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006.42 **Natural Science.**

006.42A Grade Levels: 7-12

006.42B Endorsement Type: Field

006.42C Persons with this endorsement may teach any **natural** science course in grades 7 through 12.

006.42D Certification Endorsement Requirements: This endorsement shall require a minimum of ~~4860~~ semester hours of laboratory-based courses **with a minimum of two courses in each of the four disciplines** in the **natural** sciences (biology, chemistry, **Earth and space** science, and physics). ~~of which 24 semester hours must be in one of the four areas and semester hours of~~ **laboratory-based courses** distributed **evenly** among the other three areas. A laboratory-based course provides activity-based, hands-on experiences for all students. Laboratory activities shall be designed to allow students to develop scientific skills and processes, discover and construct science concepts, and allow for the application of the concepts to the real lives of students.

006.42E Endorsement Program Requirements: Nebraska teacher education institutions offering this endorsement program must have on file, within the institution, a plan which identifies the courses and the course completion requirements which the institution utilizes to grant credit toward completion of this endorsement.

***THE FOLLOWING ARE RECOMMENDED GUIDELINES
FOR INCLUSION AS PART OF THE INSTITUTION'S PLAN
UNDER THIS ENDORSEMENT.***

Through the courses identified in its plan, the institution must provide secondary science teacher candidates with opportunities to demonstrate the dispositions and competencies required by the following guidelines, based on National Science Teachers Association Standards (2011).

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 application in their fields of licensure. Candidates will:

Element 1. Understand the major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields as

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recommended by the National Science Teachers Association.

- Element 2. Understand the central concepts of the supporting disciplines as outlined in the Nebraska Department of Education Rule 24 matrix.
- Element 3. Show an understanding of state and national curriculum standards and their impact on the content knowledge necessary for teaching P-12 students.
- Element 4. All teachers of **biology** should be prepared to lead students to understand the unifying concepts required of all teachers of science, and should also be prepared to lead students to understand the following:
- A. Life processes in living systems including organization of matter and energy;
 - B. Similarities and differences among animals, plants, fungi, microorganisms, and viruses;
 - C. Ecological systems including the interrelationships and dependencies of organisms with each other and their environments;
 - D. Population dynamics and the impact of population on its environment;
 - E. General concepts of genetics and heredity;
 - F. Organizations and functions of cells and multi-cellular systems;
 - G. Behavior of organisms and their relationships to social systems;
 - H. Regulation of biological systems including homeostatic mechanisms;
 - I. Fundamental processes of modeling and investigating in the biological sciences;
 - J. Applications of biology in environmental quality and in personal and community health;
 - K. Bioenergetics including biochemical pathways;
 - L. Molecular genetics and heredity and mechanisms of genetic modification; and
 - M. Molecular basis for evolutionary theory and classification.
- Element 5. All teachers of **chemistry** will be prepared to lead students to understand the unifying concepts required of all teachers of science, and will also be prepared to lead students to understand the following:
- A. Fundamental structures of atoms and molecules;

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- B. Basic principles of ionic, covalent, and metallic bonding;
- C. Periodicity of physical and chemical properties of elements;
- D. Laws of conservation of matter and energy;
- E. Fundamentals of chemical kinetics, equilibrium, and thermodynamics;
- F. Kinetic molecular theory and gas laws;
- G. Mole concept, stoichiometry, and laws of composition;
- H. Solutions, colloids, and colligative properties;
- I. Acids/base chemistry;
- J. Fundamental oxidation-reduction chemistry, fundamental organic chemistry and biochemistry;
- K. Fundamental biochemistry;
- L. Nature of Science and fundamental processes in chemistry;
- M. Applications of chemistry in personal and community health and environmental quality;
- N. Fundamentals of nuclear chemistry; and
- O. Historical development and perspectives in chemistry.

