

# Higher Education Teacher Preparation Standards

Chemistry grades 6-12



*Kansas leads the world in the success of each student.*

# CHEMISTRY

Early Adolescence through Late Adolescence

Grades 6-12, adopted March 14, 2017

**"Learner(s)"** is defined as children including those with disabilities or exceptionalities, who are gifted, and students who represent diversity based on ethnicity, race, socioeconomic status, gender, language, religion, and geographic origin.

## Standard 1: Content Pedagogy

*Effective science teachers understand how students learn and develop science concepts and practices. They incorporate disciplinary core ideas, scientific and engineering practices, and crosscutting concepts into instruction.*

**Function 1:** The teacher plans multiple lessons using a variety of inquiry approaches incorporating science and engineering practices.

### Content Knowledge

1.1.1 CK The teacher knows how to locate resources, design and conduct inquiry-based open-ended science investigations, interpret findings, communicate results, and make judgments based on evidence.

### Professional Skills

1.1.2 PS The teacher supports student learning through appropriate curricular and instructional experiences linked to the standards

1.1.3 PS The teacher is able to develop lessons for students that demonstrate knowledge of the practices of science and engineering by questioning, defining problems, modeling, investigating, and analyzing evidence in order to construct explanations and alternative explanations.

1.1.4 PS The teacher is able to develop lessons in which students collect and interpret data, develop and communicate concepts, and understand scientific processes, relationships and natural patterns from empirical experiences. Applications of science-specific technology are included in the lessons when appropriate.

**Function 2:** The teacher demonstrates knowledge and understanding of how diverse students learn science.

### Content Knowledge

1.2.1 CK The teacher knows learning is influenced by cultural and environmental differences of the student and family.

1.2.2 CK The teacher understands developmentally and chronologically age-appropriate needs and practices of students.

1.2.3 CK The teacher understands diverse learning styles.

**Professional Skills**

1.2.4 PS The teacher gains and values information about the family's culture and environment and uses it to understand individual development and learning.

1.2.5 PS The teacher promotes developmentally and chronologically age-appropriate educational experiences to meet the learning abilities, strengths, needs, and preferences of students.

**Function 3:** The teacher designs instruction and assessment strategies that confront and address naïve concepts/preconceptions.

**Content Knowledge**

1.3.1 CK The teacher knows learning is influenced by cultural and environmental differences of the student and family.

1.3.2 CK The teacher understands formative and summative assessment and how they are used.

**Professional Skills**

1.3.3 PS The teacher uses appropriate formal and informal evaluation/assessment instruments to identify learning needs of students.

1.3.4 PS The teacher is able to identify common student misconceptions and naïve understandings and design and implement appropriate instruction to address these.

## Standard 2: Learning Environments

*Teachers work with students and others to create and manage environments that support learning.*

**Function 1:** The teacher supports individual and group learning.

### Content Knowledge

2.1.1 CK The teacher understands the importance of rigor, respect, and responsibility for the learning environment.

2.1.2 CK The teacher understands how teacher feedback influences student learning.

### Professional Skills

2.1.3 PS The teacher sets and articulates appropriate goals that are consistent with knowledge of how students learn science.

2.1.4 PS The teacher sets goals that are aligned with state and other professional standards.

2.1.5 PS The teacher manages the environment to make learning experiences appropriately challenging.

**Function 2:** The teacher encourages positive social interaction.

### Content Knowledge

2.2.1 CK The teacher understands how learner diversity can affect communication and knows how to communicate effectively in differing environments.

2.2.2 CK The teacher understands how learning occurs, how learners construct knowledge, acquire skills, and develop disciplined thinking processes and knows how to use instructional strategies that promote student learning.

### Professional Skill

2.2.3a PS The teacher plans fair and equitable assessment strategies to analyze student learning and to evaluate if the learning goals are met.

2.2.3b PS The teacher promotes celebration of learning by providing positive reinforcement and encouraging learners to present work demonstrating their learning and interacting with community members about their work.

2.2.3c PS The teacher communicates verbally and nonverbally, with families, communities, colleagues, and other professionals, in ways that demonstrate respect for and responsiveness to the cultural backgrounds and differing perspectives learners bring to the learning environment.

