Curriculum Map: Chemistry

Course: CHEMISTRY Sub-topic: Chemistry

Grade(s): 10 to 12

Course Description: Chemistry is a lab-based course designed to introduce students to a broad range of topics within the study of the chemistry discipline, with a heavy emphasis on inorganic chemistry and mathematical relationships. The course provides a firm foundation of chemical principles needed for the further study of chemistry. The course stresses lab procedures, lab interpretation, problem solving skills and the scientific thought process. A strong command of algebraic skills is required. Students will be expected to move from concrete to abstract work to improve problem-solving skills, and develop concepts in preparation for higher level science courses

Unit: Unit A.1. Properties and Classification of Matter

Timeline: August to October

Month: Modern Chemistry textbook:

Chapter 1 - Aug/Sept (~10 days entire chapter + 3 intro to year days)

Chapter 2 - Sept/Oct (~18 days entire chapter)

Chapter 7 - Jan/Feb (~10 days on Nomenclature only)

Chapter 13 - May (~6 days)

Skills:

1. Classify physical or chemical changes within a system in terms of matter and/or energy.
2. Classify observations as qualitative and/or quantitative.
3. Utilize significant figures to communicate the uncertainty in a quantitative observation.
4. Relate the physical properties of matter to its atomic or molecular structure.
5. Apply IUPAC rules for naming compounds and writing chemical formulas. (e.g., binary covalent, binary ionic, polyatomic ionic)
6. Compare properties of solution containing ionic or molecular solutes. (e.g., dissolving vs. dissociating)
7. Differentiate between homogeneous and heterogeneous mixtures.
8. Describe how factors (temperature, concentration, surface area) can affect solubility.
9. Describe ways that concentration can be expressed and calculated. (e.g., molarity, percent by mass, percent volume)
10. Describe how chemical bonding can affect whether a substance dissolves in a given liquid.

Essential Questions: How are observable and measurable properties and changes used to classify and describe matter and energy?

How do different mixtures compare to each other?

Content:

1. Properties of Matter
2. States of Matter

3. Classification of Matter

4. Measurement

5. IUPAC Nomenclature of Compounds

6. Properties of Solutions

Assessments: Classwork

Homework

Lab Experiments

Quarter Projects

Tests and Quizzes

Vocabulary: chemistry (E)

matter (E)

energy (E)

kinetic energy (E)

potential energy (E)

thermal energy (heat) (I)

physical property (E)

chemical property (E)

physical change (E)

chemical change (E)

reactant (E)

product (E)

endothermic (E)

exothermic (E)

element (E)

compound (E)

mixture (E)

homogeneous (E)

heterogeneous (E)

solid (E)

liquid (E)

gas (E)

plasma (I)

qualitative (E)

quantitative (E)

significant figure (E)

binary (E)

polyatomic (E)

cation (E)

anion (E)

ionic (E)

molecular (E)

intermolecular force (E)

dipole-dipole bond (E)

hydrogen bonding (E)

London dispersion force (E)

solution (E)

solute (E)

solvent (E)

dissolve (E)

dissociate (E)

concentration (E)

solubility (E)

STANDARDS:

STANDARDS

NGSS Arranged by Disciplinary Core Idea (DCI) - Science (2013)

HS-PS1-1 (Advanced)	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-2 (Advanced)	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

STATE: Pennsylvania SAS Keystone Anchors (2010-2014)

CHEM.A.1.1 (Advanced)	Identify and describe how observable and measurable properties can be used to classify and describe matter and energy.
CHEM.A.1.1.1 (Advanced)	Classify physical or chemical changes within a system in terms of matter and/or energy.
CHEM.A.1.1.2 (Advanced)	Classify observations as qualitative and/or quantitative.
CHEM.A.1.1.3 (Advanced)	Utilize significant figures to communicate the uncertainty in a quantitative observation.
CHEM.A.1.1.4 (Advanced)	Relate the physical properties of matter to its atomic or molecular structure.
CHEM.A.1.1.5 (Advanced)	Apply a systematic set of rules (IUPAC) for naming compounds and writing chemical formulas (e.g., binary covalent, binary ionic, ionic compounds containing polyatomic ions).
CHEM.A.1.2 (Advanced)	Compare the properties of mixtures.
CHEM.A.1.2.1	Compare properties of solutions containing ionic or

(Advanced)	molecular solutes (e.g., dissolving, dissociating).
CHEM.A.1.2.2 (Advanced)	Differentiate between homogeneous and heterogeneous mixtures (e.g., how such mixtures can be separated).
CHEM.A.1.2.3 (Advanced)	Describe how factors (e.g., temperature, concentration, surface area) can affect solubility.
CHEM.A.1.2.5 (Advanced)	Describe how chemical bonding can affect whether a substance dissolves in a given liquid.

