Chemistry Course Content Syllabus
Mr. Sutherland

1. **The Periodic Table** - The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. After completing this section you will be able to:

   - Relate the position of an element in the periodic table to its atomic number and atomic mass.
   - Use the periodic table to identify metals, semimetals, nonmetals, and halogens.
   - Use the periodic table to identify families and trends such as alkali metals, alkaline earth metals and transition metals, the lanthanide, actinide, and transactinide elements, trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.
   - Use the periodic table to determine the number of electrons available for bonding.
   - Use the periodic table to identify and know that the transuranium elements were synthesized and identified in laboratory experiments through the use of nuclear accelerators.
   - Describe how to relate the position of an element in the periodic table to its quantum electron configuration and to its reactivity with other elements in the table.
   - Know the experimental basis for Thomson's discovery of the electron and Rutherford's nuclear atom.
   - Know the experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.

2. **Chemical Bonds** - Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. After completing this section you will be able to:

   - Know how atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.
   - Know how chemical bonds between atoms in molecules such as H_2 , CH_4 , NH_3 , H_2CCH_2 , N_2 , Cl_2 , and many large biological molecules are covalent.
   - Know how salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.

- Know how intermolecular forces determine the states of matter.
- Know how to draw Lewis dot structures.
- Know how to predict the shape of simple molecules and their polarity from Lewis dot structures.

3. **Stoichiometry** - The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants is called stoichiometry. After completing this section you will be able to:

    - Know how to describe chemical reactions by writing balanced equations.
    - Know the definition, value, and use of the mole in stoichiometry calculations.
    - Know how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.
    - Know how to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic masses.
    - Know how to calculate limiting and excess reactants and percent yield in a chemical reaction.

4. **Gases** - The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. After completing this section you will be able to:

    - Know how the random motion of molecules and their collisions with a surface create the observable pressure on that surface.
    - Know how the random motion of molecules explains the diffusion of gases.
    - Know how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.
    - Know the values and meanings of standard temperature and pressure (STP).
    - Know how to convert between the Celsius and Kelvin temperature scales.
    - Know how to solve problems by using the ideal gas law: $PV = nRT$.
    - Know how to apply Dalton's law of partial pressures to describe the composition of gases and Graham's law to predict diffusion of gases.

5. **Acids and Bases** - Acids, bases, and salts are three classes of compounds that form ions in water solutions. After completing this section you will be able to:

    - Know the observable properties of acids, bases, and salt solutions.
    - Know acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.
    - Know the differences between strong and weak acids and bases.
    - Know how to use the pH scale to characterize acid and base solutions.
    - Know the Arrhenius, Brønsted-Lowry, and Lewis acid-base definitions.
    - Know how to calculate pH from the hydrogen-ion concentration.

6. **Solutions** - Solutions are homogeneous mixtures of two or more substances. After completing this section you will be able to:

    - Know the definitions of solute and solvent.
    - Know how to describe the dissolving process at the molecular level by using the concept of random molecular motion.
    - Know temperature, pressure, and surface area affect the dissolving process.
    - Know how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.
    - Know the relationship between the molality of a solute in a solution and the solution's depressed freezing point or elevated boiling point.

7. **Chemical Thermodynamics** - Energy is exchanged or transformed in all chemical reactions and physical changes of matter. After completing this section you will be able to:

    - Know how to describe temperature and heat flow in terms of the motion of molecules (or atoms).
    - Know how chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
    - Know how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.

8. **Reaction Rates** - Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. After completing this section you will be able to:

- Know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
- Know how reaction rates depend on such factors as concentration, temperature, and pressure.
- Know the role a catalyst plays in increasing the reaction rate.
- Know the definition and role of activation energy in a chemical reaction.

9. **Chemical Equilibrium** - Chemical equilibrium is a dynamic process at the molecular level. After completing this section you will be able to:

    - Know how to use Le Chatelier's principle to predict the effect of changes in concentration, temperature, and pressure.
    - Know how equilibrium is established when forward and reverse reaction rates are equal.
    - Know how to write and calculate an equilibrium constant expression for a reaction.

10. **Organic Chemistry** - The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. After completing this section you will be able to:

    - Know large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.
    - Know the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
    - Know amino acids are the building blocks of proteins.
    - Know the system for naming the ten simplest linear hydrocarbons and isomers that contain single bonds, simple hydrocarbons with double and triple bonds, and simple molecules that contain a benzene ring.

11. **Nuclear Chemistry** - Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. After completing this section you will be able to:

- Know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.
- Know the how to calculate the energy release per gram of material and that it is much larger in nuclear fusion or fission reactions than in chemical reactions.
- Know why some naturally occurring isotopes of elements are radioactive, as how isotopes are formed in nuclear reactions.
- Know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.
- Know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.
- Know how to calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed.