

Proficiency Level Descriptors – Chemistry

Policy

Students who are designated Below Proficient (Level 1) will be able to perform up to the level described by the Proficiency Level Descriptor (PLD). Level 1 is the lowest reported proficiency designation; some student may perform below the provided description.

- Below Proficient – The Level 1 Student is below proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs significantly below the standard for his or her grade level, is likely able to partially access grade-level content and engage with higher-order thinking skills with extensive support.
- Approaching Proficient – The Level 2 Student is approaching proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs slightly below the standard for his or her grade level, is likely able to access grade-level content and engage in higher-order thinking skills with some independence and support.
- Proficient - The Level 3 Student is proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs at the standard for his or her grade level, is able to access grade level content, and engage in higher order thinking skills with some independence and minimal support.
- Highly Proficient - The Level 4 Student is highly proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs significantly above the standard for his or her grade level, is able to access above grade level content, and engage in higher order thinking skills independently.

Structure and Origin of Matter

Objective I.1 – Recognize the origin and distribution of elements in the universe.

- Below Proficient – The Level 1 Student - Identifies that all elements formed in stars.
- Approaching Proficient – The Level 2 Student - Recognizes that all matter in the universe is composed of the same elements.

- Proficient – The Level 3 Student - Identifies the distribution of elements. Compares the occurrence of heavier elements on Earth and in the universe.
- Highly Proficient – The Level 4 Student - Relates the assumption that matter in the universe has a common origin to matter on Earth and the distribution of elements in the universe.

Objective I.2 – Relate the structure, behavior, and scale of an atom to the particles that compose it.

- Below Proficient – The Level 1 Student – Identifies protons, neutrons, and electrons as parts of the atom. Identifies the protons of an element. Recognizes that the current model of the atom is based on historical evidence.
- Approaching Proficient – The Level 2 Student – Matches the charge and position of protons, neutrons, and electrons. Given texts that describe a discovery, makes connection to how the model of the atom has changed. States that there is a fixed number of atoms in a mole.
- Proficient – The Level 3 Student – Compares the relative sizes of protons, neutrons, and electrons. Explains the relationship between proton number and an element's identity. When given text, evaluates the limitation of atomic models. Relates the mass and the number of atoms to gram-sized quantities of matter in a mole.
- Highly Proficient – The Level 4 Student – Explains why atomic models are limited and gives specific evidence. Determines mass, number of atoms, or number of moles in a sample.

Objective I.3 – Correlate atomic structure and the physical and chemical properties of an element to the position of the element on the periodic table.

- Below Proficient – The Level 1 Students - Identifies the number of protons in atoms of an element using the periodic table. Recognizes that position on the periodic table is based on properties of the elements.
- Approaching Proficient – The Level 2 Student - Identifies the number of electrons in neutral atoms of an element using the periodic table. Recognizes that different isotopes have different masses. Explains that an element's properties determine its position on the period table.
- Proficient – The Level 3 Student - Determines the number of neutrons in a given isotope. Compares the protons and neutrons of different isotopes of the same element. Explains that properties of elements are

similar going down groups and properties of elements change across periods. Generalizes the trends of reactivity within a group.

- Highly Proficient – The Level 4 Student - Determines the number of neutrons in atoms using the periodic table. Makes the connection between the masses of isotopes and on the periodic table. Compares and contrasts the properties exhibited by elements within groups of the periodic table. Generalizes the trends of reactivity between groups.

Atoms and Energy

Objective II.1 – Evaluate quantum energy changes in the atom in terms of the energy contained in light emissions.

- Below Proficient – The Level 1 Student – Recognizes that light is energy. Recognizes that different elements have different emission spectra.
- Approaching Proficient – The Level 2 Student – Recognizes that there is a relationship between wavelength and energy of electromagnetic waves. Recognizes that the light being given off in an emission spectrum is energy. Recognizes that different colors have different energies.
- Proficient – The Level 3 Student – Given a graph, describes the relationship between wavelength and energy. Given experimental evidence, identifies an unknown element from its emission spectrum. Ranks colors of light based on energy. Indicates if energy is being absorbed or released by electrons from emission/absorption spectra evidence.
- Highly Proficient – The Level 4 Student – Calculates and describes the wavelength, energy, or frequency of a wave. Explains the connection between electron movement and the energy of the associated photons.