Element 6. All teachers of the **Earth and space sciences** will be prepared to lead students to understand the unifying concepts required of all teachers of science, and will also be prepared to lead students to understand the following:

- A. Characteristics of land, atmosphere, and ocean systems on Earth;
- B. Properties, measurement, and classification of Earth materials;
- C. Changes in the Earth including land formation and erosion;
- D. Geochemical cycles including biotic and abiotic systems;
- E. Energy flow and transformation in Earth systems;
- F. Hydrological features of the Earth;
- G. Patterns and changes in the atmosphere, weather, and climate;
- H. Origin, evolution, and planetary behaviors of Earth;
- I. Origin, evolution, and properties of the universe;
- J. Fundamental processes of investigating in the Earth and space sciences;
- K. Sources and limits of natural resources; and

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

Element 7. All teachers of **physics** will be prepared to lead students to understand the unifying concepts required of all teachers of science, and will also be prepared to lead students to understand:

- A. Energy, work, and power;
- B. Motion, major forces, and momentum;
- C. Newtonian principles and laws including engineering applications;
- D. Conservation of mass, momentum, energy, and charge;
- E. Physical properties of matter;
- F. Kinetic-molecular motion and atomic models;
- G. Radioactivity, nuclear reactors, fission, and fusion;
- H. Wave theory, sound, light, the electromagnetic spectrum and optics;
- I. Electricity and magnetism;
- J. Fundamental processes of investigating in physics; and
- K. Applications of physics in environmental quality and to personal and community health.

Element 8. All secondary teachers will also be prepared to lead students to understand the unifying concepts of science, including:

- A. Multiple ways to organize perceptions of the world and how systems organize the studies and knowledge of science;
- B. Nature of scientific evidence and the use of models for explanation;
- C. Measurement as a way of knowing and organizing observations of constancy and change;
- D. Evolution of natural systems and factors that result in evolution or equilibrium;
- E. Interrelationships of form, function, and behaviors in living and nonliving systems; and, in addition,
- F. How to design, conduct, and report research in science.

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

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- Element 1. Plan multiple lessons using a variety of inquiry approaches that demonstrate their knowledge and understanding of how students learn science;
- Element 2. Include active inquiry lessons where students collect and interpret data in order to develop and communicate concepts and understand scientific processes, relationships and natural patterns from empirical experiences; and
- Element 3. Design instruction and assessment strategies that confront and address naïve concepts/preconceptions.

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. Candidates will:

- Element 1. Use a variety of strategies that demonstrate the candidates' knowledge and understanding of how to select the appropriate teaching and learning activities – including laboratory or field settings -- to help all students learn;
- Element 2. Make plans which include active inquiry lessons where students collect and interpret data in order to develop concepts, understand scientific processes, relationships and natural patterns from empirical experiences;
- Element 3. Plan fair and equitable assessment strategies to analyze student learning and to evaluate if the learning goals are met. Assessment strategies are designed to continuously evaluate preconceptions and ideas that students hold and the understandings that students have formulated; and
- Element 4. Plan a learning environment and learning experiences for all students that demonstrate chemical safety, safety procedures, and the ethical treatment of living organisms within their licensure area.

Standard 4: Safety -- Effective teachers of science can, in a P-12 classroom setting, demonstrate and maintain chemical safety, safety procedures, and the

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ethical treatment of living organisms needed in the P-12 science classroom appropriate to their area of licensure. Candidates will:

- Element 1. Design activities in a P-12 classroom that demonstrate the safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials used within their subject area science instruction;
- Element 2. Design and demonstrate activities in a P-12 classroom that demonstrate an ability to implement emergency procedures and the maintenance of safety equipment, policies and procedures that comply with established state and/or national guidelines. Candidates ensure safe science activities appropriate for the abilities of all students; and
- Element 3. Design and demonstrate activities in a P-12 classroom that demonstrate ethical decision-making with respect to the treatment of all living organisms in and out of the classroom. They emphasize safe, humane, and ethical treatment of animals and comply with the legal restrictions on the collection, keeping, and use of living organisms.

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. Candidates will:

- Element 1. Collect, organize, analyze, and reflect on diagnostic, formative and summative evidence of a change in mental functioning demonstrating that scientific knowledge is gained and/or corrected;
- Element 2. Provide data to show that P-12 students are able to distinguish science from nonscience, understand the evolution and practice of science as a human endeavor, and critically analyze assertions made in the name of science; and
- Element 3. Engage students in developmentally appropriate inquiries that require them to develop concepts and relationships from their observations, data, and inferences in a scientific manner.

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

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community. Candidates will:

Element 1. Engage in professional development opportunities in their content field such as talks, symposiums, research opportunities, or projects within their community; and

Element 2. Engage in professional development opportunities such as conferences, research opportunities, or projects within their community.

