Pocatello/Chubbuck School District #25
Science Course: Physical Science - Chemistry

Grade: 9 **Unit 1: Energy and Matter** **Pacing: 3 WEEKS**

Pocatello/Chubbuck School District #25
PS Chemistry
Unit 3: Chemical Reactions

Science and Engineering Practices (What students do) **Crosscutting Concepts (How students think)** **Disciplinary Core Ideas** (What students know)

Unit Overview: Learners will develop a deeper understanding of the Crosscutting Concepts of P*atterns, Cause and Effect, Energy and Matter, and Stability and Change,* and the Science and Engineering Practices of D*eveloping Models, Analyzing and Interpreting Data, Using Mathematics and Computational Thinking, and Constructing Explanations.* **New learning will include predicting products of chemical reactions based on the Law of Conservation of Mass, relating energy release or absorption to bond energy, and identifying factors that can change the rate of a reaction.**

Anchoring Phenomena:

- What is happening to elements and compounds while a chemical reaction takes place?
- What are some processes that can change the rate of a reaction and why does it change?
- Why does dissolving an alka seltzer pill into hot water take significantly less time than dissolving an alka setza pill into cold water?
- If chemical reactions generally give off heat, then how does a cold pack work?
- Demo - Combustion reactions (various applications).
- Demo - Heat a dry powdery solid (calcium carbonate or baking soda) ⟶ produces a gas⟶ run through lime water (or pH indicator) to get a cloudy substance (precipitate) – How can this powder produce a gas? What's happening in the lime water?

Pacing: 3 weeks

SCIENCE STANDARD PROGRESSION (6th Grade)
MS-PS-1.5: Students who demonstrate understanding can: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

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Idaho Standard	National Standard	Idaho Performance Standard	Science Practices	CCC
HS-PSC-2.1	**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. (Patterns)** **Supporting Content PS1.A: Structure and Properties of Matter** ● The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar physical and chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PSC-2.1) **Supporting Content 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-PSC-2.1, HSPSC-2.4) **Further Explanation:** ● Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen. **Assessment Limit:** ● Assessment is limited to synthesis, decomposition, single replacement/displacement, double replacement/displacement—including neutralization—and combustion reactions. Predict the products of double replacement, single replacement, and combustion reactions only. Assessment excludes writing formulas or names of acids and hydrocarbons.	Construct and revise an explanation	Patterns

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HS-PSC-2.2	**HS-PS1-4**	**Develop a model to illustrate that the energy transferred during an exothermic or endothermic chemical reaction is based on the bond energy difference between bonds broken (absorption of energy) and bonds formed (release of energy). (Energy and Matter)** **Supporting Content PS1.A: Structure and Properties of Matter** ● A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PSC-2.2) **Supporting Content 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-PSC-2.2, HS-PSC-2.3) **Further Explanation:** ● 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 Limit:** ● Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.	Develop a Model	Energy and Matter

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HS-PSC-2.3	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. (Patterns)** **Supporting Content 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-PSC-2.2, HS-PSC-2.3) **Further Explanation:** ● Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules. **Assessment Limit:** ● 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.	Apply scientific principle and evidence to provide an explanation	Patterns

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HS-PSC-2.4	HS-PS1-7	**Use mathematical representations to support the claim that the number and types of atoms, and therefore mass, are conserved during a chemical reaction. (Energy and Matter)** **Supporting Content 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-PSC-2.1, HSPSC-2.4) **Further Explanation:** ● 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 Limit:** ● Conversion problems will be one to two steps (e.g., grams to moles to atoms/molecules). Compounds and formulas should be provided in the stem of the question. Students should be given molecular masses in problems involving gram to other unit conversions. Molar mass calculations should not be combined with conversion problems. All volumes must be at standard temperature and pressure (STP). A balanced equation and molar masses should be included in the item. Calculations may include grams/moles/volume of reactant to grams/moles/volume of product.	Use mathematical representations to support a claim	Energy and Matter

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HS-PSC-3.1 Note: Focusing on photons only	HS-PS4-3	**Ask questions to clarify the idea that electromagnetic radiation can be described either by a wave model or a particle model.** **Supporting Content PS4.B: Electromagnetic Radiation** ● Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PSC-3.1) **Further Explanation:** ● Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include interference, diffraction, and photoelectric effect. **Assessment Limit:** ● Assessment does not include using quantum theory.	Ask questions to clarify an idea	Systems and System Models
HS-PSC-3.2	HS-PS3-5	**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. (Systems and System Models)** **Supporting Content PS3.A: Definitions of Energy** ● Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PSC-3.2, HS-PSC-3.3) **Supporting Content PS3.B: Conservation of Energy and Energy Transfer** ● Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PSC-3.2)	Create a Computational Model	Systems and System Models

		● Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSC-3.2, HS-PSC-3.5) ● Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PSC-3.2) ● The availability of energy limits what can occur in any system. (HS-PSC-3.2) **Further Explanation:** ● Emphasis is on explaining the meaning of mathematical expressions used in the model. **Assessment Limit:** ● 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 electrostatic ~~field~~ forces. Two temperatures (initial and final), a temperature-time graph, or an enthalpy diagram must be provided.		

UNIT LEARNING INTENTIONS
● **HS-PSC-2.1:** Learners will understand that the end result of most reactions are substances with a stable electron configuration. ● **HS-PSC-2.1:** Learners will understand the different types of reactions and how to identify simple examples. ● **HS-PSC-2.2:** Learners will understand the difference between exothermic and endothermic reactions and identify graphs that show each process. ● **HS-PSC-2.2:** Learners will understand the difference between the energy of the products and the reactants is the total energy gained and or released during a reaction. ● **HS-PSC-2.3:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the resting particles on the rate of which a reaction occurs.

