East Penn School District
Curriculum and Instruction

Curriculum for: Chemistry, Honors

Course(s): Honors Chemistry

Grades: 10-12

Department: Science | **Length of Period (average minutes): 42**

Periods per cycle: 8 | **Length of Course (yrs): 1**

Type of offering: elective | **Credit(s) awarded: 1.4 4.5/4.0**

Developed by: Donna Hertzog, Rebecca Augustin, Brian Harkness

ADOPTED: 2018

Enduring Understandings & Essential Questions	Knowledge	Skills	Standards
Enduring Understandings: • Chemical equilibrium is reached when the rate of a forward reaction equals the rate of a reverse reaction. • The equilibrium of a chemical reaction can be manipulated to maximize the amount of products made. • Reactions are driven by energy changes and therefore always involve them. Essential Questions: • How is energy involved in a chemical reaction? • What is chemical equilibrium? • How is equilibrium impacted by temperature, pressure and the concentration of reactants and products?	• Collision theory • Reversible reactions achieve equilibrium. • Le Chatelier's Principle can be used to predict the response of a reaction at equilibrium when a stress is applied to that reaction. • Reaction rates can be controlled. • The difference between exothermic and endothermic reactions. • Saturated solutions and phase changes exhibit equilibrium • Potential energy diagrams illustrate the energy changes involved in a reaction • The energy changes that drive reactions can be evaluated through the Gibbs Free Energy equation • How to predict if a reaction will occur spontaneously or non-spontaneously • Energy is conserved in chemical reactions • Phase and chemical changes involve enthalpy (heat) changes	• Predict and explain how the addition of a stress will affect the equilibrium. • Determine whether a reaction is endothermic or exothermic • Manipulate the rate of a reaction • Evaluate the comparative amounts of kinetic energy within a system • Predict and explain the effect of a catalyst on a reaction (both at and not at equilibrium) • Model the energy changes involved in a chemical reaction • Identify favorable thermodynamic conditions for a reaction and use them to evaluate the spontaneity of a reaction • Use equilibrium expressions for various types of equilibriums to predict equilibrium concentrations and vice versa	NGSS Standards: • 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] • 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. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.] • HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or

● Why are some reactions spontaneous while some are not?	● The equilibrium expression is determined by the ratio of concentrations of products to reactants		concentration of the reacting particles on the rate at which a reaction occurs. ● 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.* [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.] ● PS1.B: Chemical Reactions - Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5) - In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6) - The fact that atoms are conserved, together with knowledge of the chemical properties of

			the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)
Enduring Understandings: ● Chemical reactions can be classified by type, which helps to predict products. ● Chemical reactions can be expressed as equations. ● A chemical reaction is the breaking and forming of chemical bonds to produce new substances. ● Nuclear reactions involve changes in the nucleus whereas chemical reactions involve changes in electrons. Essential Questions: ● How can one explain the structure, properties, and interactions of matter? ● How are chemical and nuclear reactions fundamentally different?	● How to identify and predict the products for different types of chemical reactions (synthesis, decomposition, single replacement, double replacement, neutralization, oxidation, redox and combustion). ● The electrons gained and lost in a redox reaction can be identified and balanced through the assigning of oxidation numbers in half reactions. ● How atoms recombine to form new products in a chemical reaction ● The law of conservation of mass requires the balancing of chemical equations. ● The scale of energy in a nuclear process is much larger than in a chemical process ● Fission, fusion and radioactive decay (alpha,beta,gamma) involve changes in the nucleus of the atom ● The total number of nuclear subatomic particles	● Predict the products of a reaction ● Write balanced chemical equations according to the law of conservation of mass. ● Perform and identify product formation in chemical reactions ● Identify when an acid or base has been neutralized. ● Identify conjugate acid and base pairs ● Assign oxidation states in order to balance redox reactions by using the half reaction method ● Predict the missing components of a nuclear reaction. ● Explain the dangers/effects and the appropriate precautions for radioactive exposure. ● Model energy changes of nuclear reactions	NGSS Standards: ● 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] ● HS-PS1-8. 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. [Clarification Statement: ● PS1.B: Chemical Reactions - The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)