Topic:

Unit: Unit A.2. Atomic Structure and the Periodic Table
Timeline: October to November

Month:

Modern Chemistry textbook:

Chapter 3 - Oct (~6 days on Atomic theory and Structure only)

Chapter 22 - Oct (Projected 2022 school year; ~10 days estimated)

Chapter 4 - Oct/Nov (~12 days entire chapter)

Chapter 5 - Nov (~10 days entire chapter)

Skills:

1. Describe the evolution of atomic theory based on the models of Dalton, Thomson, Rutherford, and Bohr.

2. Differentiate between the mass number and average atomic mass of an element.

3. Determine the number of subatomic particles in a specific atom or ion.

4. Calculate the average atomic mass of an element.

5. Determine the product of a nuclear decay reaction. (projected 2022 school year)

6. Determine amounts of isotopes/ time elapsed in half-life scenarios. (projected 2022 school year)

7. Determine the missing reactant or product from a nuclear fission and fusion reaction. (projected 2022 school year)

8. Predict and write the ground state electron configuration for an element.

9. Predict the number of valence electrons of an atom or ion based on its location on the periodic table.

7. Explain the relationship between the electron configuration of an atom and its atomic structure. (Energy level, sublevel, orbital, electron spin)

8. Describe the quantized nature of energy levels and relate them to atomic spectra.

9. Predict and compare the properties of elements using their locations on the periodic table. (atomic radius, ionization energy, electron affinity, electronegativity, etc..)

Essential Questions:

1. How does atomic theory serve as the basis for the study of matter?

2. How do changes in the structure of a nucleus affect the properties of an atom? (Projected 2022)

3. How do electrons behave in an atom?

4. How do periodic trends allow for the prediction of physical and chemical properties of

elements?

Content:

1. Evolution of Atomic theory from Dalton to Quantum theory
2. Structure of the Atom (Subatomic Particles)
3. Average atomic mass
4. Nuclear reactions - Alpha decay, Beta decay, Gamma decay, Fission, and Fusion (Projected 2022 school year)
5. Half-life (Projected 2022 school year)
6. Electron arrangements
7. Organization of the Periodic Table
8. Periodic Properties and Trends

Assessments:

Classwork

Homework

Lab Experiments

Quarter Projects

Tests and Quizzes

Vocabulary:

proton (E)

neutron (E)

electron (E)

nucleus (E)

energy level (E)

atomic number (E)

mass number (E)

average atomic mass (E)

atom (E)

isotope (E)

ion (E)

cation (E)

anion (E)

law of conservation of mass (E)

law of definite proportions (E)

law of multiple proportions (E)

half-life (E)

ground state (I)

excited state (I)

energy level (E)

sublevel (E)

orbital (E)

electron spin (E)

quantized (C)

valence electrons (E)

s, p, d, f orbital shapes (E)

group (E)

family (E)

alkali metal (E)

alkaline earth metal (E)

halogen (E)

noble gas (E)

transition metal (E)

lanthanide (E)

actinide (E)

atomic radius (E)

electrongegativity (E)

ionization energy (I)

electron affinity (I)

STANDARDS:

STANDARDS

NGSS Arranged by Disciplinary Core Idea (DCI) - Science (2013)

HS-PS1-1 (Advanced)	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-2 (Advanced)	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-3 (Advanced)	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
HS-PS1-7 (Advanced)	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
HS-PS1-8 (Advanced)	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

STATE: Pennsylvania SAS Keystone Anchors (2010-2014)

CHEM.A.2 (Advanced)	Atomic Structure and the Periodic Table
CHEM.A.2.1 (Advanced)	Explain how atomic theory serves as the basis for the study of matter.
CHEM.A.2.1.1 (Advanced)	Describe the evolution of atomic theory leading to the current model of the atom based on the works of Dalton, Thomson, Rutherford, and Bohr.
CHEM.A.2.1.2 (Advanced)	Differentiate between the mass number of an isotope and the average atomic mass of an element.
CHEM.A.2.2 (Advanced)	Describe the behavior of electrons in atoms.
CHEM.A.2.2.1 (Advanced)	Predict the ground state electronic configuration and/or orbital diagram for a given atom or ion.
CHEM.A.2.2.2 (Advanced)	Predict characteristics of an atom or an ion based on its location on the periodic table (e.g., number of valence electrons, potential types of bonds, reactivity).
CHEM.A.2.2.3 (Advanced)	Explain the relationship between the electron configuration and the atomic structure of a given atom or ion (e.g., energy levels and/or orbitals with electrons, distribution of electrons in orbitals, shapes of orbitals).
CHEM.A.2.2.4 (Advanced)	Relate the existence of quantized energy levels to atomic emission spectra.
CHEM.A.2.3 (Advanced)	Explain how periodic trends in the properties of atoms allow for the prediction of physical and chemical properties.
CHEM.A.2.3.1 (Advanced)	Explain how the periodicity of chemical properties led to the arrangement of elements on the periodic table.
CHEM.A.2.3.2 (Advanced)	Compare and/or predict the properties (e.g., electron affinity, ionization energy, chemical reactivity, electronegativity, atomic radius) of selected elements by using their locations on the periodic table and known trends.