Objective II.2 – Evaluate how changes in the nucleus of an atom result in emission of radioactivity.

- Below Proficient – The Level 1 Student – Recognizes that radioactive elements give off radiation. Identifies that different types of radiation are classified by energy. Recognizes that a large amount of energy is given off in a nuclear reaction. Recognizes that nuclear radiation affects organisms.
- Approaching Proficient – The Level 2 Student – Recognizes alpha, beta, and gamma radiation as forms of radioactive decay. Identifies the mass, energy, and penetrating power of alpha, beta, and gamma radiation. Recognizes that there is a difference in the amount of

energy being given off between a nuclear reaction and a chemical reaction. Recognizes that overexposure to nuclear radiation is harmful to organisms.

- Proficient – The Level 3 Student – Recognizes and explains that radioactive particles and electromagnetic radiation are products of the decay of an unstable nucleus. Compares the mass, energy, and penetrating power of alpha, beta, and gamma radiation. Compares the amount of energy released in a nuclear reaction vs. a chemical reaction. Given text, identifies the effects of nuclear radiation on organisms.
- Highly Proficient – The Level 4 Student – Predicts the products of the decay of an unstable nucleus. Determines the type of radiation from data about penetration power. Compares the dangers of the three types of radiation to organisms. Compares the strong nuclear force to the amount of energy released in nuclear reactions. Given text, evaluates the effects of nuclear radiation on organisms.

Chemical Bonds

Objective III.1 – Analyze the relationship between the valence (outermost) electrons of an atom and the type of bond formed between atoms.

- Below Proficient – The Level 1 Student – Identifies that ions have an electrical charge. Identifies the three types of chemical bonds. Recognizes that electrons are involved in bonds.
- Approaching Proficient – The Level 2 Student – Defines valence electron. Recognizes that charges on ions come from gaining and losing electrons. Identifies the type of chemical bond based on the behavior of valence electrons. Recognizes that different types of bonds have different strengths.
- Proficient – The Level 3 Student – Determines the number of valence electrons from the periodic table. Predicts the charge of an atom when it forms an ion. Predicts the type of bond based on the behavior of valence electrons. Compares the different bond strengths relative to type of bond.
- Highly Proficient – The Level 4 Student – Based on the number of valence electrons, predicts reactivity. Understands why the group has a specific charge.

Objective III.2 - Explain that the properties of a compound may be different from those of the elements or compounds from which it is formed.

- Below Proficient – The Level 1 Student – Recognizes that chemical formulas are made of chemical symbols. Recognizes that different compounds have different physical and chemical properties.
- Approaching Proficient – The Level 2 Student – Given a chemical formula, determines the number of atoms of each element that are represented. Recognizes that compounds made of elements in differing proportions have different physical and chemical properties.
- Proficient – The Level 3 Student – Explains that each chemical formula is unique to a specific compound. Compares the physical and chemical properties of a compound to the elements that form it.
- Highly Proficient – The Level 4 Student – Writes the chemical formulas of unfamiliar compounds. Infers physical and chemical properties of unfamiliar compounds based on similarities to familiar compounds.

Objective III.3 – Relate the properties of simple compounds to the type of bonding, shape of molecules, and intermolecular forces.

- Below Proficient – The Level 1 Student – Recognizes that molecules with different types of bonds have different types of physical properties. Recognizes that molecules are polar or nonpolar. Recognizes that water has unique properties.
- Approaching Proficient – The Level 2 Student – Matches the physical properties of a molecule to the type of bond comprising the molecule. Recognizes that molecular shape produced by the orientation of bonds affects polarity. Recognizes that there is a connection between water's unique properties and hydrogen bonding.
- Proficient – The Level 3 Student – Given data, determines the physical properties of molecules with different bond types. Given a model, describes the shape and polarity of water, ammonia, and methane molecules. Identifies how hydrogen bonding affects water's properties.
- Highly Proficient – The Level 4 Student - Identifies the types of bonds of unknown compounds based on experimental data. Explains why water has its unique properties.

Chemical Reactions

Objective IV.1 - Identify evidence of chemical reactions and demonstrate how chemical equations are used to describe them.

- Below Proficient – The Level 1 Student – Recognizes that a visual change in the appearance of a substance can indicate a chemical reaction. Recognizes that a chemical reaction can be represented by a

chemical equation. Recognizes that chemical reactions occur every day.

- Approaching Proficient – The Level 2 Student – Recognizes that the release of heat and light are evidence of a chemical reaction. Recognizes that reactants and products do not have the same properties. Given a reaction, identifies the reactants and products of a reaction. Recognizes that the number of atoms in a chemical reaction do not change. Recognizes that coefficients indicate molar proportions. Distinguishes chemical reactions from examples of physical change.
- Proficient – The Level 3 Student – Describes all evidences of chemical reactions. Explains why the properties of products are independent of the properties of reactants. Given a reaction, writes a balanced chemical equation. Determines molar proportions from a balanced chemical equation. Gives examples of chemical reactions in everyday life.
- Highly Proficient – The Level 4 Student – Uses evidences of chemical reactions to predict products. Given the reactants of a chemical reaction, predicts the products and balances the equation. Uses molar proportions to predict the amount of products.

Objective IV.2 - Analyze evidence for the laws of conservation of mass and conservation of energy in chemical reactions.

- Below Proficient – The Level 1 Student – Recognizes that reactions can produce heat. States that batteries produce electricity through chemical reactions.
- Approaching Proficient – The Level 2 Student – Recognizes that mass cannot be created nor destroyed during a chemical reaction. Recognizes that the amount of product is determined by the amount of reactant. Defines exothermic and endothermic reactions. Recognizes that chemical reactions can absorb or produce energy.
- Proficient – The Level 3 Student – Interprets evidence supporting conservation of mass in reactions. Uses molar relationships from a balanced reaction to predict mass of product in a reaction that goes to completion. Analyzes evidence of energy transformation and classifies it as endothermic or exothermic. Describes how electrical energy is produced by an electrochemical cell.
- Highly Proficient – The Level 4 Student – Shows mathematically the conservation of mass in a chemical reaction. Determines which reactant is the limiting factor in a chemical reaction. Classifies everyday reactions as endothermic or exothermic. Explains why reversing a chemical reaction reverses the energy flow.

Equilibrium

Objective V.1 – Evaluate factors specific to collisions (e.g., temperature, particle size, concentration, and catalysts) that affect the rate of chemical reaction.

- Below Proficient – The Level 1 Student – Identifies factors that speed up or slow down reactions. Explains that collisions between particles must occur in order for reactions to happen. Recalls that some chemicals increase reaction rates.
- Approaching Proficient – The Level 2 Student – Follows a procedure to conduct an experiment comparing reaction rates. Identifies a trend in reaction rate from a graph. Correlates frequency of collisions to reaction rates. Identifies that catalysts are effective in increasing reaction rates.
- Proficient – The Level 3 Student – Conducts an experiment to determine factors affecting reaction rate. Interprets graphs to draw conclusions about reaction rates. Correlates frequency and energy of collisions to reaction rates. Describes how catalysts increase reaction rates.
- Highly Proficient – The Level 4 Student – Designs and conducts an experiment to determine factors affecting reaction rate. Makes inferences about the rates of unknown reactions based on similarities to known reactions. Uses information from graphs to draw conclusions about reaction rates and uses the findings to generalize the results to other reactions. Creates energy diagrams showing how catalysts affect reaction rate.

Objective V.2 - Recognize that certain reactions do not convert all reactants to products, but achieve a state of dynamic equilibrium that can be changed.