• How does one know how to predict what will form when substances react?	is the same both before and after the nuclear process		
Enduring Understandings: • Substances can be manipulated to obtain varying properties. • Solutions play a role in our bodies and environment. • Properties of substances, both mixtures and pure, are predictable functions of their intermolecular interactions. Essential Questions: • How are the phases of matter affected by environmental conditions? • How are solutions valuable to our lives? • How do solutions affect our bodies and our environment?	• Temperature and pressure affect the states of matter. • Kinetic molecular theory is used to describe the motion of particles. • Varying factors affect the strength of intermolecular forces between particles. • The strength of forces between particles determine the bulk properties of substances. • The classification of solutions based on concentration and solubility. • Quantitative expression of concentration. • The addition of a solute affects the boiling point, melting point and vapor pressure of a pure solvent. • The temperature, pressure, and volume of a gas affect each other.	• Predict the response of a gas to changes in pressure, volume and/or temperature, using the appropriate gas law. • Utilize the Ideal Gas Law to solve problems • Explain how the addition of a solute will affect its colligative properties. • Describe the relationship between bulk properties of a substance and the strength of its intermolecular forces. • Calculate the concentration of a solution. • Interpret a phase diagram appropriately. • Model the three states of matter. • Experiment with intermolecular forces. • Make solutions. • Use the process of titration to analyze the unknown concentration of a solution	NGSS Standards • 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. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.] • 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. [(Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.][Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration and rate data; and qualitative relationships between rate and temperature.]

			● HS-PS2-6 Communicate scientific and technical information about why the molecular level structure is important in the functioning of designed materials. [Clarification statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are durable are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.] ● 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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.] ● PS2.B: Types of Interactions - Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between

			material objects. (secondary to HS-PS1-1),(secondary to HS-PS1-3),(HS-PS2-6)
Enduring Understandings: ● Scientists use a systematic approach to solving problems. ● Scientists measure with accuracy and precision. ● Scientists have created the mole concept to make quantitative relationships practical. ● We can use balanced chemical equations to predict and analyze quantities used and produced in a reaction. Essential Questions: ● How can we use stoichiometry to understand reactions? ● Why is the mole so useful and important? ● What are the meanings of limiting reactant and excess reactant? ● How can we use stoichiometry to	● The use of significant figures communicates the level of precision with which the data has been measured. ● How to determine the formula mass of a compound. ● The relationship between the mole (Avogadro's number) and the mass of a substance. ● How dimensional analysis can be used in performing mathematical conversions. ● The empirical formula of a compound can be derived from the percent composition ● How to use mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products ● How a chemical equation can be used to communicate relationships of mass, particles, or volume of reactants and products in a reaction. ● How to use stoichiometric relationships to determine	● Record and correctly calculate quantitative data with proper significant figures. ● Convert between mass, mole, volume and particles. ● Use dimensional analysis to convert between units. ● Use stoichiometry and balanced chemical equations to convert from the known quantity of one substance to an unknown quantity of another. ● Use formula mass to calculate the percent composition of a compound ● Determine empirical and molecular formulas based upon the masses of the elements in a compound ● Predict the amount of product formed in an experiment in which varying amounts of reactants are available.	NGSS Standards: ● 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] ● HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.] ● PS1.B: Chemical Reactions - The fact that atoms are conserved, together with knowledge of the chemical properties of

understand how "good" or "useful" a reaction is with percent yield and percent error?	the limiting reactant of a reaction and the amount of excess reactants.		the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)
Enduring Understandings: ● Matter is made of atoms. ● The periodic table is the most important tool in chemistry. ● New bonds form to produce new substances. ● There is a systematic way to name chemicals. ● The properties of a substance are determined by its chemical composition. Essential Questions: ● How do we know what we can not see? ● What is periodic about the table? ● Why is the Periodic Table so important? ● How do new substances form? ● How do we name chemicals?	● Matter is made of atoms. ● The periodic table is the most important tool in chemistry. ● New bonds form to produce new substances. ● There is a systematic way to name chemicals. ● The properties of a substance are determined by its chemical composition.	● Determine the number of protons, electrons, and neutrons in an atom, ion, or isotope. ● Explain the developments that led to the modern model of the atom. ● Draw models of atoms, including orbital filling diagrams, electron configurations and Lewis Dot Diagrams for the representative elements ● Predict periodic trends and resulting properties, due to an element's location on the periodic table and provide an explanation as to why it varies the way it does. ● Relate a chemical formula to what has occurred in the bonding process between atoms ● Write the chemical formulas and names of compounds.	NGSS Standards: ● 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. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.] ● 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] ● 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.

● What determines the properties of substances?		● Predict the type of bond that occurs between atoms ● Use models to illustrate forces between ions and atoms. ● Determine the number (single, double, or triple) of bonds that will occur between two atoms and the reason why. ● Identify a stable electron configuration and how metals and nonmetals obtain them.	[Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.] ● HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.] ● PS2.B: Types of Interactions - Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (secondary to HS-PS1-1), (secondary to HS-PS1-3), (HS-PS2-6) ● HS-PS1-8 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. [Clarification Statement: ● PS1.A: Structure and Properties of Matter - Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) - The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1) - The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6) ● PS1.C: Nuclear Processes - Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

Materials and Resources:
"Modern Chemistry"
ISBN 0-03-073546-7 (Holt, Rinehart & Winston) 2006