2.2.3d PS The teacher knows how to help learners work productively and cooperatively with each other to achieve learning goals.

2.2.4a PS The teacher develops plans that reflect the nature and social context of science and inquiry.

- 2.2.4b PS The teacher creates developmentally appropriate instruction that takes into account individual learners' strengths, interests, and needs and that enables each learner to advance and accelerate his/her learning.

**Function 3:** The teacher promotes active engagement in learning and self-motivation.

**Content Knowledge**

- 2.3.1 CK The teacher understands the relationships between motivation, engagement, and self-efficacy, and knows how to design learning experiences using strategies that build learner self-direction and ownership of learning.
- 2.3.2 CK The teacher creates learning environments where students have an opportunity to actively engage in the practices of science and engineering.

**Professional Skill**

- 2.3.3a PS The teacher shows the ability to 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 and applicable instruments and technology.
- 2.3.3b PS The teacher incorporates differentiated instruction strategies to engage students with diverse learning needs.
- 2.3.3c PS The teacher incorporates tools of language development into planning and instruction, including strategies for making content accessible to English language learners and for evaluating and supporting their development of English proficiency.
- 2.3.4a PS The teacher will develop lesson plans that include active inquiry lessons where students are collecting, analyzing and interpreting data.
- 2.3.4b PS The teacher will develop lesson plans that allow students to engage in developing and using models, constructing explanations and designing solutions, engaging in argument from evidence, and evaluating and communicating information.

### **Standard 3: Safety**

*Effective teachers of science demonstrate and implement safety procedures, material safety practices, and the ethical treatment and use of living organisms (appropriate to their area of licensure).*

**Function 1:** The teacher implements safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials.

#### **Content Knowledge**

3.1.1 CK The teacher understands safety considerations affecting the purchase, storage, maintenance, and disposal of materials such as minimizing quantities in ordering, tracking usage of materials and production of waste, and keeping current on inventory of materials.

3.1.2 CK The teacher understands proper techniques and precautions for controlling access to materials in the student laboratory including appropriate dispensing, supervision of materials, and handling of waste.

#### **Professional Skill**

3.1.3 PS The teacher understands, applies, and promotes the maintenance of a safe environment in accordance with the recommendations of the National Science Teachers Association.

3.1.4 PS The teacher maintains an orderly environment, uses safe and appropriate storage of materials and equipment, and minimizing clutter so as to reduce the potential for accidents.

**Function 2:** The teacher designs and models activities to implement emergency procedures. The teacher understands the maintenance of safety equipment and follows policies and procedures that comply with established state and/or national guidelines. The teacher ensures safe science activities appropriate for the abilities of all students.

#### **Content Knowledge**

3.2.1 CK The teacher understands appropriate emergency procedures and maintenance of safety equipment, policies and procedures that comply with established state and/or national guidelines.

3.2.2 CK The teacher understands how students' developmental levels affect safety in classroom, laboratory and field environments, and considers this in designing activities to maintain a safe environment.

#### **Professional Skill**

3.2.3 PS The teacher designs and implements activities that demonstrate emergency procedures and the proper use of safety equipment in accordance with the recommendations of the National Science Teachers Association.

3.2.4 PS The teacher enforces safe science practices in activities appropriate to the abilities of all students.

**Function 3:** The teacher designs and implements activities that demonstrate ethical decision-making with respect to the treatment of living organisms in and out of the classroom. The teacher emphasizes safe, humane, and ethical treatment of animals and complies with the legal restrictions on the collection, keeping, use, and treatment of living organisms.

**Content Knowledge**

3.3.1 CK The teacher understands the principles of ethical decision-making with respect to the treatment of living organisms in and out of the classroom.

3.3.2 CK The teacher knows the legal restrictions on the collection, keeping, use, and treatment of living organisms.

3.3.3 CK The teacher is aware of hazards from exposure to allergens, toxins, and pathogens in the classroom, laboratory, or field environment.

**Professional Skill**

3.3.4 PS The teacher designs and implements activities that demonstrate ethical decision-making with respect to the treatment of living organisms in and out of the classroom.

