Critical Chemistry Course Objectives

Unit 0: Introduction

Unit Goal
Students learn the basic skills required of a chemistry course including converting units, counting significant figures, and solving basic algebraic equations. This is completed through case studies and mini-math lessons that have students apply their basic chemistry skills to help solve real-world problems.

Topics Covered
Dimensional analysis, significant figures, algebraic equations, logarithms

Unit Standards

CME3: Perform calculations using dimensional analysis.

1. Students can state the purpose of dimensional analysis
2. Students can perform a dimensional analysis (up to 4 steps)

Topic	Lesson Name	Prerequisites	Lesson Objective
Dimensional Analysis	Case Study	-	Students will determine the correct dosage to administer to patients by solving a four-step dimensional analysis problem.
Basic Algebraic Equations	Case Study	-	Students will solve basic algebraic equation involving a single unknown variable, using this information to help a chef and a team of race car engineers with their job.
Logarithms	Case Study	-	Students will solve equations that contain logarithms and see how similar equations can be used to test the safety of a water source.
Significant figures	Guided Reading	-	Students will differentiate between exact numbers and values with uncertainty, determine the number of significant figures in a value, and apply the correct number of significant figures after completing basic mathematical operations.

Unit 1: Fighting Disease

Unit Goal
Students determine the parts of an atom and their placement, exploring how manipulating the parts of an atom can be used to treat cancer or create carcinogenic substances.

Topics Covered
Subatomic particles, mass number, atomic number, isotopes, radioactive decay, alpha/beta/gamma decay, nuclear reaction equations, valence electrons, octet rule, electron configuration,

Unit Standards

- CAT4:Atomic Structure: Determine the number of each subatomic particle in atoms, ions, and isotopes
- CNU4:Nuclear Chemistry: Identify and describe natural and artificial uses of nuclear chemistry
- CEB1:Electron Configuration: Determine the electron configuration of an element

Topic	Lesson Type	Prerequisites	Lesson Objective
Atomic Structure	Case Study	-	Identify, define, and manipulate the various subatomic particles in an atom, using that information to help treat a patient's liver cancer.
Nuclear Chemistry	Case Study	Lesson: Atomic structure or proficiency in identifying isotopes and calculating an atom's subatomic particles from the periodic table	Evaluate various isotopes and different forms radioactive decay to detect and destroy the thyroid cancer cells in a patient.
Electron Configuration	Case Study	Lesson: Atomic structure or proficiency in identifying isotopes and calculating an atom's subatomic particles from the periodic table	Write the electron configuration of an atom or ion in both shorthand, box, and exponential notation, applying this information to explain a chemical outbreak in Hinkley,CA.
PhET's Build an Atom	Mini-interactive	-	Define and create an ion by manipulating the net charge of an atom via a simulation.
Periodic Table	Guided Reading	-	Classify elements based on their position on the periodic table.

Periodic Trends	**Periodic Trends**	**Lesson: Periodic Table or proficiency in identifying the properties of an atom based on it's placement on the periodic table**	**Determine how the placement of elements on the periodic table correlates to their properties.**
Atomic Structure Problem Set	**Problem Set**	**Lesson: Atomic structure or proficiency in identifying isotopes and calculating an atom's subatomic particles from the periodic table**	**Students answer a series 10 progressively challenging questions aimed to assess their understanding on the learning objectives shown for this topic.**

Unit 2: Opioid Crisis

Unit Goal
In this unit, students explore the effects opioids have on the human body. Using their knowledge of molecular geometries and intermolecular forces, students will also piece together why certain drugs are more potent than others as well as why countermeasures such as Narcan can prevent overdosing.

Topics Covered
Lewis dot diagrams, valence electrons, bonding and nonbonding pairs, VSEPR theory, molecular geometry, electron-pair geometry, London dispersion forces, dipole-dipole interactions, ion-dipole interactions, and hydrogen bonding

Unit Standards

- CEB5: Lewis Structures: Sketch Lewis structures of covalent compounds.
- CEB9: Molecular Geometry: Determine the molecular geometry surrounding atoms within a covalent compound.
- CEB7: Intermolecular Forces: Describe the forces that hold particles together in condensed states of matter.

Topic	Lesson Type	Prerequisites	Lesson Objective
Lewis Structures	Case Study	-	Sketch Lewis structures of covalent compounds.
Molecular Geometry	Case Study	Lesson: Lewis Structures or proficiency in sketching the lewis structure of a molecule	Determine the molecular geometry surrounding atoms within a covalent compound.
Intermolecular Forces	Case Study	Lesson: Molecular Geometry	Describe the forces that hold particles together in condensed states of matter.
Types of Bonds	Guided Reading	-	Identify the chemical formula and the type of bonds in a substance based on its component elements
Ionic and Covalent Bonding	Guided Reading	Lesson: Types of Bonds or knowledge of the types of ionic and covalent compounds	Differentiate between ionic and covalent substances, explaining how each is formed as well as the properties for each
Chemical Nomenclature	Guided Reading	-	Determine how to name ionic and covalent compounds.
IMF Problem Set	Problem Set	Lesson: Intermolecular Forces or proficiency in identifying a bond's relative strength and type.	Students answer a series 10 progressively challenging questions aimed to assess their understanding on the

			learning objectives shown for this topic.

Unit 3: Clean Water

Unit Goal
In this unit, students will determine the best way to safeguard water supplies through investigating the contamination of bodies of water such as the Gulf of Mexico after the BP oil spill (Aqueous Solvation) or the municipal water supply in Flint, MI (Concentration). In the final lesson of this unit, Limiting Reactants, students take on a case from Japan in 1956 to uncover the source of contamination causing a mysterious and deadly disease outbreak.

