# Course Outline
## Chemistry

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| **Developmental Module:** *The purpose of this module is to review skills that students need in order to be successful in other areas of the course.* | | |
| **Introductory Module: Fundamentals of Science** | | |
| Topic 1 | The Scientific Method | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>i) construction and defense of a scientific viewpoint. |
| Topic 2 | Measurement Systems | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>e) accurate recording, organization, and analysis of data through repeated trials;<br>g) mathematical manipulations using SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis; and<br>h) use of appropriate technology including computers, graphing calculators, and probe-ware for gathering data, communicating results, and using simulations to model concepts. |
| Topic 3 | Significant Figures | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>f) mathematical and procedural error analysis; and<br>g) mathematical manipulations using SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis. |
| Topic 4 | Graphing and Data Analysis | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>d) manipulation of multiple variables using repeated trials;<br>e) accurate recording, organization, and analysis of data through repeated trials;<br>f) mathematical and procedural error analysis; and<br>h) use of appropriate technology including computers, graphing calculators, and probe-ware for gathering data, communicating results, and using simulations to model concepts. |
| Topic 5 | Laboratory Equipment and Techniques | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>a) designated laboratory techniques; and<br>j) the use of current applications to reinforce chemistry |

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| | | concepts. |
| Topic 6 | Safety in the Lab | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>b) safe use of chemicals and equipment; and<br>c) proper response to emergency situations. |
| **Module 1: What is Chemistry?** | | |
| Topic 1 | Classification of Matter | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>h) chemical and physical properties. |
| Topic 2 | Properties of Matter | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>h) chemical and physical properties. |
| Topic 3 | Density | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>d) manipulation of multiple variables using repeated trials.<br>CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>h) chemical and physical properties. |
| Topic 4 | Separation Techniques | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>a) designated laboratory techniques; and |
| Topic 5 | Dimensional Analysis | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>g) mathematical manipulations using SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis. |
| **Module 2: Atomic Structure and the History of Atomic Theory** | | |
| Topic 1 | Foundations of Atomic Structure - Democritus and Dalton | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>i) historical and quantum models. |
| Topic 2 | The Electron | CH.2 The student will investigate and understand that the |

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| | | placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>c) mass and charge characteristics of subatomic particles; and<br>i) historical and quantum models. |
| Topic 3 | The Nucleus | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>c) mass and charge characteristics of subatomic particles; and<br>i) historical and quantum models. |
| Topic 4 | Parts of the Atom and Isotope Symbol | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>a) average atomic mass, mass number, and atomic number; and<br>c) mass and charge characteristics of subatomic particles. |
| Topic 5 | Nuclear Chemistry | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>b) isotopes, half-lives, and radioactive decay. |
| Topic 6 | Average Atomic Mass and Percent Abundance | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>a) average atomic mass, mass number, and atomic number. |
| Topic 7 | Mendeleev and the Periodic Table | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>d) families or groups;<br>e) periods; and<br>i) historical and quantum models. |
| **Module 3: Modern Atomic Theory, Electron Structure, and Periodicity** | | |
| Topic 1 | Light, the Quantum Concept, and the Photoelectric Effect | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>i) historical and quantum models. |
| Topic 2 | Bohr and the Hydrogen Atom | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>i) historical and quantum models. |
| Topic 3 | The Quantum Mechanical Model | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the |

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| | | investigations of:<br>g) electron configurations, valence electrons, and oxidation numbers; and<br>i) historical and quantum models. |
| Topic 4 | Electron Configuration and Orbital Diagrams | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>g) electron configurations, valence electrons, and oxidation numbers. |
| Topic 5 | Moseley and Periodic Law | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>f) trends including atomic radii, electronegativity, shielding effect, and ionization energy. |
| Topic 6 | Periodic Trends | CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of:<br>f) trends including atomic radii, electronegativity, shielding effect, and ionization energy. |
| **Module 4: Bonding, Formula Writing, and Nomenclature** | | |
| Topic 1 | Types of Chemical Bonds - Ionic, Covalent and Metallic | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>d) bonding types.<br>CH.6 The student will investigate and understand how basic chemical properties relate to organic chemistry and biochemistry. Key concepts include:<br>a) unique properties of carbon that allow multi-carbon compounds. |
| Topic 2 | Lewis Dot Structures | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>b) writing chemical formulas; and<br>c) bonding types.<br>CH.6 The student will investigate and understand how basic chemical properties relate to organic chemistry and biochemistry. Key concepts include:<br>a) unique properties of carbon that allow multi-carbon compounds. |
| Topic 3 | Ionic Formula Writing and Naming - Binary | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>a) nomenclature; and<br>c) writing chemical formulas. |

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| Topic 4 | Ionic Formula Writing and Naming - Ternary | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>a) nomenclature; and<br>c) writing chemical formulas. |
| Topic 5 | Naming Molecular Compounds | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>a) nomenclature; and<br>c) writing chemical formulas.<br>CH.6 The student will investigate and understand how basic chemical properties relate to organic chemistry and biochemistry. Key concepts include:<br>a) unique properties of carbon that allow multi-carbon compounds. |
| Topic 6 | VSEPR Theory and Orbital Hybridization | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>c) writing chemical formulas. |
| Topic 7 | Molecular Polarity | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>d) bonding types. |
| Topic 8 | Intermolecular Forces | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>d) phase changes. |
| **Module 5: Chemical Quantities and Composition** | | |
| Topic 1 | The Mole | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>b) stoichiometric relationships. |
| Topic 2 | Percent Composition | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>c) writing chemical formulas. |
| Topic 3 | Calculating Empirical and Molecular Formulas | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>c) writing chemical formulas. |
| **Module 6: Chemical Reactions** | | |
| Topic 1 | Writing and Balancing Chemical Equations | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>b) balancing chemical equations; and<br>c) writing chemical formulas. |
| Topic 2 | Types of Chemical | CH.3 The student will investigate and understand how |

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| | Reactions | conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types. |
| Topic 3 | Predicting Products | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types. |
| Topic 4 | Precipitate Reactions | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types. |
| Topic 5 | Net Ionic Equations and Spectator Ions | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types. |
| **Module 7: Stoichiometry** | | |
| Topic 1 | Mole Ratios | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>b) stoichiometric relationships. |
| Topic 2 | Mass to Mass Stoichiometry | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>b) stoichiometric relationships. |
| Topic 3 | Other Stoichiometry Variations: Gas Volumes, Density, Molarity | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>a) Avogadro's principle and molar volume. |
| Topic 4 | Limiting and Excess Reactants | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>b) stoichiometric relationships. |
| Topic 5 | Percent Yield | CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:<br>g) mathematical manipulations including SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis.<br>CH.6 The student will investigate and understand how basic chemical properties relate to organic chemistry and biochemistry. Key concepts include:<br>a) unique properties of carbon that allow multi-carbon compounds.<br>b) uses in pharmaceuticals and genetics, petrochemicals, plastics and food. |

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| **Module 8: Thermochemistry** | | |
| Topic 1 | Heat Changes Associated with Chemical Reactions, Hess' Law, and Reaction Profiles | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types; and<br>f) reaction rates, kinetics, and equilibrium. |
| Topic 2 | Catalysis and Activation Energy | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>f) reaction rates, kinetics, and equilibrium. |
| Topic 3 | Thermostoichiometry | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types.<br>CH.6 The student will investigate and understand how basic chemical properties relate to organic chemistry and biochemistry. Key concepts include:<br>b) uses in pharmaceuticals and genetics, petrochemicals, plastics and food. |
| Topic 4 | Entropy | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>f) reaction rates, kinetics, and equilibrium. |
| Topic 5 | Free Energy | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>f) reaction rates, kinetics, and equilibrium. |
| Topic 6 | Heat Changes Associated with Physical Changes and Heating Curves | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>e) molar heats of fusion and vaporization; and<br>f) specific heat capacity. |
| Topic 7 | Phase Change Calculations | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>e) molar heats of fusion and vaporization. |
| Topic 8 | Specific Heat Capacity | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>f) specific heat capacity. |
| Topic 9 | Calorimetry | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>e) molar heats of fusion and vaporization. |
| **Module 9: States of Matter and Gas Laws** | | |
| Topic 1 | Kinetic Molecular Theory | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction |

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| | | between particles. Key concepts include:<br>b) partial pressure and gas laws. |
| Topic 2 | Phase Diagrams and Vapor Pressure Diagrams | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>a) pressure, temperature, and volume;<br>c) vapor pressure; and<br>d) phase changes. |
| Topic 3 | Charles' Law, Boyle's Law, Avogadro's Principle, Gay-Lussac's Law, and the Combined Gas Law | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>a) pressure, temperature, and volume; and<br>b) partial pressure and gas laws. |
| Topic 4 | Ideal Gas Law | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>a) pressure, temperature, and volume; and<br>b) partial pressure and gas laws. |
| Topic 5 | Graham's Law | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>b) partial pressure and gas laws. |
| Topic 6 | Dalton's Law | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>b) partial pressure and gas laws. |
| Topic 7 | Gas Stoichiometry | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>b) stoichiometric relationships. |
| **Module 10: Solutions** | | |
| Topic 1 | Types of Mixtures | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>c) solution concentrations.<br>CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>e) molar heats of fusion and vaporization; and<br>g) colligative properties. |
| Topic 2 | Electrolytes | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>d) acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process. |

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| Topic 3 | Concentration Calculations | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>c) solution concentrations. |
| Topic 4 | Dilution | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>c) solution concentrations. |
| Topic 5 | Colligative Properties | CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:<br>g) colligative properties. |
| **Module 11: Acid/Bases, Neutralization, and Redox Reactions** | | |
| Topic 1 | pH and pOH | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>d) acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process. |
| Topic 2 | Naming of Acids | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>a) nomenclature. |
| Topic 3 | Neutralization Reactions | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>d) acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process. |
| Topic 4 | Titrations | CH.4 The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:<br>d) acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process. |
| Topic 5 | Oxidation Numbers | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types. |
| Topic 6 | Oxidation/Reductions Reactions | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>e) reaction types. |
| **Module 12: Kinetics and Equilibrium** | | |
| Topic 1 | Equilibrium Expressions - Kp, Ka, Kb, Ksp, Keq | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical |

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| | | formulas and balanced equations. Key concepts include:<br>f) reaction rates, kinetics, and equilibrium. |
| Topic 2 | Le Chatelier's Principle and Effects on Equilibrium | CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:<br>f) reaction rates, kinetics, and equilibrium. |