Unit 3: Intermolecular Forces and Properties

Content Area: **Science**
Course(s): **AP Chemistry**
Time Period: **Semester 1**
Length: **6 weeks**
Status: **Published**

Standards

SCI.9-12.5.2.12	All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.
SCI.9-12.5.2.12.A	All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.
SCI.9-12.5.2.12.A.1	Use atomic models to predict the behaviors of atoms in interactions.
SCI.9-12.5.2.12.A.2	Account for the differences in the physical properties of solids, liquids, and gases.
SCI.9-12.5.2.12.A.3	Predict the placement of unknown elements on the Periodic Table based on their physical and chemical properties.
SCI.9-12.5.2.12.A.4	Explain how the properties of isotopes, including half-lives, decay modes, and nuclear resonances, lead to useful applications of isotopes.
SCI.9-12.5.2.12.A.5	Describe the process by which solutes dissolve in solvents.
SCI.9-12.5.2.12.A.6	Relate the pH scale to the concentrations of various acids and bases.
SCI.9-12.5.2.12.A.a	Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.
SCI.9-12.5.2.12.A.b	Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.
SCI.9-12.5.2.12.A.c	In the Periodic Table, elements are arranged according to the number of protons (the atomic number). This organization illustrates commonality and patterns of physical and chemical properties among the elements.
SCI.9-12.5.2.12.A.d	In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.
SCI.9-12.5.2.12.A.e	Solids, liquids, and gases may dissolve to form solutions. When combining a solute and solvent to prepare a solution, exceeding a particular concentration of solute will lead to precipitation of the solute from the solution. Dynamic equilibrium occurs in saturated solutions. Concentration of solutions can be calculated in terms of molarity, molality, and percent by mass.
SCI.9-12.5.2.12.A.f	Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.
SCI.9-12.5.2.12.B.1	Model how the outermost electrons determine the reactivity of elements and the nature of the chemical bonds they tend to form.
SCI.9-12.5.2.12.B.2	Describe oxidation and reduction reactions, and give examples of oxidation and reduction reactions that have an impact on the environment, such as corrosion and the burning of fuel.
SCI.9-12.5.2.12.B.3	Balance chemical equations by applying the law of conservation of mass.

SCI.9-12.5.2.12.B.a	An atom's electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.
SCI.9-12.5.2.12.B.b	A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.
SCI.9-12.5.2.12.B.c	The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept.

Big Idea 3

Big Idea 3: Changes in matter involve the rearrangement and/or the reorganization of atoms and /or the transfer of electrons.

Learning Objective 3.1

LO 3.1 Students can translate among macroscopic observations of change, chemical equations, and particle views

Enduring Understanding 3.A

Enduring understanding 3.A: Chemical changes are represented by a balanced chemical equation that identifies the ratios with which reactants react and products form.

Essential knowledge 3.A.2

Essential knowledge 3.A.2: Quantitative information can be derived from stoichiometric calculations that utilize the mole ratios from the balanced chemical equations. The role of stoichiometry in real-world applications
is important to note, so that it does not seem to be simply an exercise done only by chemists.
a. Coefficients of balanced chemical equations contain information regarding the proportionality of the amounts of substances involved in the reaction. These values can be used in chemical calculations that apply the mole concept; the most important place for this type of quantitative exercise is the laboratory.
1. Calculate amount of product expected to be produced in a laboratory experiment.
2. Identify limiting and excess reactant; calculate percent and theoretical yield for a given laboratory experiment.

Learning Objective 3.3 and 3.4

LO 3.3 The student is able to use stoichiometric calculations to predict the results of performing a reaction in the laboratory and/or to analyze deviations from the expected results.
LO 3.4 The student is able to relate quantities (measured mass of substances, volumes of solutions, or volumes and pressures of gases) to identify stoichiometric relationships for a reaction, including situations involving limiting reactants and situations in which the reaction has not gone to completion.

Enduring understanding 3.B

Enduring understanding 3.B: Chemical reactions can be classified by considering what the reactants are, what the products are, or how they change from one into the other. Classes of chemical reactions include synthesis, decomposition, acid-base, and oxidation-reduction reactions.

Essential knowledge 3.B.1

Essential knowledge 3.B.1: Synthesis reactions are those in which atoms and/or molecules combine to form a new compound. Decomposition is the reverse of synthesis, a process whereby molecules are decomposed, often by the use of heat.
a. Synthesis or decomposition reactions can be used for acquisition of basic lab techniques and observations that help students deal with the abstractions of atoms and stoichiometric calculations

Learning Objective 3.5 and 3.6

LO 3.5 The student is able to design a plan in order to collect data on the synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.
LO 3.6 The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

Essential knowledge 3.B.2

Essential knowledge 3.B.2: In a neutralization reaction, protons are transferred from an acid to a base.
a. The amphoteric nature of water plays an important role in the chemistry of aqueous solutions, since water can both accept protons from and donate protons to dissolved species.
b. Acid-base reactions:
1. Only reactions in aqueous solutions are considered.
2. The Brønsted-Lowry concept of acids and bases is the focus of the course.
3. When an acid or base ionizes in water, the conjugate acid-base pairs can be identified and their relative strengths compared.

