, and of forces;

IV. Mathematical and statistical concepts including the use of statistics, of differential equations, and of calculus;

V. Earth Science, including geochemistry, cycles of matter, and energetics of Earth systems;

VI. Physics, including energy, stellar evolution, properties and functions of waves, motions and forces, electricity, and magnetism; and

VII. Mathematical and statistical concepts and skills including statistics and the use of differential equations and calculus.

(iii) Earth and Space Sciences.

(I) Core Competencies. All teachers of the Earth and space sciences should be prepared to lead students to understand:

I. Characteristics of land, atmosphere, and ocean systems on Earth;

II. Properties, measurement, and classification of Earth materials;

III. Changes in the Earth including land formation and erosion;

IV. Geochemical cycles including biotic and abiotic systems;

V. Energy flow and transformation in Earth systems;

VI. Hydrological features of the Earth;

VII. Patterns and changes in the atmosphere, weather, and climate;

VIII. Origin, evolution, and planetary behaviors of Earth;

IX. Origin, evolution, and properties of the universe;

X. Fundamental processes of investigating in the Earth and space sciences;

XI. Sources and limits of natural resources; and

XII. Applications of Earth and space sciences to environmental quality and to personal and community health and welfare.

(II) Advanced Competencies. In addition to the core competencies, teachers of the Earth and space sciences as a primary field should be prepared to effectively lead students to understand:

I. Gradual and catastrophic changes in the Earth;

II. Oceans and their relationship to changes in atmosphere and climate;

III. Hydrological cycles and problems of distribution and use of water;

IV. Dating of the Earth and other objects in the universe;

V. Structures and interactions of energy and matter in the universe;

VI. Impact of changes in the Earth on the evolution and distribution of living things;

VII. Issues related to changes in Earth systems such as global climate change, mine subsidence, and channeling of waterways;

VIII. Historical development and perspectives including contributions of significant figures and underrepresented groups, and the evolution of theories in the fields of Earth and Space Sciences; and

IX. How to design, conduct, and report research in the Earth and space sciences.

(III) Supporting Competencies. All teachers of Earth and space sciences should be prepared to effectively apply concepts from other sciences and mathematics to the teaching of Earth and space sciences including concepts of:

I. Biology, including evolution, ecology, population dynamics, and the flow of energy and materials through Earth systems;

II. Chemistry, including broad concepts and basic laboratory techniques of inorganic and organic chemistry;

III. Physics, including electricity, forces and motion, energy, magnetism, thermodynamics, optics, and sound; and

IV. Mathematics, including statistics and probability.

(iv) Physics.

(I) Core Competencies. All teachers of physics should be prepared lead students to understand:

I. Energy, work, and power;

II. Motion, major forces, and momentum;

III. Newtonian physics including engineering applications;

IV. Conservation of mass, momentum, energy, and charge;

V. Physical properties of matter;

VI. Kinetic-molecular motion and atomic models;

VII. Radioactivity, nuclear reactors, fission, and fusion;

VIII. Wave theory, sound, light, the electromagnetic spectrum and optics;

IX. Electricity and magnetism;

X. Fundamental processes of investigating in physics; and

XI. Applications of physics in environmental quality and to personal and community health.

(II) Advanced Competencies. In addition to the core competencies, teachers of physics as a primary field should be prepared to effectively lead students to understand:

I. Thermodynamics and energy-matter relationships;

II. Nuclear physics including matter-energy duality and reactivity;

III. Angular rotation and momentum, centripetal forces, and vector analysis;

IV. Quantum mechanics, space-time relationships, and special relativity;

V. Models of nuclear and subatomic structures and behavior;

VI. Light behavior, including wave-particle duality and models;

VII. Electrical phenomena including electric fields, vector analysis, energy, potential, capacitance, and inductance;

VIII. Issues related to physics such as disposal of nuclear waste, light pollution, shielding communication systems and weapons development;

IX. Historical development and cosmological perspectives in physics including contributions of significant figures and underrepresented groups, and evolution of theories in physics;

X. How to design, conduct, and report research in physics; and

XI. Applications of physics and engineering in society, business, industry, and health fields.

(III) Supporting Competencies. All teachers of physics should be prepared to effectively apply concepts from other sciences and mathematics to the teaching of physics including concepts of:

I. Biology, including organization of life, bioenergetics, biomechanics, and cycles of matter;

II. Chemistry, including organization of matter and energy, electrochemistry, thermodynamics, and bonding;

III. Earth sciences and space sciences related to structure of the universe, energy, and interactions of matter; and

IV. Mathematical and statistical concepts and skills including statistics and the use of differential equations and calculus.

2. Standard 2: Content Pedagogy. Effective teachers of science understand how students learn and develop scientific knowledge. Preservice teachers use scientific inquiry to develop this knowledge.

3. Standard 3: Learning Environments. Effective teachers of science are able to plan for engaging students in science learning by setting appropriate goals that are consistent with knowledge of how students learn science and are aligned with state and national standards. The plans reflect the nature and social context of science, inquiry, and appropriate safety considerations. Candidates design and select learning activities, instructional settings, and resources--including technology, to achieve those goals; and they plan fair and equitable assessment strategies to evaluate if the learning goals are met.

4. Standard 4: Safety. Effective teachers of science can, in a P-12 classroom setting, demonstrate and maintain chemical safety, safety procedures, and the ethical treatment of living organisms needed in the P-12 science classroom appropriate to their area of licensure.

5. Standard 5: Impact on Student Learning. Effective teachers of science provide evidence to show that P-12 students' understanding of major science concepts, principles, theories, and laws have changed as a result of instruction by the candidate and that student knowledge is at a level of understanding beyond memorization.

6. Standard 6: Professional Knowledge and Skills. Effective teachers of science strive continuously to improve their knowledge and understanding of the ever changing knowledge base of both content and science pedagogy. They identify with and conduct themselves as part of the science education community.

(b) Programs may be offered as single field programs in one of the specialty fields of biology, chemistry, earth/space science, and physics; as dual field programs in two of the specialty fields; and/or as broad field science. Requirements are based on the National Science Teachers Association 2011 Standards.

1. Single Field Program Requirements.

(i) Candidates will meet a minimum of eighty (80) percent of the core, advanced, and supporting competencies in a specialty field as indicated in (2)(a).

2. Dual Field Program Requirements.

(i) Candidates will meet a minimum of eighty (80) percent of the core, advanced, and supporting competencies in one of the specialty fields, and a minimum of eighty (80) percent of the core competencies and a minimum of sixty (60) percent of the advanced competencies in another specialty field as indicated in (2)(a).

3. Broad field Program Requirements.

(i) Candidates will meet a minimum of eighty (80) percent of the core, advanced, and supporting competencies in a primary specialty field, and a minimum of eighty (80) percent of core and supporting competencies in two or more additional specialty fields as indicated in (2)(a).

The program shall meet all requirements specified in Rule 505-3-.01, SPECIAL GEORGIA REQUIREMENTS.

Authority O.C.G.A. § 20-2-200