St. Joseph Public Schools

Science Curriculum

Honors Chemistry

2018 - 2019

Year at a Glance

Name of Unit	Learning Goals (The student will be able to...)	Essential Standards
Unit 1: Analyzing Data/Matter-Properties and Changes	• Identify SI base units for time, length, mass and temperature. (Patterns) • Determine how derived units are different for volume and density. (Patterns) • Be able to use scientific notation to express numbers. (Scale, Proportion and Quantity) • Use dimensional analysis (factor-label) to solve problems. (Scale, Proportion and Quantity) • Be able to apply precision and accuracy to a set of data. (Patterns) • Be able to calculate percent error. (Patterns) • Be able to use significant figure rules in all calculations. (Patterns) • Be able to use the accepted graphing techniques when constructing a graph. (Patterns) • Be able to identify a substance. (Structure and Function) • Determine the differences between chemical and physical properties. (Cause and Effect) • Differentiate between chemical and physical changes. (Cause and Effect) • Apply the law of conservation of mass to a chemical reaction. (Scale, Proportion and Quantity) • Identify and differentiate between mixtures and substances. (Structure and Function) • Be able to apply the law of definite and multiple proportions. (Patterns)	HS-PS1-1 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-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. * HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

	• Distinguish between elements and compounds. (Patterns)	
Unit 2: Structure of the Atom/Electrons in Atoms/Periodic Table and Periodic Law	• Determine the similarities and differences of the atomic models of Democritus, Aristotle, and Dalton.(Patterns) • Apply Dalton's atomic theory to explain the law of conservation of mass. (Systems and System Models) • Differentiate between the subatomic particles in terms of mass and charge. (Structure and Function) • Identify the positions of each subatomic particles. (Scale, Proportion and Quantity) • Use atomic numbers to identify elements. (Patterns) • Be able to use atomic number and mass number to identify the number of subatomic particles in an isotope. (Patterns) • Identify the three types of radiation and how it relates to particle size and charge. (Patterns) • Be able to explain the wave-particle duality of light. (Energy and Matter in Systems) • Identify quanta and how it's related to energy change of matter. (Scale, Proportion and Quantity) • Explain the relationship between emission spectra and the electromagnetic spectrum. (Patterns) • Explain how the Bohr and quantum mechanical models of the atom compare. (Systems and System Models) • Use deBroglie's hypothesis to explain the motion of particles. (Cause and Effect) • Relate energy levels to sublevels of the atom. (Patterns) • Use the Pauli Exclusion Principle, aufbau principle, and Hund's rule to write electron configurations. (Systems and System Models)	HS-PS1-1 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 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-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. * HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model,

	• Be able to identify the number of valence electrons and use that information to write electron-dot diagrams. (Patterns) • Explain the history behind the development of the periodic table. (Systems and System Models) • Identify the main parts of the periodic table and relate it to electron configurations. (Patterns) • Be able to use the periodic table to understand the trends of atomic radius, ionization energy and electronegativity. (Patterns)	and that for some situations one model is more useful than the other. HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
Unit 3: Ionic and Covalent Bonding	**1. Identify what the general idea of what a bond is. (System and System Models)** **2. Be able to explain how positive and negative ions form. (Cause and Effect)** **3. Relate electron configuration to the type of ion formed. (Cause and Effect)** **4. Explain the process of the formation of an ionic bond. (Cause and Effect)** **5. Relate ionic bond strength to chemical and physical properties. (Structure and Function)** **6. Know the energetics of bond breaking and bond formation. (Energy and Matter in Systems)** **7. Be able to write formulas and names of ionic compounds to include binary, polyatomic ions and transition metals. (Patterns)** **8. Identify the characteristics of metallic bonds. (Structure and Function)** **9. Explain how the "sea of electrons" account for the properties of metals. (Structure and Function)** **10. Apply the octet rule to the formation of covalent bonds. (Patterns)** **11. Explain the reasoning behind the formation of single, double and triple covalent bonds. (Systems and System Models)**	HS-PS1-1 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 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-PS2-6 Communicate scientific and technical information about why the molecularlevel structure is important in the functioning of designed materials. * HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