3.3.5 PS The teacher complies with the legal restrictions on the collection, keeping, and use of living organisms.

## Standard 4: Impact on Student Learning

*Science teachers provide evidence that students' understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts have increased in sophistication as a result of instruction. Candidates provide evidence representative of the entire population they teach.*

**Function 1:** Collect, organize, analyze, and reflect on diagnostic, formative and summative evidence of student learning.

### **Content Knowledge**

4.1.1 CK The teacher understands the various methodologies to assess and analyze student learning and address misconceptions.

### **Professional Skills**

4.1.2 PS The teachers utilize knowledge of appropriate developmental levels within the classroom environment.

4.1.3 PS The teacher reflects on formative and summative assessments and adjusts instruction appropriately.

**Function 2:** Provide data to show that students are able to distinguish science from nonscience, understand the evolution and practice of science as a human endeavor, and critically analyze the quality of evidence supporting scientific claims.

### **Content Knowledge**

4.2.1 CK The teacher understands the distinction between science and nonscience and can distinguish between the two.

4.2.2 CK The teacher understands the history, development and practice of science as a human endeavor.

4.2.3 CK The teacher critically analyzes the quality of evidence supporting scientific claims.

### **Professional Skills**

4.2.4 PS The teacher demonstrates that students are able to understand the distinction between science and nonscience and can distinguish between the two.

4.2.5 PS The teacher demonstrates that students are able to understand the history, development and practice of science as a human endeavor.

4.2.6 PS The teacher demonstrates that students are able to critically analyze the quality of evidence supporting scientific claims.

## Standard 5: Professional Knowledge and Skills

*Effective science teachers are aware of and engage in professional development opportunities to continually improve their knowledge and understanding of science content and pedagogy. They conduct themselves as part of the science education community.*

**Function 1:** The teacher engages in professional development opportunities in his/her content field such as talks, symposiums, research opportunities, projects within their community, and/or social media.

### **Content Knowledge**

5.1.1 CK The teacher demonstrates an awareness of professional organizations in science/education, and professional development available from these organizations.

### **Professional Skills**

5.1.2 PS The teacher engages in professional development opportunities such as conferences, research opportunities, projects within the community, and/or social media.

## Standard 6: Engineering, Technology, and the Applications of Science

*The teacher demonstrates an understanding of concepts and practices of engineering, technology, and the applications of science in developing instruction for students.*

**Function 1:** The teacher incorporates engineering design in instruction to solve problems. Engineering design includes the iterative processes of defining problems, developing solutions, and optimizing solutions.

### **Content Knowledge**

- 6.1.1 CK The teacher can define and delimit engineering problems with precision, and specify the goals intended to be reached.
- 6.1.2 CK The teacher can develop possible solutions for a defined problem.
- 6.1.3 CK The teacher can systematically evaluate alternative solutions to engineering problems, analyzing data from tests of different solutions, and combining the best ideas into an improved solution.

### **Professional Skills**

- 6.1.4 PS The teacher develops and implements lessons in which students use engineering design principles (define the problem, develop solutions, and optimize solutions) in applications appropriate to their content area.

**Function 2:** The teacher makes authentic connections among engineering, technology, science, and society.

### **Content Knowledge**

- 6.2.1 CK The teacher understands the interdependence of science, engineering, and technology.
- 6.2.2 CK The teacher understands the influences of engineering, technology, and science to the broader society and environment.

### **Professional Skills**

- 6.2.3 PS The teacher incorporates into instruction examples of the interdependence of science, engineering, and technology. Examples include: 1) advances in scientific understanding in genetics can be translated into medical treatments, and 2) new technology such as advanced telescopes and probes provide new understandings of outer space.
- 6.2.4 PS The teacher incorporates into instruction examples of the influences of engineering, technology, and science to the broader society and environment. Examples include: 1) how measurement technologies have changed civilizations throughout history, and 2) how the use of natural resources has impacted the natural world.

**Standard 7: Structure and Properties of Matter**

*Effective teachers understand the structure of matter on the atomic and macroscopic levels, and the relationship between structure and properties of matter, engaging students in using the periodic table as a model to predict the properties of elements based on the patterns of valence electrons as well as facilitating student investigations to gather evidence to compare trends in the periodic table and knowledge of the patterns of chemical properties.*

**Function 1:** Atoms: The teacher designs and models investigations of the concept that matter consists of atoms having internal structures that dictate their chemical and physical behavior.