Topic:

Unit: Unit B.1. The Mole and Chemical Bonding
Timeline: November to January

Month: Modern Chemistry textbook

Chapter 3 - October (~6 days on the Mole concept)

Chapter 6 - December/January (~18 days entire chapter)

Chapter 7 - February (~8 days on Mathematical applications only)

Chapter 13 - April/May (~4 days on Molarity and molality)

Skills:

1. Be able to use electron configurations and the periodic table to draw an electron dot symbol for a given element.

2. Draw Lewis diagrams for compounds containing ionic and covalent bonds.

3. Explain the tenants of the VSEPR theory.

4. Identify the shapes of molecules based on arrangement of atoms in a molecule.

5. Identify the polarity of a molecule based on its structure.

6. Describe properties of matter that are affected by the polarity of a molecule.

5. Use the factor-label method to perform atoms/molecules to moles to grams conversions.

7. Calculate the molar mass of a substance based on its chemical composition.

8. Apply the law of definite proportions by calculating the percentage composition of a compound.

9. Calculate the empirical and molecular formulas for compounds.

10. Calculate the Molarity of a solution.

Essential Questions:

1. What are the different ways in which elements bond to form compounds?

2. How does a mole contribute to the understanding of quantitative chemistry?

Content:

1. Electron Dot Symbols

2. Ionic and Covalent Bond Formation (Lewis Structures)

3. VSEPR Theory and Molecular Shapes

4. Polarity of molecules

5. Avogadro's number (counting atoms)

6. Molar Mass

7. Percentage Composition, Empirical Formula, Molecular Formulas

8. Molarity of Solutions

Assessments:

Classwork

Homework

Lab Experiments

Quarter Projects

Tests and Quizzes

Vocabulary:

valence electron (E)

electron configuration (E)

electron dot symbol (E)

Lewis diagram/Lewis structure (E)

ionic bond (E)

covalent bond (E)

Valence Shell Electron Pair Repulsion Theory/VSEPR (E)

linear (E)

bent (E)

trigonal planar (E)

trigonal pyramidal (E)

tetrahedral (E)

trigonal bipyramidal (E)

octahedral (E)

polar (E)

nonpolar (E)

mole (E)

Avogadro's number (E)

molar mass (E)

percentage composition (E)

empirical formula (E)

molecular formula (E)

solution (E)

solute (E)

solvent (E)

molarity (E)

STANDARDS:

STANDARDS

NGSS Arranged by Disciplinary Core Idea (DCI) - Science (2013)

HS-PS1-1 (Advanced)	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-3 (Advanced)	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
HS-PS1-7 (Advanced)	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

STATE: Pennsylvania SAS Keystone Anchors (2010-2014)

CHEM.B.1 (Advanced)	The Mole and Chemical Bonding
CHEM.B.1.1 (Advanced)	Explain how the mole is a fundamental unit of chemistry.
CHEM.B.1.1.1 (Advanced)	Apply the mole concept to representative particles (e.g., counting, determining mass of atoms, ions, molecules, and/or formula units).
CHEM.B.1.2 (Advanced)	Apply the mole concept to the composition of matter.
CHEM.B.1.2.1 (Advanced)	Determine the empirical and molecular formulas of compounds.
CHEM.B.1.2.2 (Advanced)	Apply the law of definite proportions to the classification of elements and compounds as pure substances.
CHEM.B.1.2.3 (Advanced)	Relate the percent composition and mass of each element present in a compound.
CHEM.B.1.3 (Advanced)	Explain how atoms form chemical bonds.

