Bemidji State University

8710.4750 TEACHERS OF SCIENCE – Chemistry 9-12 **FORM I-C MATRIX**

Professional Education Program Evaluation Report (PEPER II)	**MATRIX Form I-C**											
8710.4750 Teachers of Science-Chemistry 9-12	**Identify coding used to indicate placement or assignment of standards here: (example: K=knowledge, A= assessed)** **Insert COURSE NUMBER & ID below**											
Subp. 4. **Subject matter standards for teachers of chemistry.** A candidate for licensure as a teacher of chemistry in grades 9 through 12 must complete a preparation program under subpart 2, item C, that must include the candidate's demonstration of the knowledge and skills in items A to C.	**CHEM 1211**	**CHEM 1212**	**CHEM 2311**	**CHEM 2312**	**CHEM 2371**	**CHEM 2372**	**CHEM 2510**	**CHEM 2570**	**CHEM 3110**	**CHEM 3411**	**CHEM 3811**	**CHEM 3930 (Re-search)**
A. A teacher of chemistry must demonstrate a conceptual understanding of chemistry. The teacher must:												
(1) use sources of information to solve unfamiliar quantitative problems and communicate the solution in a logical and organized manner as evidenced by the ability to:												
(a) describe, in terms of the known and unknown quantities, a given problem in appropriate pictorial, graphical, or written forms;	KA	K					K	K		K	K	
(b) describe, in terms of the relevant numerical and algebraic quantities and equations, a given problem mathematically;	KA	K					K	K		K	K	
(c) plan, using words, diagrams, and mathematical relationships, a solution for a given problem in terms of steps necessary to solve the problem and to verify the solution; and	KA	K					K	K		K	K	
(d) evaluate, in terms of unit consistency, reasonableness, and completeness of solution, the solution of a given problem;	KA	K					K			K		
(2) use computers to display and analyze experimental and theoretical data as evidenced by the ability to:												

(a) describe data graphically using a computer; and	KA	K					K	K		K		
	CHEM 1211	**CHEM 1212**	**CHEM 2311**	**CHEM 2312**	**CHEM 2371**	**CHEM 2372**	**CHEM 2510**	**CHEM 2570**	**CHEM 3110**	**CHEM 3411**	**CHEM 3811**	
(b) design a mathematical model to provide a reasonable fit to a given set of data; and	KA	K					K	K		K		
(3) develop a plan to ensure a safe environment and practices in chemistry learning activities.									A			
B. A teacher of chemistry must demonstrate a knowledge of chemistry concepts. The teacher must:												
(1) understand the properties and structure of matter as evidenced by the ability to:												
(a) explain and predict, using the principles for filling the electron orbitals of atoms and the Periodic Table, the periodic trends in electrical conductivity, atomic radii, ionization energy, electronegativity, electron affinity, and metallic character of a given set of elements;	KA		K								K	
(b) predict, using the Periodic Table and the arrangement and energies of the element's outermost electrons, whether the bonding in a given substance is primarily covalent, metallic, or ionic;	K										KA	
(c) explain and predict, using the periodic trends in the physical and chemical characteristics of the elements and the type of bonds, or intermolecular forces, or both, the relative magnitudes of a given property for a set of elements or compounds;	K									K	KA	
(d) predict, using existing models including the Valence Shell electron Pair Repulsion theory, the shape of a given molecule; and	K		K	K							KA	
(e) describe, with words and diagrams using neutron to proton ratios and binding energies, the changes in matter and energy that occur in the nuclear processes of radioactive decay, fission, fusion, and other common nuclear transformations;		KA									K	

(2) understand chemical reactions as evidenced by the ability to:												
(a) perform measurements and calculations to determine the chemical formulas of the products of a given chemical reaction;	KA	K									K	
	CHEM 1211	**CHEM 1212**	**CHEM 2311**	**CHEM 2312**	**CHEM 2371**	**CHEM 2372**	**CHEM 2510**	**CHEM 2570**	**CHEM 3110**	**CHEM 3411**	**CHEM 3811**	
(b) explain and predict qualitatively and quantitatively, using the Periodic Table and the concept of chemical stoichiometry, the mass relationships between reactants and products for a given chemical reaction;	KA	K	K				K	K			K	
(c) predict quantitatively, using the principle of state functions and Hess's Law, the molar heat of a given reaction from known values of molar heats of formation or molar heats of a series of related reactions; and	KA		K	K								
(d) explain and predict qualitatively and quantitatively, using solubility rules, the common oxidation states of elements, the activity series of metals and nonmetals, stability of radicals, and the properties of acids and bases, the most likely type of reaction for a given set of given reactants;	K		K	K			K				KA	
(3) understand thermodynamics as evidenced by the ability to:												
(a) perform measurements and calculations to determine the molar heat energy absorbed or released in a given phase change or chemical reaction;	KA										K	
(b) predict qualitatively and quantitatively, using the Ideal Gas Law, changes in the pressure, volume, temperature, or quantity of gas in a given thermally isolated ideal gas system when the gas is heated or cooled, is compressed or expanded adiabatically, or enters or leaves the system;	KA						K					
(c) describe, using words, diagrams, energy graphs, and mathematical relationships, the changes in the enthalpy, entropy, and Gibb's free energy during a given chemical reaction;	KA	K	K							K	K	