**Content Knowledge**

- 7.1.1 CK The teacher understands the historical development of atomic theory and changes in the model of the atom including the experimental data supporting those changes.
- 7.1.2 CK The teacher knows core principles and concepts associated with electronic structure of atoms including electronic configurations.
- 7.1.3 CK The teacher understands periodic law, the organization of the periodic table, and how similarities and differences in atomic structure of the elements underlie chemical trends in the periodic table.

**Professional Skills**

- 7.1.4 PS The teacher develops and implements lessons to demonstrate atomic theory and the organization of the periodic table, specifically periodic trends in reactivity.

**Function 2:** The teacher understands that matter absorbs and emits energy

**Content Knowledge**

- 7.2.1 CK The teacher can describe the relationships between energy, wavelength, and frequency and relate them to regions of the electromagnetic spectrum. The teacher knows the types and uses of spectroscopic methods used to deduce atomic and molecular structure.
- 7.2.2 CK The teacher knows how matter responds to different types of electromagnetic radiation.

**Professional Skills**

- 7.2.3 PS The teacher engages students in investigating the structure of matter through spectroscopic methods.

**Function 3:** The teacher understands and can model the concept that compounds have geometric structures that influence their chemical and physical behaviors.

**Content Knowledge**

7.3.1 CK The teacher understands various models describing the electronic and geometric structure of molecules such as VSEPR and Lewis Dot structures.

**Professional Skills**

7.3.2 PS The teacher engages students in constructing and describing models using VSEPR theory.

**Function 4:** The teacher designs investigations into the concept that matter consists of pure substances or mixtures.

**Content Knowledge**

7.4.1 CK The teacher knows the principles and concepts of chemical separations and how the components in complex mixtures can be separated.

7.4.2 CK The teacher knows the nomenclature, nature, structure, and characteristics of atoms, molecules, and ions.

**Professional Skills**

7.4.3 PS The teacher engages students in performing experiments to separate the components of mixtures.

**Standard 8: Matter and Its Interactions**

*Effective teachers will engage students in developing models that illustrate the release or absorption of energy from a chemical reaction system as well as investigating reaction rates and equilibrium states.*

**Function 1:** The teacher understands that matter interacts with energy and undergoes physical and/or chemical changes.

**Content Knowledge**

- 8.1.1 CK The teacher knows that atoms interact via electrostatic forces to form chemical bonds.
- 8.1.2 CK The teacher understands kinetic molecular theory and its application to states and properties of matter.
- 8.1.3 CK The teacher understands intermolecular forces and their influence of on the physical properties and chemical behavior of substances.
- 8.1.4 CK The teacher understands the nature and properties of solutions, with particular emphasis on aqueous solutions and colligative properties.

**Professional Skills**

- 8.1.5 PS The teacher engages students in investigating colligative properties and applying kinetic theory in laboratory situations.

**Function 2:** The teacher engages students in investigations involving the changes of matter and that these changes form products that have new chemical and/or physical properties.

**Content Knowledge**

- 8.2.1 CK The teacher understands the concepts and principles of stoichiometry involving the study of quantitative relationships among reactants and products in chemical reactions.
- 8.2.2 CK The teacher knows that enthalpy and entropy are the driving forces of chemical reactions in molecular-scale systems as well as macroscopic systems.
- 8.2.3 CK The teacher understands that all chemical changes are, in principle, reversible. Teachers can apply Le Chatelier's principle and equilibrium constants to describe a dynamic equilibrium
- 8.2.4 CK The teacher understands the core theories, laws, and concepts of chemical kinetics and their applications to the rates, mechanisms, and catalysis of chemical reactions.

**Professional Skills**

- 8.2.5 PS The teacher engages students in identifying different types of chemical reactions based on experimentation, including acid-base, combustion, precipitation, and oxidation-reduction reactions.

8.2.6 PS The teacher engages students in writing balanced molecular, ionic and net ionic reaction equations.

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