



## Field 043: Science—Chemistry REPA Educator Standards

### **Standard 1: The Nature and Processes of Science**

**Chemistry teachers have a broad and comprehensive understanding of the nature of science and the processes of scientific inquiry, including:**

- 1.1** the characteristics, assumptions, and goals of science
- 1.2** the tentative nature of scientific knowledge, which is subject to change as new evidence, new tools, or new ways of thinking become available
- 1.3** the formulation of testable hypotheses and the principles and procedures for designing and conducting scientific investigations
- 1.4** common tools, materials, and technology used in chemistry investigations
- 1.5** the collection, organization, analysis, interpretation, and communication of scientific data, including the use of technology
- 1.6** the safe execution of laboratory exercises and the safe storage and disposal of chemicals
- 1.7** the role and applications of mathematics in science
- 1.8** the characteristics and uses of various sources of scientific information and the evaluation of scientific information, claims, and arguments
- 1.9** the role of peer review and critical evaluation of the results of scientific investigations, models, and explanations

### **Standard 2: Central Concepts and Connections in Science**

**Chemistry teachers have a broad and comprehensive understanding of the core ideas in other science disciplines and of the relationships between science, engineering, technology, and society, including:**

- 2.1** the unifying concepts and processes that cut across the sciences and engineering
- 2.2** the basic concepts and major principles of life science
- 2.3** the basic concepts and major principles of physics
- 2.4** the basic concepts and major principles of Earth and space science
- 2.5** the basic characteristics, principles, and goals of the engineering, or technological, design process
- 2.6** the interconnections between the various disciplines of science
- 2.7** the interrelationships between science and technology
- 2.8** the social, cultural, and ethical aspects of science, engineering, and technology
- 2.9** the historical development of important ideas in science from different periods and cultures

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### **Standard 3: Atomic Structure**

**Chemistry teachers have a broad and comprehensive understanding of the structure of atoms, including:**

- 3.1** the mass, charge, and arrangement of subatomic particles
- 3.2** historical and contemporary models of atomic structure
- 3.3** electron configurations of atoms and ions and the relationship to chemical behavior
- 3.4** the relationship between subatomic particles and the organization of the periodic table
- 3.5** periodic trends in physical and chemical properties
- 3.6** the properties of radioactive materials, including nuclear stability, half-life, and the types of emissions resulting from radioactive decay
- 3.7** the nature of nuclear reactions and the processes of fission and fusion

### **Standard 4: The Properties of Matter**

**Chemistry teachers have a broad and comprehensive understanding of the states of matter and their characteristic properties, including:**

- 4.1** the principles of kinetic molecular theory
- 4.2** the movement, arrangement, and interaction of particles in the solid, liquid, gas, and plasma states of matter
- 4.3** the characteristics of elements, molecules, ions, compounds, and mixtures
- 4.4** the chemical and physical properties of matter and the nature of chemical and physical changes of matter
- 4.5** the application of the gas laws to chemical systems
- 4.6** the composition of solutions, suspensions, and colloids
- 4.7** the colligative properties of solutions, the factors that affect solubility, and units of concentration
- 4.8** the rules of nomenclature for inorganic substances

### **Standard 5: Chemical Bonding**

**Chemistry teachers have a broad and comprehensive understanding of the principles of chemical bonding and the characteristics of intermolecular forces, including:**

- 5.1** the characteristics of ionic bonds, covalent bonds, and metallic bonds and the principles of chemical bonding
- 5.2** the use of Lewis structures to represent the chemical bonding in a molecule
- 5.3** the application of the valence-shell electron-pair repulsion (VSEPR) model, valence bond theory, and molecular orbital theory
- 5.4** the determination of molecular geometry of molecules and ions
- 5.5** the characteristics of different types of intermolecular forces such as dipole-dipole, dispersion, and hydrogen bonding
- 5.6** the relationship between intermolecular forces and the properties of matter

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### **Standard 6: Chemical Reactions**

**Chemistry teachers have a broad and comprehensive understanding of common inorganic chemical reaction types and the principles of chemical reactivity, including:**

- 6.1** the basic types of inorganic chemical reactions and the possible indications of a chemical reaction
- 6.2** the mole concept and its use in chemical calculations such as limiting reagents, theoretical yield, and percent yield
- 6.3** the law of conservation of mass and its application in balancing chemical equations
- 6.4** collision theory and the factors that affect reaction rates
- 6.5** chemical kinetics, including reaction rates, rate constants, rate laws, reaction order, and basic reaction mechanisms
- 6.6** the dynamic nature of chemical equilibrium, equilibrium constants, and the factors that affect chemical equilibrium
- 6.7** the Arrhenius, Brønsted-Lowry, and Lewis definitions of acids and bases and the determination of pH and pOH of strong and weak acids and bases
- 6.8** the workings of buffer systems and the principles and applications of acid-base titration
- 6.9** the principles and applications of electrochemistry, including electrolytic and galvanic cells, cell potentials, and cell equilibrium

### **Standard 7: Thermochemistry**

**Chemistry teachers have a broad and comprehensive understanding of the laws of thermodynamics and how they apply to chemical systems, including:**

- 7.1** the principles and applications of the three laws of thermodynamics
- 7.2** forms of energy and the transformation of energy from one form to another
- 7.3** the concepts of heat and temperature
- 7.4** the use of calorimetry to determine the amount of heat absorbed or released in chemical reactions and physical processes
- 7.5** the energy changes associated with the formation and breaking of chemical bonds
- 7.6** the energy changes associated with chemical reactions and physical processes
- 7.7** free energy and the spontaneity of chemical reactions

### **Standard 8: Organic Chemistry and Biochemistry**

**Chemistry teachers have a broad and comprehensive understanding of organic chemistry and biochemistry, including:**

- 8.1** the chemical bonding characteristics of the carbon atom, including single bonds, hybridization, and multiple bonds
- 8.2** the composition, structure, and properties of organic compounds
- 8.3** the naming of organic compounds and functional groups
- 8.4** the basic types of organic reactions and the reactants and products of common reaction types
- 8.5** cellular respiration, fermentation, photosynthesis, and major anabolic and catabolic pathways
- 8.6** the structure and properties of nucleic acids, amino acids, proteins, carbohydrates, lipids, and polymers and their role in biochemical processes

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## **Standard 9: Science Instruction and Assessment**

**Chemistry teachers have a broad and comprehensive understanding of content-specific instruction and assessment in science, including:**

- 9.1** the Indiana Revised Academic Standards for Science
- 9.2** the National Science Education Standards, the NCATE/NSTA Standards for Science Teacher Preparation, the Common Core State Standards for English Language Arts & Literacy in Science and Technical Subjects, and the ISTE National Educational Technology Standards for Teachers
- 9.3** instructional strategies and resources for promoting students' development of conceptual understanding, inquiry skills, and scientific habits of mind
- 9.4** strategies and skills for planning and designing science instruction, including the use of techniques and approaches that meet the needs of diverse learners
- 9.5** instructional strategies and communication methods that encourage active inquiry, supportive interaction, and collaboration in the science classroom
- 9.6** strategies and resources for promoting students' reading, writing, and mathematics skills in science
- 9.7** strategies and skills for selecting, adapting, and using technological resources to enhance teaching and learning in science
- 9.8** procedures, resources, and guidelines for maintaining a safe science learning environment
- 9.9** strategies and skills for effectively assessing student understanding and mastery of essential science concepts and skills