Learning Objective 3.7

LO 3.7 The student is able to identify compounds as Brønsted-Lowry acids, bases, and/or conjugate acid-base pairs, using proton-transfer reactions to justify the identification.

Essential knowledge 3.B.3

Essential knowledge 3.B.3: In oxidation-reduction (redox) reactions, there is a net transfer of electrons. The species that loses electrons is oxidized, and the species that gains electrons is reduced.
a. In a redox reaction, electrons are transferred from the species that is oxidized to the species that is reduced.

b. Oxidation numbers may be assigned to each of the atoms in the reactant and products; this is often an effective way to identify the oxidized and reduced species in a redox reaction.
c. Balanced chemical equations for redox reactions can be constructed from tabulated half-reactions.
d. Recognizing that a reaction is a redox reaction is an important skill; an apt application of this type of reaction is a laboratory exercise where students perform redox titrations.
e. There are a number of important redox reactions in energy production processes (combustion of hydrocarbons and metabolism of sugars, fats, and proteins).

Learning Objective 3.8 and 3.9

LO 3.8 The student is able to identify redox reactions and justify the identification in terms of electron transfer.
LO 3.9 The student is able to design and/or interpret the results of an experiment involving a redox titration.

Enduring understanding 3.C

Enduring understanding 3.C: Chemical and physical transformations may be observed in several ways and typically involve a change in energy.

Essential knowledge 3.C.1

Essential knowledge 3.C.1: Production of heat or light, formation of a gas, and formation of a precipitate and/or a color change are possible evidences that a chemical change has occurred.
a. Laboratory observations are made at the macroscopic level, so students must be able to characterize changes in matter using visual clues and then make representations or written descriptions.

b. Distinguishing the difference between chemical and physical changes at the macroscopic level is a challenge; therefore, the ability to investigate chemical properties is important.
c. In order to develop the ability to distinguish experimentally between chemical and physical changes, students must make observations and collect data from a variety of reactions and physical changes within the laboratory setting.
d. Classification of reactions provides important organizational clarity for chemistry; therefore, students need to identify precipitation, acid-base, and redox reactions.

Learning Objective 3.10

LO 3.10 The student is able to evaluate the classification of a process as a physical change, chemical change, or ambiguous change based on both macroscopic observations and the distinction between rearrangement of covalent interactions and noncovalent interactions.

Essential knowledge 3.C.2

Essential knowledge 3.C.2: Net changes in energy for a chemical reaction can be endothermic or exothermic.
a. Macroscopic observations of energy changes when chemicals react are made possible by measuring temperature changes.
b. These observations should be placed within the context of the language of exothermic and endothermic change.
c. The ability to translate observations made at the macroscopic level in the laboratory to a conceptual framework is aided by a graphical depiction of the process called an energy diagram, which provides a visual representation of the exothermic or endothermic nature of a reaction.
d. It is important to be able to use an understanding of energy changes in chemical reactions to identify the role of endothermic and exothermic reactions in realworld processes.

Learning Objective 3.11

LO 3.11 The student is able to interpret observations regarding macroscopic energy changes associated with a reaction or process to generate a relevant symbolic and/or graphical representation of the energy changes.

Essential knowledge 3.C.3

Essential knowledge 3.C.3: Electrochemistry shows the interconversion between chemical and electrical energy in galvanic and electrolytic cells.
a. Electrochemistry encompasses the study of redox reactions that occur within electrochemical cells. The reactions either generate electrical current in galvanic cells, or are driven by an externally applied electrical potential in electrolytic cells. Visual representations of galvanic and electrolytic cells are tools of analysis

to identify where half-reactions occur and the direction of current flow.
b. Oxidation occurs at the anode, and reduction occurs at the cathode for all electrochemical cells.
c. The overall electrical potential of galvanic cells can be calculated by identifying the oxidation half-reaction and reduction half-reaction, and using a table of Standard Reduction Potentials.
d. Many real systems do not operate at standard conditions; the electrical potential determination must account for the effect of concentrations. LeChâtelier's principle can be used to predict qualitatively the differences in electrical potential and electron flow compared to those at standard conditions.
e. The magnitude of the standard cell potential is proportional to $\Delta G°$ (standard Gibbs free energy) for the redox reaction from which it is constructed.
f. Faraday's laws can be used to determine the stoichiometry of the redox reactions occurring in an electrochemical cell with respect to the following:
i. Number of electrons transferred
ii. Mass of material deposited or removed from an electrode
iii. Current
iv. Time elapsed
v. Charge of ionic species

Learning Objective 3.12 and 3.13

LO 3.12 The student can make qualitative or quantitative predictions about galvanic or electrolytic reactions based on half-cell reactions and potentials and/ or Faraday's laws.
LO 3.13 The student can analyze data regarding galvanic or electrolytic cells to identify properties of the underlying redox reactions.

Resources

Powerpoint

Mass Relationships in Chemical Reactions

Chemical Equilibrium

Acids and Bases

Acids-Base Equilibrium and Solubility

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing