Secondary Chemistry 2 Endorsement Specs

Purpose

This endorsement, when attached to a current Secondary Education License, verifies that the individual has the skills and knowledge necessary to teach students in an advanced secondary physical chemistry classroom and is required to teach Advanced Chemistry (AP, CE, and IB) and high school chemistry elective courses. Those with this endorsement can also teach all the courses a Chemistry 1 endorsed educator can teach. NOTE: Advanced Chemistry (AP, CE, and IB) courses may also include additional requirements in order to be approved by the university or college board to teach.

Endorsement Prerequisites

To be eligible for this endorsement, candidates must meet the following prerequisites:

- Have a Secondary Education License
- Have the Secondary Science Core Endorsement
- Have the Secondary Chemistry 1 Endorsement

Endorsement Requirement Areas

The Science Core Endorsement has the following 2 requirement areas:

1. Advanced Quantitative Chemistry Lab Content Knowledge
2. Advanced Chemistry Content Knowledge

Endorsement Type

A professional endorsement will be awarded when all of the requirement areas have been met. An associate endorsement will be awarded if the applicant holds a professional Chemistry 1 endorsement **OR** has completed at least 1 of the 2 requirement areas.

Requirement Area Options

The different options available to complete each of the requirement areas are described below. Quick links to the requirement area competencies are linked in parentheses.

Requirement Area 1: Advanced Quantitative Chemistry Lab Content Knowledge (C2.1)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Analytical Chemistry with Lab
    - Lab course is Required to meet this requirement

College Major (Meets Requirement Areas 1-2 for this endorsement)

- College Major in Chemistry, Chemistry Education, or a Chemistry Variation (e.g., Biochemistry, Geochemistry, Physical Chemistry)
- Other College Majors may be approved for this endorsement with approval of USBE Science Specialist based on a transcript review

Requirement Area 2: Advanced Chemistry Content Knowledge (C2.2)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Complete **TWO** 3+ credit university courses (passed with a grade of C or higher) in Advanced/Applied Chemistry in addition to the courses taken to meet Chemistry 1 Endorsement requirements (if applicable). Examples of course could include: Biochemistry I and/or II; Geochemistry I and/or II; Organic Chemistry I and/or II; Physical Chemistry I and/or II; or Quantitative Analysis.
    - **NOTE:** Lab course is not required but recommended

College Major (Meets Requirement Areas 1-2 for this endorsement)

- College Major in Chemistry, Chemistry Education, or a Chemistry Variation (e.g., Biochemistry, Geochemistry, Physical Chemistry)
- Other College Majors may be approved for this endorsement with approval of USBE Science Specialist based on a transcript review

Requirement Area Competencies

The Secondary Chemistry 2 competencies are organized into 1 section:

1. **Chemistry 2 Core Ideas** – This endorsement is required to teach Advanced Chemistry (AP, CE, and IB) and high school chemistry elective courses. These competencies and requirements go above that of the core ideas found in the SEEd Chemistry Standards.
   C2.1 Advanced Quantitative Chemistry Lab
   C2.2 Advanced Chemistry Content Knowledge

Each of the requirement area competencies are described below. Quick links to each requirement area options are provided in the parentheses.

Requirement Area 1 - Advanced Data Analysis Content Knowledge (Options)

Requirement Area C2.1: Advanced Quantitative Chemistry Lab

Area C2.1.A: Question, Methods, and Argumentation

- C2.1.A.a Identify a testable scientific question based on an observation, data, or a model
- C2.1.A.b Formulate a hypothesis or predict the results of an experiment.
- C2.1.A.c Identify experimental procedures that are aligned to a scientific question (which may include a sketch of a lab setup).
- C2.1.A.d Make observations or collect data from representations of laboratory setups or results, while attending to precision where appropriate.
- C2.1.A.e Identify or describe potential sources of experimental error.
- Explain how modifications to an experimental procedure will alter results.
- C2.1.A.f Make a scientific claim. and support it with evidence from experimental data.
- C2.1.A.g Support a claim with evidence from representations or models at the particulate level, such as the structure of atoms and/or molecules.
- C2.1.A.h Provide reasoning to justify a claim using chemical principles or laws, or using mathematical justification.
- C2.1.A.i Provide reasoning to justify a claim using connections between particulate and macroscopic scales or levels.

- C2.1.A.j Explain the connection between experimental results and chemical concepts, processes, or theories.
- C2.1.A.k Explain how potential sources of experimental error may affect the experimental results.