CHEM.B.1.3.1 (Advanced)	Explain how atoms combine to form compounds through ionic and covalent bonding.
CHEM.B.1.3.2 (Advanced)	Classify a bond as being polar covalent, non-polar covalent, or ionic.
CHEM.B.1.3.3 (Advanced)	Use illustrations to predict the polarity of a molecule.
CHEM.B.1.4 (Advanced)	Explain how models can be used to represent bonding.
CHEM.B.1.4.1 (Advanced)	Recognize and describe different types of models that can be used to illustrate the bonds that hold atoms together in a compound (e.g., computer models, ball-and-stick models, graphical models, solid-sphere models, structural formulas, skeletal formulas, Lewis dot structures).
CHEM.B.1.4.2 (Advanced)	Utilize Lewis dot structures to predict the structure and bonding in simple compounds.

This Curriculum Map Unit has no Topics to display

Unit: Unit B.2. Chemical Relationships and Reactions
Timeline: January to May

Month:

Modern Chemistry Textbook

Chapter 8 - Feb/Mar (~15 days entire chapter)

Chapter 9 - March (~15 days entire chapter)

Chapter 10 - April (~6 days entire chapter)

Chapter 11 - April (~8 days entire chapter)

Skills:

1. Classify chemical reactions as synthesis, decomposition, single replacement, double replacement, and combustion.

2. Predict the products of a chemical reaction given the identity of the reactants.

3. Balance a chemical equation.

4. Perform stoichiometry calculations using the masses of reactants and products.

5. Describe the roles of limiting and excess reactants and calculate the left-overs of a chemical reaction.

6. Describe the physical properties of a gas using the Kinetic Molecular Theory.

7. Apply and perform calculations using the gas laws (Boyle, Charles, Ideal, etc...)

8. Perform stoichiometry calculations using molar volume of a gas at STP.

Essential Questions:

1. What are the chemical and mathematical processes involved with chemical reactions?

2. How does the kinetic molecular theory define the physical and mathematical characteristics of gases?

Content:

1. Classifying Chemical Reactions
2. Balancing Equations
3. Predicting products of chemical reactions
4. Stochiometry calculations of reactant and products
5. Limiting and Excess reactants
6. Kinetic molecular theory
7. The Gas Laws

Assessments:

Classwork

Homework

Lab Experiments

Quarter Projects

Tests and Quizzes

Vocabulary:

reactants (E)

products (E)

yield (I)

synthesis (E)

decomposition (E)

single replacement (E)

double replacement (E)

combustion (E)

mole ratio (E)

Law of conservation of mass (E)

coefficient (E)

subscript (E)

limiting reactant (E)

excess reactant (E)

pressure (E)

volume (E)

temperature (E)

Standard Temperature and Pressure (E)

Boyle's Law (E)

Charles' Law (E)

Gay-Lussac's Law (I)

Combined Gas Law (I)

Dalton's Law of Partial Pressures (I)

Grahams' Law of Effusion/Diffusion (C)

Ideal Gas Law (E)

Avogadro's Gas Law / Molar Volume of a gas (E)

STANDARDS:

STANDARDS

NGSS Arranged by Disciplinary Core Idea (DCI) - Science (2013)

HS-PS1-4 (Advanced)	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
HS-PS1-5 (Advanced)	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-6 (Advanced)	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-PS1-7 (Advanced)	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

STATE: Pennsylvania SAS Keystone Anchors (2010-2014)

CHEM.B.2 (Advanced)	Chemical Relationships and Reactions
CHEM.B.2.1 (Advanced)	Predict what happens during a chemical reaction.
CHEM.B.2.1.1 (Advanced)	Describe the roles of limiting and excess reactants in chemical reactions.
CHEM.B.2.1.2 (Advanced)	Use stoichiometric relationships to calculate the amounts of reactants and products involved in a chemical reaction.
CHEM.B.2.1.3 (Advanced)	Classify reactions as synthesis, decomposition, single replacement, double replacement, or combustion.
CHEM.B.2.1.4 (Advanced)	Predict products of simple chemical reactions (e.g., synthesis, decomposition, single replacement, double replacement, combustion).
CHEM.B.2.1.5 (Advanced)	Balance chemical equations by applying the Law of Conservation of Matter.
CHEM.B.2.2 (Advanced)	Explain how the kinetic molecular theory relates to the behavior of gases.
CHEM.B.2.2.1 (Advanced)	Utilize mathematical relationships to predict changes in the number of particles, the temperature, the pressure, and the volume in a gaseous system (i.e., Boyle's law, Charles's law, Dalton's law of partial pressures, the combined gas law, and the ideal gas law).
CHEM.B.2.2.2 (Advanced)	Predict the amounts of reactants and products involved in a chemical reaction using molar volume of a gas at STP.

This Curriculum Map Unit has no Topics to display