	12. Identify sigma and pi bonds in a Lewis Structure. (Patterns) 13. Relate bond strength to bond length and bond dissociation energy. (Scale, Proportion and Quantity) 14. Be able to name molecular compounds. (Patterns) 15. Be able to name binary acids and oxyacids. (Patterns) 16. Be able to draw Lewis Structures. (Patterns) 17. In a Lewis Structure, be able to use VSEPR theory to identify the following: geometry, bond angle, polarity and resonance(if any) of a molecule. (Systems and Systems Models) 18. Identify the hybridization of the central atom and relate it to the electron domains. (Patterns)	
Unit 4 Chemical Reactions, The Mole and Stoichiometry	1. Identify the reactants and products of a chemical reaction. (Patterns) 2. Be able to predict the products of the following types of reactions: (Systems and System Models) a. synthesis b. single displacement(replacement)-be able to use the activity series to determine if a reaction occurs. c. double displacement-be able to use a solubility table to predict if a product is soluble or aqueous. d. decomposition of binary compounds, carbonates and chlorates. 3. Relate how the mole is used to indirectly count the number of particles of matter. (Scale, Proportion and Quantity) 4. Be able to convert from moles to mass, heat and volume. (Scale, Proportion and Quantity)	HS-PS1-2 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-PS1-4 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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

	5. **Be able to determine the empirical and molecular formulas of a compound. (Patterns)** 6. **Be able to calculate the percent composition of a compound. (Scale, Proportion and Quantity)** 7. **Be able to calculate the formula of a hydrate. (Scale, Proportion and Quantity)** 8. **Use the coefficients of a balanced reaction to identify the mole ratio. (Patterns)** 9. **Be able to solve mass-mass, mass-heat, and mass-volume problems. (Scale, Proportion and Quantity)** 10. **Be able to solve a limiting reactant problem. (Scale, Proportion and Quantity)** 11. **Be able to calculate the percentage yield. (Scale, Proportion and Quantity)**	
Unit 5 States of Matter, Mixtures and Solutions	1. **Use the kinetic molecular theory to explain the behavior of gases. (Systems and System Models)** 2. **Be able to use Graham's Law to determine the relative rates of diffusion and effusion. (Systems and System Models)** 3. **Be able to identify if a molecule contains London Dispersion Forces, Dipole-Dipole Attraction or Hydrogen Bonding. (Systems and System Models)** 4. **Explain how the arrangements of particles is different in solids and liquids. (Patterns)** 5. **Relate Intermolecular forces to viscosity, melting point and boiling point. (Structure and Function)** 6. **Be able to identify the properties of crystalline solids. (Patterns)** 7. **Explain how energy is related to phase change. (Energy and Matter in Systems)** 8. **Explain how the properties of suspensions, colloids, and solutions compare. (Structure and Function)**	HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). HS-PS1-3 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-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. *

	9. Be able to calculate molarity, molality, mole fraction and mass percentage. (Scale, Proportion and Quantity) 10. Relate how intermolecular forces affect solvation. (Structure and Function) 11. Identify and explain the factors that affect solubility. (Systems and System Models) 12. Be able to calculate boiling point elevation and freezing point depression. (Scale, Proportion and Quantity)	
Unit 6: Gases	1.Use the kinetic molecular theory to explain the behavior of gases. (Systems and System Models) 2. Be able to use Graham's Law to determine the relative rates of diffusion and effusion. (Structure and function) 3. Be able to identify if a molecule contains London Dispersion Forces, Dipole-Dipole Attraction or Hydrogen Bonding. (Structure and function) 4. Explain the relationship between pressure, temperature, and volume of a constant amount of gas. (Patterns) 5. Use gas laws to solve problems involving pressure, temperature, and volume of a constant amount of gas. (Scale, Proportion and Quantity) 6. Explain how the amount of gas is related to pressure, temperature, and volume by the ideal gas. (Patterns) 7. Differentiate between ideal and real gases. (Structure and function) 8. Use balanced chemical reactions to connect coefficients to the number of moles of gas. (Scale, Proportion and Quantity)	HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Unit 7: Reaction Rates and Equilibrium	1. Use the collision theory theory to explain the reaction process and how it relates to potential energy diagrams. (Systems and system models)	HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or

	2. Be able to calculate rate laws,rate constants, and the order of a reaction from: **a. initial concentrations and rate (Systems and system models)** **b. initial concentrations and time(integrated rate laws) (Systems and system models)** **c. reaction mechanisms (Systems and system models)** **3. Explain the factors that affect the rate of reaction. (Stability and change of systems)** **4. Relate the function of a catalyst to potential energy diagrams. (Energy and matter in systems)** **5. Determine when equilibrium is established when observing a reaction and/or looking at graphs of concentration vs. time. (Energy and matter in systems)** **6. Be able to write the equilibrium expression and calculate the equilibrium constant. (Stability and change of systems)** **7. Explain the factors that affect chemical equilibrium. (Stability and change of systems)** **8. Apply LeChatlier's principle to a system at equilibrium. (Stability and change of systems)** **9. Be able to determine the concentration of all species at equilibrium. (Scale, proportion and quantity)** **10. Be able to calculate solubility and K_{sp}. (Scale, proportion and quantity)**	concentration of the reacting particles on the rate at which a reaction occurs.
Unit 8: Acids and Bases	**1. Be able to identify the properties of acids and bases. (Patterns)** **2. Apply the Arrhenius, Bronsted-Lowry and Lewis models to acid and base solutions. (Patterns)** **3. Be able to relate acid strength to its degree of ionization. (Structure and Function)**	HS-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. * HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction

	4. **Explain how strong and weak acids and bases ionize in solution. (Systems and System Models)** 5. **Be able to identify conjugate acids and bases in a reaction. (Patterns)** 6. **Be able to calculate pH and pOH of strong and weak acids and bases. (Scale, Proportion and Quantity)** 7. **Use neutralization reactions and titration to calculate the initial concentration of a solution. (Scale, Proportion and Quantity)** 8. **Use chemical reactions to explain how a buffer works. (System and System Models)**	based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Unit 9: Energy and Redox Reactions	1. **Explain how potential and kinetic energy differ. (Patterns)** 2. **Relate heat absorbed and released to temperature change. (Systems and System Models)** 3. **Students will be able to solve calorimetry problems. (Scale, Proportion and Quantity)** 4. **Be able to write a thermochemical equation. (Energy and Matter in Systems)** 5. **Apply Hess's law to solve for enthalpy change. (Scale, Proportion and Quantity)** 6. **Use change in enthalpy to calculate the heat released in a chemical equation. (Scale, Proportion and Quantity)** 7. **Explain the difference between spontaneous and nonspontaneous processes. (Cause and Effect)** 8. **How do changes in entropy and free energy determine spontaneity of chemical reactions. (Systems and System Models)** 9. **Students will be able to assign oxidation numbers. (Patterns)**	HS-PS1-3 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-PS1-4 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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

	10. Use the half reaction method to balance oxidation reduction reactions. (Scale, Proportion and Quantity) **11. Be able to describe a voltaic cell to include: electron flow, anode/cathode, positive and negative electrodes, ion flow at the electrodes, ion flow in the salt bridge and cell potential.** (Systems and System Models)	HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Science and Engineering Practices

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Unit 1: Analyzing Data/Matter-Properties and Changes

Unit overview: This introductory unit will introduce students to the methods used to measure, record and make calculations using the accepted scientific standards. The second part of the unit will introduce the properties of matter and its changes.

Learning Goals:

1. Identify SI base units for time, length, mass and temperature. (Patterns)
2. Determine how derived units are different for volume and density. (Patterns)
3. Be able to use scientific notation to express numbers. (Scale, Proportion and Quantity)
4. Use dimensional analysis (factor-label) to solve problems. (Scale, Proportion and Quantity)
5. Be able to apply precision and accuracy to a set of data. (Patterns)
6. Be able to calculate percent error. (Patterns)
7. Be able to use significant figure rules in all calculations. (Patterns)
8. Be able to use the accepted graphing techniques when constructing a graph. (Patterns)
9. Be able to identify a substance. (Structure and Function)
10. Determine the differences between chemical and physical properties. (Cause and Effect)
11. Differentiate between chemical and physical changes. (Cause and Effect)
12. Apply the law of conservation of mass to a chemical reaction. (Scale, Proportion and Quantity)
13. Identify and differentiate between mixtures and substances. (Structure and Function)
14. Be able to apply the law of definite and multiple proportions. (Patterns)
15. Distinguish between elements and compounds. (Patterns)

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 2.5 Weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Michigan Science Standards	
Essential	Extension
• HS-PS1-1 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-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. * • HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	•

Unit 2: Structure of the Atom/Electrons in Atoms/Periodic Table and Periodic Law

Unit overview: (Narrative description of unit purpose)

Students will investigate the history and development of atomic structure and how electrons fill the energy levels in a logical fashion. This will culminate in understanding the periodic trends in the Periodic Table.

Learning Goals:

1. Determine the similarities and differences of the atomic models of Democritus, Aristotle, and Dalton. (Patterns)
2. Apply Dalton's atomic theory to explain the law of conservation of mass. (Systems and System Models)
3. Differentiate between the subatomic particles in terms of mass and charge. (Structure and Function)
4. Identify the positions of each subatomic particles. (Scale, Proportion and Quantity)
5. Use atomic numbers to identify elements. (Patterns)
6. Be able to use atomic number and mass number to identify the number of subatomic particles in an isotope. (Patterns)
7. Identify the three types of radiation and how it relates to particle size and charge. (Patterns)
8. Be able to explain the wave-particle duality of light. (Energy and Matter in Systems)
9. Identify quanta and how it's related to energy change of matter. (Scale, Proportion and Quantity)
10. Explain the relationship between emission spectra and the electromagnetic spectrum. (Patterns)
11. Explain how the Bohr and quantum mechanical models of the atom compare. (Systems and System Models)
12. Use deBroglie's hypothesis to explain the motion of particles. (Cause and Effect)

13. Relate energy levels to sublevels of the atom. (Patterns)
14. Use the Pauli Exclusion Principle, aufbau principle, and Hund's rule to write electron configurations. (Systems and System Models)
15. Be able to identify the number of valence electrons and use that information to write electron-dot diagrams. (Patterns)
16. Explain the history behind the development of the periodic table. (Systems and System Models)
17. Identify the main parts of the periodic table and relate it to electron configurations. (Patterns)
18. Be able to use the periodic table to understand the trends of atomic radius, ionization energy and electronegativity. (Patterns)

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit): 3 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 2:

Michigan Science Standards	
Essential	**Extension**
• HS-PS1-1 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 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-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. * • HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).	•

• HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. • HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. • HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.	

Unit 3: Ionic and Covalent Bonding

Unit overview: (Narrative description of unit purpose)

Students will begin to discover the interactions between atoms and bond formation. All major bond types are discussed and analyzed as well as how the bond structure determines functions of the substance.

Learning Goals:

19. **Identify what the general idea of what a bond is.** (System and System Models)
20. **Be able to explain how positive and negative ions form.** (Cause and Effect)
21. **Relate electron configuration to the type of ion formed.** (Cause and Effect)
22. **Explain the process of the formation of an ionic bond.** (Cause and Effect)
23. **Relate ionic bond strength to chemical and physical properties.** (Structure and Function)
24. **Know the energetics of bond breaking and bond formation.** (Energy and Matter in Systems)
25. **Be able to write formulas and names of ionic compounds to include binary, polyatomic ions and transition metals.** (Patterns)

26. **Identify the characteristics of metallic bonds. (Structure and Function)**
27. **Explain how the "sea of electrons" account for the properties of metals. (Structure and Function)**
28. **Apply the octet rule to the formation of covalent bonds. (Patterns)**
29. **Explain the reasoning behind the formation of single, double and triple covalent bonds. (Systems and System Models)**
30. **Identify sigma and pi bonds in a Lewis Structure. (Patterns)**
31. **Relate bond strength to bond length and bond dissociation energy. (Scale, Proportion and Quantity)**
32. **Be able to name molecular compounds. (Patterns)**
33. **Be able to name binary acids and oxyacids. (Patterns)**
34. **Be able to draw Lewis Structures. (Patterns)**
35. **In a Lewis Structure, be able to use VSEPR theory to identify the following: geometry, bond angle, polarity and resonance(if any) of a molecule. (Systems and Systems Models)**
36. **Identify the hybridization of the central atom and relate it to the electron domains. (Patterns)**

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 2 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 3:

<table>
<tr><th colspan="2">Michigan Science Standards</th></tr>
<tr><td>Essential
HS-PS1-1 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 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-PS2-6 Communicate scientific and technical information about why the molecularlevel structure is important in the functioning of designed materials. *
HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</td><td>Extension</td></tr>
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Unit 4: Chemical Reactions, The Mole and Stoichiometry

Unit overview: (Narrative description of unit purpose)
Students will be able to predict the product(s) of a balanced chemical reaction. Once they learnt he meaning of moles and how it is useful in chemical calculations, they will apply it to solving stoichiometry problems using a balanced chemical reaction.

Learning Goals:

12. **Identify the reactants and products of a chemical reaction. (Patterns)**
13. **Be able to predict the products of the following types of reactions: (Systems and System Models)**
    a. **synthesis**
    b. **single displacement(replacement)-be able to use the activity series to determine if a reaction occurs.**
    c. **double displacement-be able to use a solubility table to predict if a product is soluble or aqueous.**
    d. **decomposition of binary compounds, carbonates and chlorates.**
14. **Relate how the mole is used to indirectly count the number of particles of matter. (Scale, Proportion and Quantity)**
15. **Be able to convert from moles to mass, heat and volume. (Scale, Proportion and Quantity)**
16. **Be able to determine the empirical and molecular formulas of a compound. (Patterns)**
17. **Be able to calculate the percent composition of a compound. (Scale, Proportion and Quantity)**
18. **Be able to calculate the formula of a hydrate. (Scale, Proportion and Quantity)**
19. **Use the coefficients of a balanced reaction to identify the mole ratio. (Patterns)**
20. **Be able to solve mass-mass, mass-heat, and mass-volume problems. (Scale, Proportion and Quantity)**
21. **Be able to solve a limiting reactant problem. (Scale, Proportion and Quantity)**
22. **Be able to calculate the percentage yield. (Scale, Proportion and Quantity)**

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 4 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 4:

Michigan Science Standards	
Essential	Extension
• HS-PS1-2 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-PS1-4 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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	•

Unit 5: States of Matter, Mixtures and Solutions

Unit overview: (Narrative description of unit purpose)

Students should be able to relate the states of matter to intermolecular forces. Then they should be able calculate the concentration of solutions and relate it to several colligative properties.

Learning Goals:

13. **Use the kinetic molecular theory to explain the behavior of gases. (Systems and System Models)**
14. **Be able to use Graham's Law to determine the relative rates of diffusion and effusion. (Systems and System Models)**
15. **Be able to identify if a molecule contains London Dispersion Forces, Dipole-Dipole Attraction or Hydrogen Bonding. (Systems and System Models)**
16. **Explain how the arrangements of particles is different in solids and liquids. (Patterns)**
17. **Relate Intermolecular forces to viscosity, melting point and boiling point. (Structure and Function)**
18. **Be able to identify the properties of crystalline solids. (Patterns)**
19. **Explain how energy is related to phase change. (Energy and Matter in Systems)**
20. **Explain how the properties of suspensions, colloids, and solutions compare. (Structure and Function)**
21. **Be able to calculate molarity, molality, mole fraction and mass percentage. (Scale, Proportion and Quantity)**
22. **Relate how intermolecular forces affect solvation. (Structure and Function)**
23. **Identify and explain the factors that affect solubility. (Systems and System Models)**
24. **Be able to calculate boiling point elevation and freezing point depression. (Scale, Proportion and Quantity)**

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 2 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 5:

Michigan Science Standards	
Essential	Extension
• HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). • HS-PS1-3 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-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. *	•

Unit 6: Gases

Unit overview: (Narrative description of unit purpose)
Be able to apply all the gas laws to solve for pressure, volume, number of moles and temperature.

Learning Goals:
1.Use the kinetic molecular theory to explain the behavior of gases. (Systems and System Models)
2. Be able to use Graham's Law to determine the relative rates of diffusion and effusion. (Structure and function)
3. Be able to identify if a molecule contains London Dispersion Forces, Dipole-Dipole Attraction or Hydrogen Bonding. (Structure and function)
4. Explain the relationship between pressure, temperature, and volume of a constant amount of gas. (Patterns)
5. Use gas laws to solve problems involving pressure, temperature, and volume of a constant amount of gas. (Scale, Proportion and Quantity)
6. Explain how the amount of gas is related to pressure, temperature, and volume by the ideal gas. (Patterns)
7. Differentiate between ideal and real gases. (Structure and function)
8. Use balanced chemical reactions to connect coefficients to the number of moles of gas. (Scale, Proportion and Quantity)

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 1.5 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 6:

Michigan Science Standards	
Essential	Extension
• HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	•

Unit 7: Reaction Rates and Chemical Equilibrium

Unit overview: (Narrative description of unit purpose)

Students will use the kinetic molecular theory to explain the the factors that affect the rate of reaction and calculate rate laws. After mastering rate laws, students will use that knowledge to explain molecular movement during an equilibrium process and make any calculations involving the equilibrium constants.

Learning Goals:

3. **Use the collision theory theory to explain the reaction process and how it relates to potential energy diagrams.** (Systems and system models)
4. **Be able to calculate rate laws,rate constants, and the order of a reaction from:**
    a. **initial concentrations and rate** (Systems and system models)
    b. **initial concentrations and time(integrated rate laws)** (Systems and system models)
    c. **reaction mechanisms** (Systems and system models)
11. **Explain the factors that affect the rate of reaction.** (Stability and change of systems)
12. **Relate the function of a catalyst to potential energy diagrams.** (Energy and matter in systems)
13. **Determine when equilibrium is established when observing a reaction and/or looking at graphs of concentration vs. time.** (Energy and matter in systems)
14. **Be able to write the equilibrium expression and calculate the equilibrium constant.** (Stability and change of systems)
15. **Explain the factors that affect chemical equilibrium.** (Stability and change of systems)
16. **Apply LeChatlier's principle to a system at equilibrium.** (Stability and change of systems)
17. **Be able to determine the concentration of all species at equilibrium.** (Scale, proportion and quantity)
18. **Be able to calculate solubility and K_{sp}.** (Scale, proportion and quantity)

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 3 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 7:

Michigan Science Standards	
Essential	Extension
• HS-PS1-5 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.	•

Unit 8: Acids and Bases

Unit overview: (Narrative description of unit purpose)

Students will be able to explain all the properties of acids and bases and be able to calculate the concentrations of of ions and the pH of strong and weak acids and bases.

Learning Goals:

9. **Be able to identify the properties of acids and bases. (Patterns)**
10. **Apply the Arrhenius, Bronsted-Lowry and Lewis models to acid and base solutions. (Patterns)**
11. **Be able to relate acid strength to its degree of ionization. (Structure and Function)**
12. **Explain how strong and weak acids and bases ionize in solution. (Systems and System Models)**
13. **Be able to identify conjugate acids and bases in a reaction. (Patterns)**
14. **Be able to calculate pH and pOH of strong and weak acids and bases. (Scale, Proportion and Quantity)**
15. **Use neutralization reactions and titration to calculate the initial concentration of a solution. (Scale, Proportion and Quantity)**
16. **Use chemical reactions to explain how a buffer works. (System and System Models)**

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 3 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 8:

Michigan Science Standards	
Essential	Extension
• HS-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. * • HS-PS1-2 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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	•

Unit 9: Energy and Redox Reactions

Unit overview: (Narrative description of unit purpose)

Students will learn about the energy and entropy changes in chemical reactions. Once that is mastered, we will perform calculations for the state functions; enthalpy, entropy and free energy and apply the results to spontaneity of reactions. For oxidation-reduction, students will be able to balance redox reactions in acid and basic solutions using the half reaction method. The last topic for the year will be voltaic cells.

Learning Goals:

12. **Explain how potential and kinetic energy differ. (Patterns)**
13. **Relate heat absorbed and released to temperature change. (Systems and System Models)**
14. **Students will be able to solve calorimetry problems. (Scale, Proportion and Quantity)**
15. **Be able to write a thermochemical equation. (Energy and Matter in Systems)**
16. **Apply Hess's law to solve for enthalpy change. (Scale, Proportion and Quantity)**

17. **Use change in enthalpy to calculate the heat released in a chemical equation. (Scale, Proportion and Quantity)**
18. **Explain the difference between spontaneous and nonspontaneous processes. (Cause and Effect)**
19. **How do changes in entropy and free energy determine spontaneity of chemical reactions. (Systems and System Models)**
20. **Students will be able to assign oxidation numbers. (Patterns)**
21. **Use the half reaction method to balance oxidation reduction reactions. (Scale, Proportion and Quantity)**
22. **Be able to describe a voltaic cell to include: electron flow, anode/cathode, positive and negative electrodes, ion flow at the electrodes, ion flow in the salt bridge and cell potential. (Systems and System Models)**

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit) 3 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 9:

Michigan Science Standards	
Essential	Extension
• HS-PS1-3 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-PS1-4 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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. • HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.	•

• HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* • HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	

Data From Previous School Year's Work:

Name of Unit	Learning Goals (The student will be able to...)	Essential Standards

• The Periodic Table and Periodic Law	• predict the sizes of atoms and ions based their location on the periodic table • determine the relative amount of energy needed to remove valence electrons • determine the pattern for successive ionization energies for atoms • determine the type of bond formed between two atoms based on electronegativity	HS-PS1-1 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
• Chemical Reactions	• determine the reactivity of each element based on its location in the periodic table • explain why some elements are only found combined with other elements based on the # of valence electrons • Use the activity series and a solubility chart to predict the outcome of single and double displacement reactions	HS-PS1-2 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.
• States of Matter	• determine the type and relative strength of intermolecular force of a solute based on its solubility in water	HS-PS1-3 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.
• Energy and Chemical Change	• construct graphs based on experimental data collected from endothermic and exothermic reactions. • Calculate the amount of energy absorbed or released based on average bond energy data.	HS-PS1-4 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.

• Reaction Rates	• determine the effect concentration and temperature have on the rate of a reaction. • Be able to calculate the rate law and rate constant from experimental data. • Use the integrated rate law to determine the rate law and the rate constant.	HS-PS1-5 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.
• Chemical Equilibrium	• determine the shift in equilibrium based on a change in reactant, product and/or temperature	HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
• The Mole	• produce a product and use mole calculations to determine the formula of a product • Perform a lab activity where students measure initial and final mass to determine the formula of a compound	HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
•	•	
• Stoichiometry	• calculate the amount of energy produced when various hydrocarbons are burned. Be able to relate the results to the amount and type of bonds in the reactants. •	HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
	• determine the specific heat of a substance by measuring the mass and change in temperature in a calorimeter	HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed

		system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
Mixtures and Solutions	• explain the likelihood of finding specific minerals naturally based upon their solubility • use experimental data to construct a solubility curve	HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
Hydrocarbons	• identify the major greenhouse gases and how they contribute to the greenhouse effect. • use real-life data to project the temperature of the earth in the future and relate this to human activity	HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
Ionic Compounds and Metals Covalent Bonding	• identify the type of bonding(covalent, ionic, covalent network and metallic) based on elemental composition in a substance and how it determines its properties.	HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
	• Reduce, Reuse, Recycle-TBD-possible ½ day lesson.	HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
Mixtures and Solutions	• create a model to illustrate the dissolving process and how the polarity of water contributes to the the dissolving of ionic solutes.	HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
Acids and Bases	• measure the pH of normal and acid rain and the effects of each on the Earth and its products	HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth

		systems and how those relationships are being modified due to human activity.
	• Rank three vehicles, including a gas, electric and hybrid in numerous categories, including fuel economy, environmental impact, aesthetics and cost.	HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

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