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- **HS-PSC-2.4:** Learners will understand that after a chemical reaction occurs the exact elements and the number of those elements is the same as before the reaction began.
- **HS-PSC-2.4:** Learners will understand molar mass and how to calculate moles and grams.
- **HS-PSC-3.2:** Learners will understand the transfer of energy over time from one system to another, including phase changes, and that energy is conserved.
- **HS-PSC-3.2:** Learners will understand heating and cooling curves with energy vs. temperature graphs.
- **HS-PSC-3.2:** In this unit, learners will understand conceptually the heat of fusion and vaporization, and that the energy required to raise the temperature of a substance is different from the energy required to change state.
- **HS-PSC-3.4:** Design & build a device the does an energy conversion **(Optional)**

SUCCESS CRITERIA ALIGNED TO UNIT LEARNING INTENTIONS		
SURFACE *Conceptual understanding and foundational information; Initial acquisition of content understanding and associated procedural skills*	**DEEP** *Uncovering relationships between terms, concepts, and ideas within a topic; understand how concepts are related to other scientific phenomena. Utilizing science process skills to plan, investigate, communicate and elaborate on initial learning, and extract generalizations about science content*	**TRANSFER** *Applying relevant scientific laws, principles, theories, and phenomena to construct solutions to problems and formulate new understandings within different contexts/disciplines*
● I can define the Law of Conservation of Mass. ● I can balance a chemical equation. ● I can define and give examples of physical and chemical properties and changes. ● I can recognize that chemical reactions are the result of atoms achieving a stable electron configuration based on valence electrons. ● I can recognize that it takes energy to break a bond and that energy is	● I can predict the number of valence electrons of an element based on the compound formed when reaching a stable electron configuration. ● I can predict the products of a combustion, single replacement, and double replacement reaction. ● I can explain endothermic and exothermic processes and relative energies of reactants and products from diagrams/graphs. ● When given an enthalpy diagram, I can	● I can formulate a balanced chemical equation when given only the reactants of combustion, single displacement, and double displacement reactions. ● I can evaluate data to determine reactions that are endothermic and exothermic and match the process with diagrams/graphs. ● I can evaluate the rate of a reaction experimentally and re-evaluate the reaction at different temperatures. ● I can convert grams of a limiting

released when a bond is formed. ● I can identify Synthesis, Decomposition, Single Replacement, Double Replacement, and Combustion reactions. ● I can define endothermic and exothermic as it applies to chemical reactions. ● I can recognize that the difference between the energy of products and reactants in a chemical reaction is the total energy gained or released during a reaction. ● I can recognize that factors such as temperature and concentration will change the overall reaction rate. ● I can solve simple calculations involving molar mass.	identify if energy is gained or lost overall. ● I can verify that changing factors such as temperature and concentration in a chemical reaction changes the rate of the reaction using the collision theory model. ● I can verify the Law of Conservation of Mass by performing an experiment. ● I can use a balanced equation to convert moles of reactant to moles of product. ● I can identify endothermic and exothermic reactions using a potential energy graph.	reactant species to grams of a product species.

ACADEMIC VOCABULARY
Basic Vocab: endothermic, exothermic, reactant, product, chemical reaction, chemical equation, coefficient, synthesis, decomposition, single replacement, double replacement, combustion, precipitate, salt, neutralization, pH, indicator, aqueous, ion, polyatomic ion, law of conservation of mass, mole, molar mass, molar ratio, reaction rate, law of conservation of mass, vaporization, condensation, sublimation, pressure, temperature, phase change, heat of fusion, heat of vaporization, amorphous solid, solute, solvent, solubility, equilibrium, concentration, phase diagram, suspension, colloid, atom, molecule, solid, liquid, gas, plasma, matter, pure substance, element, compound, heterogeneous mixture, homogeneous mixture, solution

POSSIBLE CONSIDERATIONS FOR EXTENDED LEARNING

- **Acids and Bases Intro**
- **Limiting Reactant**

POSSIBLE TEACHER MATERIALS/RESOURCES

PHENOMENA
Railroad Welding
Example phenomena and tasks in the resource folder.

RESOURCES
HS-PSC 1.1-1.4 & 2.1-2.4 NM_Resources Matter and Its Interactions pdf

- For HS-PSC 2.1 see pages 14-18 - Sub-Zero Activity
- For HS-PSC 2.2 see pages 24-26 - https://www.youtube.com/watch?v=5uxsFglz2ig (Railroad Welding)
- For HS-PSC 2.3 see pages 27-31 - Reaction Rate Activity with Zinc (can be galvanized nails) with different molarities of HCl
- For HS-PSC 2.4 see pages 36-40 - Conservation of Mass - Two Options Shown: 1) Mg and HCl; 2) Zn and HCl

HS-PSC 3.2-3.5_NM Resources-Energy

- For HS-PSC 3.2 see pages 29-35

HS-PSC 3.1_NM Resource -Waves-and-their-Applications-in-Technologies-for-Information-Transfer

- For HS-PCS 3.1 see pages 18-23 - Colored Laser on smart phone makes dot patterns on wall (might be more physics)

See “Sub-Zero” document in Unit 3 Lesson Resources folder - Focusing on Task A (predicting how elements will react with each other)

See Shared Physical Science Chemistry Drive for Rubrics, Resources, and Examples.

Essential Knowledge and Skills

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- Chemical Reactions - chemical change, chemical equations (mole-mass conversions) classification, energy, and reaction rates
- Introduce Solutions, Acids, and Bases
- Perform gram to mole and mole to ΔH calculations. Use joules as a unit of measure, as opposed to calories.

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