Montana Science Model Curriculum Guide by Grade Level: Grades 9-12 Physical Science

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Resources	Three Dimensions		
	Disciplinary Core Ideas (DCI's)	Science and Engineering Practices (SEP's)	Crosscutting Concepts (CCC's)
Paul Anderson Videos: Details on each component of the standards Next Generation Science Standards (NGSS) at National Science Teachers Association (NSTA) Hub: Detailed explanations of the three dimensions, videos of what it looks like in the classroom, curriculum guidance, and classroom resources Evidence Statements: Observations of what students should know and be able to do when they perform the standard. Helpful for formative and summative assessments The Framework: The framework for Montana Science Standards and for the Next Generation Science Standards NGSS Storylines: These storylines explain questions that students should investigating and how by grade level; they paint the big picture of the big ideas STEM Teacher Tools: This site has every resource necessary to implement the new standards *Read more about the three dimensions in the NRC Framework online here (NGSS for States, By States)*	Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four: • Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline; • Provide a key tool for understanding or investigating more complex ideas and solving problems; • Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge; • Be teachable and learnable over multiple grades at increasing levels of depth and sophistication. Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.	The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The National Research Council (NRC) uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires. Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life. (NGSS for States, By States).	Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world. (NGSS for States, By States)

Grade 9-12 Physical Science

Montana Standard *Students must know and be able to:*	Disciplinary Core Ideas (DCI's)	Science and Engineering Practices (SEP's)	Crosscutting Concepts (CCC's)
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-PS1-1. NGSS Identifier	PS1.A	developing and using models	patterns
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-PS1-3. NGSS Identifier	PS1.A PS2.B	planning and carrying out investigations	patterns
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 HS-PS1-8. NGSS Identifier	PS1.C	developing and using models	energy and matter: flows, cycles and conservation
communicate through scientific and technical information roles of molecular-level structure in the functioning of designed materials HS-PS2-6. NGSS Identifier	PS2.B	obtaining, evaluating, and communicating information	structure and function
construct and revise an explanation for outcomes of simple chemical reactions based on outer electron states of atoms, trends in the periodic table, and patterns of chemical properties HS-PS1-2. NGSS Identifier	PS1.A PS1.B	construct explanations and design solutions	patterns
develop a model to illustrate that the release or absorption of energy from chemical reactions is dependent upon changes in total bond energy HS-PS1-4. NGSS Identifier	PS1.A PS1.B	developing and using models	energy and matter: flows, cycles and conservation

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-PS1-5. NGSS Identifier	PS1.B	construct explanations and design solutions	patterns
refine the design of a chemical system by specifying changes in conditions that would alter the amount of products at equilibrium HS-PS1-6. NGSS Identifier	PS1.B ETS1.C	construct explanations and design solutions	stability and change
use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction HS-PS1-7. NGSS Identifier	PS1.B	using mathematics & computational thinking	energy and matter: flows, cycles and conservation
analyze data to support the claim that Newton's Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration HS-PS2-1. NGSS Identifier	PS2.A	analyze and interpret data	cause and effect
use mathematical representations to demonstrate how total momentum of a system is conserved when there is no net force on the system HS-PS2-2. NGSS Identifier	PS2.A	using mathematics & computational thinking	system and system models
apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes forces on an object during collisions HS-PS2-3. NGSS Identifier	PS2.A ETS1.A ETS1.C	construct explanations and design solutions	cause and effect
use a mathematical representation of Newton's Law of Gravitation and Coulomb's Law to explain gravitational and electrostatic forces between objects HS-PS2-4. NGSS Identifier	PS2.B	using mathematics & computational thinking	patterns

plan and conduct investigations to provide evidence that electric currents can produce magnetic fields and changing magnetic fields can produce electric currents HS-PS2-5. NGSS Identifier	PS2.B PS3.A	planning and carrying out investigations	cause and effect
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 and energy flows in and out of the system are known HS-PS3-1. NGSS Identifier	PS3.A PS3.B	using mathematics & computational thinking	system and system models
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 and energy associated with the relative position of particles HS-PS3-2. NGSS Identifier	PS3.A	developing and using models	energy and matter: flows, cycles and conservation
design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy HS-PS3-3. NGSS Identifier	PS3.A PS3.D ETS1.A	construct explanations and design solutions	energy and matter: flows, cycles and conservation
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 HS-PS3-4. NGSS Identifier	PS3.B PS3.D	planning and carrying out investigations	system and system models
develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the change in energy of the objects due to the interaction HS-PS3-5. NGSS Identifier	PS3.C	developing and using models	cause and effect
use mathematical representations to support a claim regarding relationships among the frequency, amplitude, wavelength, and speed of waves traveling in various media HS-PS4-1. NGSS Identifier	PS4.A	using mathematics & computational thinking	cause and effect

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-PS4-3. NGSS Identifier	PS4.A PS4.B	engaging in argument from evidence	system and system models
evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter HS-PS4-4. NGSS Identifier	PS4.B	obtaining, evaluating, and communicating information	cause and effect