(d) explain and predict qualitatively and quantitatively, using the First and Second Laws of Thermodynamics and the relationship between Gibb's free energy and the equilibrium constant, changes in the equilibrium and Gibb's free energy for a given change in the reaction conditions;		KA	K	K						K	K	
	CHEM 1211	**CHEM 1212**	**CHEM 2311**	**CHEM 2312**	**CHEM 2371**	**CHEM 2372**	**CHEM 2510**	**CHEM 2570**	**CHEM 3110**	**CHEM 3411**	**CHEM 3811**	
(e) design, using Gibb's free energy, a method for changing the direction of spontaneity of a given reaction; and		KA	K							K	K	
(f) explain qualitatively and quantitatively, using Gibb's free energy, how the electrochemical potential of a given cell depends on given changes in the temperature or the concentration of ions in solution, or both;		KA					K			K	K	
(4) understand chemical kinetics and equilibrium as evidenced by the ability to:												
(a) perform measurements and calculations to determine the rate of a chemical reaction, the rate expression, half-life of given reaction, the activation energy of a given reaction, and the equilibrium constant of a given reaction;		KA								K	K	
(b) describe, using words, energy diagrams, graphs, and mathematical relationships, the activation energy, enthalpy changes, and reaction rate of a given reaction;		KA	K	K						K	K	
(c) explain and predict qualitatively and quantitatively, using the rate equation for the reaction, changes in the reaction rate for a given change in the concentration of a reactant or product;		KA	K							K	K	
(d) predict, using the rate equation and the presence or absence of intermediates, a possible mechanism for a given reaction;		KA	K							K	K	
(e) describe, using words, diagrams, chemical equations, concentration and rate graphs, and mathematical relationships, the equilibrium of a given reaction;		KA								K		

(f) explain, in terms of changes in the number of effective collisions of the molecules in the forward and reverse reaction, why the chemical equilibrium of a given reaction is a dynamic process;		KA								K		
(g) explain and predict quantitatively, using the equilibrium constant, the concentration of a reactant or product in a given gas phase or solution chemical reaction;		KA					K					
	CHEM 1211	**CHEM 1212**	**CHEM 2311**	**CHEM 2312**	**CHEM 2371**	**CHEM 2372**	**CHEM 2510**	**CHEM 2570**	**CHEM 3110**	**CHEM 3411**	**CHEM 3811**	
(h) design, using LeChatelier's principle, a method for achieving a specified change in the equilibrium constant or the position of equilibrium of a given chemical reaction; and		KA	K	K			K			K	K	
(i) design, using the rate laws and requirements for effective collisions, a method for achieving a specified change in the rate of a given chemical reaction; and		KA	K	K						K	K	
(5) understand organic and biochemical reactions as evidenced by the ability to:												
(a) perform measurements and calculations to determine the melting point, boiling point, solubility, or other common physical properties of an organic compound;	K	K			KA					K		
(b) describe, using words, structural and chemical formulas, and physical and computer models, the functional groups and polarity of the molecule of a given organic compound;	K		KA							K	K	
(c) describe, using words, structural and chemical formulas, and physical or computer models, a given hydrocarbon compound as aromatic or aliphatic; saturated or unsaturated; alkanes, alkenes, or alkynes; and branched or straight chains;			KA	K						K		
(d) explain and predict, using a molecular orbital model of the pi-bond, the outcomes of reactions of given aromatic, allylic and conjugated alkenes, and other delocalized electron systems;				KA							K	

