CERTIFICATION EXAMINATIONS FOR OKLAHOMA EDUCATORS™ (CEOE™)

OKLAHOMA SUBJECT AREA TESTS™ (OSAT™)

FIELD 004: CHEMISTRY

TEST FRAMEWORK

July 2013

	Subarea	Range of Competencies
I.	Nature of Science	0001–0003
II.	Structure of Matter	0004–0006
III.	Properties of Matter	0007–0009
IV.	Energy in Chemical Processes	0010–0012
V.	Chemical Reactions	0013–0017
VI.	Solutions and Quantitative Relationships	0018–0020

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SUBAREA I—NATURE OF SCIENCE

Competency 0001

Apply knowledge of scientific practices.

The following topics are examples of content that may be covered under this competency.

- Analyze processes by which new scientific knowledge is generated and the ethical issues related to the practice of scientific research.
- Apply knowledge of the principles and procedures for designing and carrying out scientific investigations.
- Apply knowledge of the methods and criteria for collecting, organizing, analyzing, presenting, and communicating scientific data.
- Analyze the design of a scientific experiment or investigation and interpret data using basic statistical methods.
- Apply procedures for the proper, safe, and legal use of equipment, materials, and chemicals in the chemistry classroom.
- Identify methods for maintaining safety in the chemistry classroom and recognize appropriate responses to safety incidents.

Competency 0002

Analyze the historical progression of scientific knowledge and the role of science in contemporary society.

The following topics are examples of content that may be covered under this competency.

- Analyze the significance of key events, theories, experiments, and individuals in the history of chemistry.
- Analyze social, economic, and ethical issues associated with technological and scientific developments.
- Analyze industrial processes, chemical processes in the home, and related safety issues.
- Assess the risks and benefits of nuclear materials and nuclear processes.
- Analyze how the release of chemicals affects the atmosphere, aquatic environments, and terrestrial environments.
- Analyze practices for preventing environmental damage resulting from the release of chemicals into the environment.

Competency 0003

Apply knowledge of the crosscutting concepts in the sciences.

The following topics are examples of content that may be covered under this competency.

- Demonstrate knowledge of major contemporary theories, laws, models, and concepts in engineering, physics, biology, and Earth and space science.
- Apply chemical theory to various sciences and disciplines outside of chemistry.
- Apply literacy skills to the interpretation and synthesis of scientific information from a range of sources.
- Analyze patterns and causal relationships in natural phenomena.
- Apply the concepts of scale, proportion, and quantity to the analysis of scientific phenomena and engineered systems.
- Use models to explain and predict scientific phenomena and to evaluate engineered solutions.
- Analyze natural and engineered systems and track the cycling of energy within them.
- Analyze the relationship between structure and function in natural and engineered systems.
- Analyze the stability of physical systems and the forces affecting stability.

SUBAREA II—STRUCTURE OF MATTER

Competency 0004

Analyze the atomic structure of matter.

The following topics are examples of content that may be covered under this competency.

- Analyze historical and contemporary models of atomic structure and the supporting evidence for these models.
- Relate interactions among electrons, protons, and neutrons to their properties (e.g., mass, charge).
- Analyze the relationships among electron energy levels, photons, and atomic spectra.
- Analyze the electron configurations of atoms and ions.

Competency 0005

Apply knowledge of the periodic table.

The following topics are examples of content that may be covered under this competency.

- Analyze the organization of the periodic table in terms of atomic number and properties of the elements.
- Analyze trends within periods and groups in the periodic table.
- Predict physical and chemical properties of given elements on the basis of their positions in the periodic table.
- Use the periodic table to gain information about given elements (e.g., relative reactivity).

Competency 0006

Apply knowledge of chemical nomenclature and chemical structure.

The following topics are examples of content that may be covered under this competency.

- Apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature to the naming of inorganic and organic compounds.
- Analyze the characteristics of ionic solids, network solids, and metallic solids.
- Analyze the chemical composition and basic structure of inorganic compounds.
- Recognize common organic compounds, including saturated, unsaturated, and aromatic hydrocarbons; nucleic acids; amino acids; carbohydrates; and lipids.
- Differentiate among structural, geometric, and optical isomers.

SUBAREA III—PROPERTIES OF MATTER

Competency 0007

Apply knowledge of the properties of matter.

The following topics are examples of content that may be covered under this competency.

- Differentiate among elements, compounds, and mixtures.
- Distinguish between physical and chemical changes in matter.
- Use physical and chemical properties to identify an unknown substance.
- Analyze the methods by which chemical and physical properties of matter are determined.

Competency 0008

Apply knowledge of kinetic molecular theory, the nature of phase changes, and the gas laws.

The following topics are examples of content that may be covered under this competency.

- Apply knowledge of the basic principles of kinetic molecular theory.
- Compare arrangements and movements of particles in the four states of matter.
- Analyze heating and cooling curves and phase diagrams.
- Apply knowledge of the relationships between temperature, pressure, and volume in gases.
- Solve problems involving the gas laws.