Area C2.1.B: Models, Data, Analysis, and Mathematical Routines

- C2.1.B.a Describe the components of and quantitative information from models and representations that illustrate particulate-level properties only.
- C2.1.B.b Describe the components of and quantitative information from models and representations that illustrate both particulate-level and macroscopic level properties.
- C2.1.B.c Represent chemical phenomena using appropriate graphing techniques, including correct scale and units.
- C2.1.B.d Represent chemical substances or phenomena with appropriate diagrams or models (e.g., electron configuration).
- C2.1.B.e Represent visually the relationship between the structures and interactions across multiple levels or scales (e.g., particulate to macroscopic).
- C2.1.B.f Explain chemical properties or phenomena (e.g., of atoms or molecules) using given chemical theories, models, and representations.
- C2.1.B.g Explain whether a model is consistent with chemical theories.
- C2.1.B.h Explain the connection between particulate-level and macroscopic properties of a substance using models and representations.
- C2.1.B.i Explain the degree to which a model or representation describes the connection between particulate-level properties and macroscopic properties.
- C2.1.B.j Identify quantities needed to solve a problem from given information (e.g., text, mathematical expressions, graphs, or tables).
- C2.1.B.k Identify an appropriate theory, definition, or mathematical relationship to solve a problem.
- C2.1.B.l Explain the relationship between variables within an equation when one variable changes.
- C2.1.B.m Identify information presented graphically to solve a problem.
- C2.1.B.n Determine a balanced chemical equation for a given chemical phenomenon.
- C2.1.B.o Calculate, estimate, or predict an unknown quantity from known quantities by selecting and following a logical computational pathway and attending to precision (e.g., performing dimensional analysis and attending to significant figures).

Requirement Area 2 - Advanced Life Science Content Knowledge (Options)

Requirement Area C2.2: Advanced Chemistry Content Knowledge

Area C2.2.A: Atomic and Molecular Structure and Properties

- C2.2.A.a Quantitative relationship between the mass spectrum of an element and the masses of the element's isotopes.
- C2.2.A.b Quantitative relationship between the elemental composition by mass and the composition of substances in a mixture.
- C2.2.A.c Represent the electron configuration of an element or ions of an element using the Aufbau principle
- C2.2.A.d Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength.
- C2.2.A.e Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.

- C2.2.A.f Represent a molecule with a Lewis diagram that accounts for resonance between equivalent structures or that uses formal charge to select between nonequivalent structures.
- C2.2.A.g Based on the relationship between Lewis diagrams, VSEPR theory, bond orders, and bond polarities: a) Explain structural properties of molecules. b) Explain electron properties of molecules.

Area C2.2.B: Intermolecular Forces and Properties

- C2.2.B.a Explain the relationship among the macroscopic properties of a substance, the particulate-level structure of the substance, and the interactions between these particles
- C2.2.B.b Explain the relationship between the macroscopic properties of a sample of gas or mixture of gases using the ideal gas law.
- C2.2.B.c Explain the relationship between the motion of particles and the macroscopic properties of gases with: a) The kinetic molecular theory (KMT). b) A particulate model. c) A graphical representation.
- C2.2.B.d Explain the relationship among non-ideal behaviors of gases, interparticle forces, and/or volumes.
- C2.2.B.e Calculate the number of solute particles, volume, or molarity of solutions.
- C2.2.B.f Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.
- C2.2.B.g Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.
- C2.2.B.h Explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region.
- C2.2.B.i Explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule.
- C2.2.B.j Explain the amount of light absorbed by a solution of molecules or ions in relationship to the concentration, path length, and molar absorptivity

Area C2.2.C: Chemical Reactions

- C2.2.C.a Explain the relationship between macroscopic characteristics and bond interactions for: a. Chemical processes. b. Physical processes.
- C2.2.C.b Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.
- C2.2.C.c Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.
- C2.2.C.d Identify a reaction as acid base, oxidation-reduction, or precipitation.
- C2.2.C.e Identify species as Brønsted Lowry acids, bases, and/or conjugate acid-base pairs, based on proton-transfer involving those species.
- C2.2.C.f Represent a balanced redox reaction equation using half-reactions.

Area C2.2.D: Kinetics

- C2.2.D.a Explain the relationship between the rate of a chemical reaction and experimental parameters.
- C2.2.D.b Identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time.
- C2.2.D.c Explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of molecular collisions.
- C2.2.D.d Represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile.
- C2.2.D.e Identify the components of a reaction mechanism

- C2.2.D.f Identify the rate law for a reaction from a mechanism in which the first step is rate limiting.
- C2.2.D.g Identify the rate law for a reaction from a mechanism in which the first step is not rate limiting.
- C2.2.D.h Represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile.
- C2.2.D.i Explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism.

Area C2.2.E: Thermodynamics

- C2.2.E.a Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation.
- C2.2.E.b Represent a chemical or physical transformation with an energy diagram.
- C2.2.E.c Calculate the heat *q* absorbed or released by a system undergoing heating/ cooling based on the amount of the substance, the heat capacity, and the change in temperature.
- C2.2.E.d Explain changes in the heat *q* absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition.
- C2.2.E.e Calculate the heat *q* absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction.
- C2.2.E.f Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction.
- C2.2.E.g Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.