- Below Proficient – The Level 1 Student – Recognizes that not all reactions go to completion. Observes that equilibrium will change in different conditions.
- Approaching Proficient – The Level 2 Student – Recognizes that at equilibrium, amounts of reactants and products do not change. Given an equation, identifies the effect of adding either a product or a reactant to a shift in equilibrium. Indicates that temperature changes equilibrium.
- Proficient – The Level 3 Student – Explains the concept of dynamic equilibrium, showing that the rates of forward and reverse reactions are equal and that the reaction has not stopped. Given an equation, predicts how to shift equilibrium towards the product or reactant.

Indicates the effect of temperature change on equilibrium, using an equation containing a heat term.

- Highly Proficient – The Level 4 Student – Explains the concept of dynamic equilibrium, showing that the rates of forward and reverse reactions are equal, but the amounts of reactants and products are not usually equal. Describes uses of equilibrium in industry. Designs a method to shift equilibrium by altering reaction variables.

Solutions

Objective VI.1 - Describe factors affecting the process of dissolving and evaluate the effects that changes in concentration have on solutions.

- Below Proficient – The Level 1 Student – Identifies common chemical solutions. Describes the relative amount of solute particles in concentrated and dilute solutions. Identifies factors that affect the rate of dissolution.
- Approaching Proficient – The Level 2 Student – Identifies the solute and solvent in solutions given a description or model. Identifies examples of solutions and non-solutions from sketches. Given the molarity of different solutions, states which is more concentrated and which is more dilute. Follows a procedure to conduct an experiment to compare rates of dissolution. Connects the concept of ppm to environmental issues.
- Proficient – The Level 3 Student – Describes the action of dissolution at the molecular level. Sketches a solution, showing even distribution at the particle level. Expresses concentration in terms of molarity and molality. Conducts an experiment to determine factors affecting rate of dissolution. Draws conclusions from graphs of ppm about environmental issues.
- Highly Proficient – The Level 4 Student - Sketches a solution, showing direction of forces, relative numbers of solvent and solute particles, and separation of ions, at the particle level. Distinguishes between molarity and molality and calculates those quantities. Designs and conducts an experiment to determine factors affecting rate of dissolution.

Objective VI.2 - Summarize the quantitative and qualitative effects of colligative properties on a solution when a solute is added.

- Below Proficient – The Level 1 Student – Recognizes what boiling and freezing points are. Recognizes that solutes have practical applications.

- Approaching Proficient – The Level 2 Student – Recognizes that different concentrations of solutions have different boiling and freezing points. Determines the boiling or freezing point of a solution given a graph of concentration vs. temperature. Identifies an example of solutes being used in everyday applications.
- Proficient – The Level 3 Student – Recognizes that boiling point increases and freezing point decreases as concentration of solute increases. Measures change in boiling and/or freezing point of a solvent when a solute is added. Describes how colligative properties affect the behavior of solutions in everyday applications.
- Highly Proficient – The Level 4 Student - Designs an experiment to collect and analyze data and makes inferences about freezing or boiling point of different solutes in the same concentrations. Extrapolates examples of colligative properties to unfamiliar situations.

Objective VI.3 - Differentiate between acids and bases in terms of hydrogen ion concentration.

- Below Proficient – The Level 1 Student – Recognizes that the pH scale includes acids, bases, and neutral solutions. Recognizes that acids and bases neutralize each other. Recognizes that acids and bases are used in industry.
- Approaching Proficient – The Level 2 Student – Using a common indicator, classifies a solution as an acid or base. Identifies neutralization using simple acid-base titration. Recognizes that acids and bases are used differently in different industries. Recognizes that acids and bases affect the environment.
- Proficient – The Level 3 Student – Relates hydrogen ion concentration to pH values and to the terms acidic, basic, or neutral. Using an indicator, measures the pH of common household substances. Determines the relative acidity or basicity of solutions using simple acid-base titration. Reports on the uses of acids and bases in industry, citing evidence. Identifies ways that acids and bases affect the environment.
- Highly Proficient – The Level 4 Student - Recognizes the logarithmic nature of the pH scale. Determines the concentration of an acid or a base using simple acid-base titration. Describes situations and makes inferences about the uses of acids or bases in industry. Evaluates mechanisms by which pollutants modify the pH of environments.