Competency 0009

Apply knowledge of nuclear processes.

The following topics are examples of content that may be covered under this competency.

- Compare the characteristics of the different types of emanations from radioactive materials.
- Analyze the processes of natural radioactivity and artificial transmutation.
- Solve problems involving the half-life of radioactive materials.
- Relate nuclear mass defect to nuclear binding energy.
- Analyze the processes of fission and fusion.

SUBAREA IV—ENERGY IN CHEMICAL PROCESSES

Competency 0010

Apply knowledge of the principles of thermodynamics and calorimetry.

The following topics are examples of content that may be covered under this competency.

- Analyze the three laws of thermodynamics and their application to chemical systems.
- Analyze the results of calorimetry experiments.
- Differentiate between heat and temperature.

Competency 0011

Analyze energy changes in chemical bonding, chemical reactions, and physical processes.

The following topics are examples of content that may be covered under this competency.

- Analyze energy changes due to the formation or breaking of chemical bonds.
- Solve problems involving energy changes during chemical reactions.
- Interpret potential energy diagrams of chemical reactions.
- Predict the spontaneity of given chemical reactions.
- Analyze energy changes involved in phase transitions, dissolving solutes in solvents, and diluting solutions.

Competency 0012

Apply knowledge of chemical bonding and intermolecular forces.

The following topics are examples of content that may be covered under this competency.

- Compare the characteristics of various types of chemical bonds.
- Analyze chemical bonding in terms of electron behavior and the factors that affect bond strength.
- Predict and interpret Lewis structures.
- Use the valence-shell electron-pair repulsion (VSEPR) model and valence-bond theory to predict molecular geometry and molecular polarity.
- Analyze the characteristics of various types of intermolecular forces.
- Predict the type of interaction between molecules of a given structure.
- Relate the properties of substances to their atomic bonds and intermolecular forces.

SUBAREA V—CHEMICAL REACTIONS

Competency 0013

Apply knowledge of the nature of chemical reactions.

The following topics are examples of content that may be covered under this competency.

- Classify different types of inorganic chemical reactions.
- Predict the outcomes of chemical reactions.
- Demonstrate knowledge of collision theory and the factors that influence reaction rate.
- Analyze rate problems and experimental rate data.
- Relate reaction mechanisms to rate laws.

Competency 0014

Apply knowledge of the principles of chemical equilibrium.

The following topics are examples of content that may be covered under this competency.

- Analyze the effects of concentration, pressure, temperature, and catalysts on chemical equilibrium.
- Apply Le Chatelier's principle to chemical systems.
- Solve problems involving equilibrium constants.
- Solve problems involving solubility product constants.

Competency 0015

Analyze the theories, principles, and applications of acid-base chemistry.

The following topics are examples of content that may be covered under this competency.

- Analyze acids and bases according to operational and conceptual definitions.
- Analyze the principles and applications of acid-base titration.
- Calculate the hydronium ion concentration, hydroxide ion concentration, and pH and pOH for acid, base, and salt solutions.
- Compare the relative strengths of given acids using knowledge of periodic relationships.

Competency 0016

Analyze oxidation-reduction reactions and electrochemical processes.

The following topics are examples of content that may be covered under this competency.

- Analyze processes that occur during oxidation-reduction reactions.
- Determine oxidation numbers and balance oxidation-reduction reactions.
- Analyze the components and operating principles of electrochemical cells and electrolytic cells.
- Predict whether a given oxidation-reduction reaction will occur using standard reduction potentials.

Competency 0017

Analyze organic reactions.

The following topics are examples of content that may be covered under this competency.

- Analyze common types of organic reactions (e.g., combustion, addition, substitution, polymerization, oxidation, esterification).
- Analyze the rates of reactions involving organic compounds on the basis of bond types and strengths.
- Apply knowledge of fundamental biochemical processes (e.g., photosynthesis, cellular respiration, fermentation).

SUBAREA VI—SOLUTIONS AND QUANTITATIVE RELATIONSHIPS

Competency 0018

Apply knowledge of solutions and suspensions.

The following topics are examples of content that may be covered under this competency.

- Compare the characteristics of different types of solutions and suspensions.
- Analyze factors affecting solubility (e.g., temperature, pressure, molecular structure).
- Analyze the colligative properties of solutions.
- Solve problems involving concentrations of solutions.

Competency 0019

Apply knowledge of the mole concept.

The following topics are examples of content that may be covered under this competency.

- Relate the mole to Avogadro's number.
- Solve problems involving molar mass, molecular and formula masses, and percent composition.
- Determine empirical and molecular formulas.

Competency 0020

Apply knowledge of stoichiometry.

The following topics are examples of content that may be covered under this competency.

- Interpret chemical notation.
- Balance chemical equations.
- Analyze net ionic equations.
- Solve stoichiometric problems involving moles, mass, volume, and energy.