(e) explain and predict, using functional groups, structure, and polarity, the reactivity, solubility, melting point, and boiling point of an organic compound;	K		K	K		KA				K		
(f) predict, using infrared, nuclear magnetic resonance, and mass spectra, the structure of an organic molecule;			KA	K	K	K					K	
(g) design and carry out a single step synthesis of an organic compound, purify the compound, and characterize the product;			K	K	K	KA						
(h) describe, using words, diagrams, structural and chemical formulas, and physical and computer models, the origin of optical activity of a given chiral organic compound;			KA	K						K	K	
	CHEM 1211	**CHEM 1212**	**CHEM 2311**	**CHEM 2312**	**CHEM 2371**	**CHEM 2372**	**CHEM 2510**	**CHEM 2570**	**CHEM 3110**	**CHEM 3411**	**CHEM 3811**	
(i) explain why the reactivity of a chiral compound depends on its stereo chemistry when acted upon by a living system, and predict whether a particular substrate enantiomer would or would not react with its enzyme;			KA	K						K		
(j) describe, using words, structural and chemical formulas, and physical and computer models, a given set of biomolecules as a carbohydrate, lipid, protein, or nucleic acid, and explain how biomolecules are made from typical chemical components by chemical reactions;		KA		K						K		
(k) perform tests and measurements to determine if a given biological substance is a carbohydrate, lipid, protein, or nucleic acid;		KA								K		
(l) explain, using the concepts of electrostatic attraction, repulsion, and stereochemistry in the catalytic process, how enzymes facilitate a given biochemical reaction; and										KA		
(m) design a method to use organic compounds to demonstrate a given general chemical principle.			K		KA					K		

C. A teacher of chemistry must demonstrate an advanced conceptual understanding of chemistry and the ability to apply its fundamental principles, laws, and concepts by completing a full research experience. The teacher must:												
(1) identify various options for a research experience including independent study projects, participation in research with an academic or industry scientist, directed study, internship, or field study;											A	**A**
(2) select an option and complete a research experience that includes conducting a literature search on a problem;						A		A				**A**
(3) design and carry out an investigation;						A		A				**A**
(4) project; and identify modes for presenting the research						A		A				**A**
(5) present the research project in the selected mode.						A		A				**A**

Standards that integrate knowledge of science with knowledge of pedagogy, students, learning environments, and professional development were articulated in subpart 3 E of rule 8710.4750. These pedagogy standards need to be evidenced in addition to the specific content science standards.

	ED 3140	**ED 3203**	**ED 3350**	**SCI 3450**		
E. A teacher of science must have a broad-based knowledge of teaching science that integrates knowledge of science with knowledge of pedagogy, students, learning environments, and professional development. A teacher of science must understand:						
(1) curriculum and instruction in science as evidence by the ability to:						
(a) select, using local, state, and national science standards, appropriate science learning goals and content;				A		
(b) plan a coordinated sequence of lessons and instructional strategies that support the development of students' understanding and nurture a community of science learners including appropriate inquiry into authentic questions generated from students' experiences; strategies for eliciting students' alternative ideas; strategies to help students' understanding of scientific concepts and theories; and strategies to help students use their scientific knowledge to describe real-world objects, systems, or events;				A		
(c) plan assessments to monitor and evaluate learning of science concepts and methods of scientific inquiry; and				A		
(d) justify and defend, using knowledge of student learning, research in science education, and national science education standards, a given instructional model or curriculum;				A		
(2) safe environments for learning science as evidenced by the ability to:						

(a) use required safety equipment correctly in classroom, field, and laboratory settings;				A		
(b) describe, using knowledge of ethics and state and national safety guidelines and restrictions, how to make and maintain a given collection of scientific specimens and data;				A		
(c) describe, using knowledge of ethics and state and national safety guidelines and restrictions, how to acquire, care for, handle, and dispose of live organisms;				A		
(d) describe, using state and national guidelines, how to acquire, care for, store, use, and dispose of given chemicals and equipment used to teach science;				A		
(e) implement safe procedures during supervised science learning experiences in the public schools; and				A		
(f) develop a list of materials needed in an elementary science safety kit;				A		
(3) how to apply educational principles relevant to the physical, social, emotional, moral, and cognitive development of preadolescents and adolescents;			A			
(4) how to apply the research base for and the best practices of middle level and high school education;			A			
(5) how to develop curriculum goals and purposes based on the central concepts of science and how to apply instructional strategies and materials for achieving student understanding of the discipline;				A		
(6) the role and alignment of district, school, and department mission and goals in program planning;			A			
(7) the need for and how to connect students' schooling experiences with everyday life, the workplace, and further educational opportunities;	A					
	ED 3140	**ED 3203**	**ED 3350**	**SCI 3450**		
(8) how to involve representatives of business, industry, and community organizations as active partners in creating educational opportunities;	A					
(9) the role and purpose of cocurricular and extracurricular activities in the teaching and learning process;	A					
(10) the impact of reading ability on student achievement in science, recognize the varying reading comprehension and fluency levels represented by students, and possess the strategies to assist students to read science content more effectively; and		A				
(11) how to apply the standards of effective practice in teaching through a variety of early and ongoing clinical experiences with middle level and high school students within a range of educational programming models.				A		