Topics Covered
Aqueous Solvation, polarity, sphere of hydration, hydrogen bonding, nonpolar, "like-dissolves-like", intermolecular forces, solubility, ion-dipole force, solute, solution, solvent, concentration, molarity, the mole, limiting reactant, excess reactant, theoretical yield

Unit Standards

- CAQ2:Solutions Describe the process of aqueous solution formation on a molecular level including the role of intermolecular forces and spheres of hydration
- CAQ3:Concentration: Calculate the molar concentration of a solution in units of molarity (mol/L) and use that concentration in stoichiometric calculations
- CST5:Limiting Reactant: Solve stoichiometric problems including finding limiting reactant, mass of product, and percent yield.

Topic	Lesson Type	Prerequisites	Lesson Objective
Aqueous Solvation	Case Study	-	Students will analyze the structure of water to determine what can and cannot dissolve in it and use this information to save wildlife affected by an oil spill.
Concentration	Case Study	-	Calculate the molar concentration of a solution in units of molarity (mol/L) and use that concentration in stoichiometric calculations
Limiting Reactants	Case Study	Proficiency in identifying and interpreting the basic parts of a chemical reaction: reactants, products, and coefficients.	Solve stoichiometric problems including finding limiting reactant, mass of product, and percent yield.
Concentration Problem Set	Problem Set	Lesson: Concentration or proficiency in identifying the parts of a solution and its molar concentration	Students answer a series 10 progressively challenging questions aimed to assess their understanding on the learning objectives shown for this topic.

Unit 4: Poisons

Unit Goal
In this unit, students obtain basic chemistry skills such as balancing chemical equations, identifying types of reactions, and using data to determine the empirical or molecular formula of a compound. The Types of Chemical Reactions lesson explores how toxins can undergo a variety of reactions inside the human body. In the Empirical and Molecular Formulas lesson, students help a forensic team determine the identity of an unknown white powder left at the scene of a crime.

Topics Covered
Parts of a chemical equation, balancing chemical equations, coefficients, mole ratios, combustion, decomposition, single replacement, double replacement, neutralization, combination, oxidation, reduction, formula weight, molecular formula, empirical formula

Unit Standards

- CST3: Write balanced equations for chemical reactions including appropriate coefficients and phases.
- CST4: Identify various types of reactions including combustion, decomposition, single replacement, double replacement, neutralization, and combination.
- COR1: Define oxidation and reduction
- CST2: Empirical and Molecular Formulas: Determine the empirical formula of a compound from the molecular formula and elemental composition data.

Topic	Lesson Type	Prerequisites	Lesson Objective
Balancing Chemical Reactions	Case Study	-	Write balanced equations for chemical reactions including appropriate coefficients and phases.
Types of Reactions	Case Study	-	Classify various chemical reactions into the following categories: combustion, decomposition, single replacement, double replacement, neutralization, and combination.
Empirical and Molecular Formulas	Case Study	-	Determine the empirical formula of a compound from the molecular formula and elemental composition data.
Balancing Equations Problem Set	Problem Set	Lesson: Balancing Chemical Reactions	Students answer a series 10 progressively challenging questions aimed to assess their understanding on the learning objectives shown for this topic.

Unit 5: Healthy Living

Unit Goal

In this unit, students explore the concepts of acids and bases, gas laws, and thermochemistry. For each of these topics, students will participate in a case study in which they will apply their knowledge of chemistry to help solve the case. In the Acids and Bases lesson, students will help a medical team determine whether or not a baby has enough oxygen while being birthed. In the Thermochemistry lesson, students determine the correct formulation for an energy bar used to treat malnourishment.

Topics Covered

Arrhenius acids and bases, Bronsted-Lowry acids and bases, pH, pOH, the pH scale, Charles Law, Boyle's Law, Gay-Lussac's Law, Avogadro's Law, Combined Gas Law, enthalpy, entropy, bond energy, endothermic, exothermic

Unit Standards

- CAQ4: Acids and Bases: Describe acids and bases according to the Arrhenius and Bronsted-Lowry models.
- CAQ5:Acids and Bases: Calculate pH and pOH for a solution
- CGS2: Gas Laws: Use experimental data to make observations related to four gas laws and use these laws to predict the behavior of gases under various conditions.
- CTD1:Thermochemistry: Identify a reaction as endothermic or exothermic given enthalpy data for the reaction.
- CTD10: Bond Energy and Enthalpy: Apply the concept of enthalpy to describe the strength of bonds and energy stored in materials.

Topic	Lesson Type	Prerequisites	Lesson Objective
Acids and Bases	**Case Study**	**Lesson: Logarithms or proficiency in solving equations using the log and antilog operations.**	**Explain acids and bases according to the Arrhenius and Bronsted-Lowry models and calculate the pH and pOH for a solution**

Gas Laws	**Case Study**	**Lesson: Solving Basic Algebraic Equations or proficiency in solving equations involving a single unknown variable.**	**Use experimental data to make observations related to four gas laws and use these laws to predict the behavior of gases under various conditions.**
Thermochemistry	**Case Study**	**-**	**Identify a reaction as endothermic or exothermic given enthalpy data for the reaction.**
Solids	**Guided Reading**	**-**	**Differentiate between a variety of solids, analyzing how their molecular arrangement affects their macroscopic properties.**
Liquids	**Guided Reading**	**-**	**Determine how the intermolecular forces in liquids affect their macroscopic properties.**
Phase Diagrams	**Guided Reading**	**-**	**Explain the relationship between temperature, pressure, and a substance's phase through close examination of a phase diagram.**
Acids and Bases Problem Set	**Problem Set**	**Lesson: Acids and Bases**	**Students answer a series 10 progressively challenging questions aimed to assess their understanding on the learning objectives shown for this topic.**