~~Through the courses identified in its plan, the institution should prepare prospective teachers to be able to:~~

- ~~A. Demonstrate knowledge and understanding of and be able to teach the concepts, skills and processes of science as defined in the Nebraska Content Standards for eighth and twelfth grades. Demonstrate the appropriate depth of understanding in the 24 hours of emphasis.~~
- ~~B. Design and manage safe and supportive learning environments reflecting high expectations for the success of all students, including being able to:
 - ~~1. Manage physical spaces within which science learning occurs;~~
 - ~~2. Demonstrate proper treatment and ethical use of living organisms; and~~
 - ~~3. Demonstrate safety in all areas related to science instruction;~~~~
- ~~C. Relate science to the community and to use human and institutional resources in the community to advance the education of their students in science, including being able to:
 - ~~1. Utilize social and community support networks;~~
 - ~~2. Relate science teaching and learning to the needs and values of the community; and~~
 - ~~3. Involve people and institutions from the community in the teaching of science;~~~~
- ~~D. Apply the unifying concepts and processes that help students think about and integrate a range of basic ideas which build an understanding of the natural world, including:
 - ~~1. Systems, order and organization;~~
 - ~~2. Evidence, models and explanation;~~
 - ~~3. Change, constancy and measurement;~~
 - ~~4. Evolution and equilibrium; and~~
 - ~~5. Form and function;~~~~
- ~~E. Apply the processes of scientific inquiry, including the ability to:
 - ~~1. Identify questions and concepts that guide scientific investigations;~~~~

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- ~~2. Design and conduct scientific investigations;~~
- ~~3. Use appropriate tools and techniques to gather, analyze and interpret data;~~
- ~~4. Develop descriptions, explanations, predictions and models using evidence;~~
- ~~5. Think critically and logically to make relationships between evidence and explanation;~~
- ~~6. Recognize and analyze alternative explanations and models;~~
- ~~7. Communicate and defend a scientific argument; and~~
- ~~8. Understand the unique characteristics of scientific inquiry;~~
- ~~F. Apply physical science facts, concepts, principles, theories and models, including:~~
 - ~~1. Structure and properties of the atom;~~
 - ~~2. Structure and properties of matter;~~
 - ~~3. Chemical reactions;~~
 - ~~4. Motions and forces;~~
 - ~~5. Conservation of energy and increase in disorder; and~~
 - ~~6. Interactions of energy and matter;~~
- ~~G. Apply life science facts, concepts, principles, theories and models, including:~~
 - ~~1. The cell;~~
 - ~~2. Molecular basis of heredity;~~
 - ~~3. Biological evolution;~~
 - ~~4. Interdependence of organisms;~~
 - ~~5. Matter, energy and organization in a human and other living systems; and~~
 - ~~6. Behavior of organisms;~~
- ~~H. Apply earth and space science facts, concepts, principles, theories and models, including:~~
 - ~~1. Structure of the earth system;~~
 - ~~2. Earth's history;~~
 - ~~3. Earth in the solar system;~~
 - ~~4. Energy in the earth system;~~
 - ~~5. Geochemical cycles;~~
 - ~~6. Origin and evolution of the earth system; and~~
 - ~~7. Origin and evolution of the universe;~~
- ~~I. Establish connections between the natural and designed world, linking science and technology, including being able to:~~

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- ~~1. Plan, create or modify, and evaluate a technological solution to a scientific problem; and~~
- ~~2. Describe the relationship between science and technology, including the cyclical relationship for advancement;~~
- ~~3. Demonstrate an understanding of the interdisciplinary nature of science as it approaches human problems, e.g., engineering, geophysics and biochemistry;~~
- ~~J. Apply science concepts, principles, and processes to personal and social decision making, including:~~
 - ~~1. Personal and community health;~~
 - ~~2. Population growth;~~
 - ~~3. Natural resources;~~
 - ~~4. Environmental quality;~~
 - ~~5. Natural and human-induced hazards; and~~
 - ~~6. Science and technology in local, national, and global challenges; and~~
- ~~K. Demonstrate an understanding of the history and nature of science, including:~~
 - ~~1. An understanding of science as a human endeavor, including the ability to:
 - ~~a. Describe significant scientists, including individuals from both genders, and of different races and ethnic groups;~~
 - ~~b. Describe the societal, cultural, and personal beliefs that influence scientists; and~~
 - ~~c. Demonstrate the nature and practice of scientists, for example, ethical behaviors, peer review, truthful reporting, public disclosure;~~~~
 - ~~2. The nature of scientific knowledge; and~~
 - ~~3. The history of science.~~

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Natural Science
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To Accompany Rule 24
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