Middle School Physical Science

Essential Standards Extended Guide

MIDDLE SCHOOL PHYSICAL SCIENCE

Background information about this document:

In response to requests from schools and districts for guidance on essential standards, committees of educators from around Idaho collaborated in the summer of 2024 to categorize Science standards into three groups:

1. **Essential standards** are explicitly taught, assessed multiple times, and receive targeted interventions for students who have not yet reached proficiency.
2. **Supporting standards** are taught to reinforce essential standards and may or may not be formally assessed.
3. **Additional standards** extend learning and are incorporated as time allows within course units, with assessment being optional.

This guidance helps LEAs prioritize the most critical standards, recognizing that not all standards are of equal importance. This document serves as a resource—not a mandate—to assist local efforts. Importantly, this work did not remove or revise any of the adopted Idaho Content Standards and is intended to refocus time and effort.

The committees developed instructional grouping models to demonstrate how standards can be combined into focused units. However, this is just one approach, and other combinations are possible. Educators can use this guide to begin developing scope and sequence for their instructional time and district-specific courses. It also provides a useful starting point for creating formative and summative assessments aligned with the standards.

Guidance: For standards 3.1, 3.2, and 3.5 – We placed into forces and motion based on the “further explanation” descriptions. Could also be placed in the Energy unit and should be taught before Contact Forces and Motion.

Instructional Grouping 1: Structure and Properties of Matter

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	Supporting Standards and Content **Taught to support the learning of essential standards and may or may not be formally assessed.**
MS-PS-1.1 Develop models to describe the atomic composition of simple molecules	Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MSPS-1.1) Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS-1.1)
MS-PS-1.4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS-1.4) In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS-1.4) The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS-1.4) The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (MS-PS-1.4) The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system’s total thermal energy. The total thermal energy (sometimes called total internal energy) of a system depends jointly on

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	the temperature, the total number of atoms in the system, and the state of the material. (MS-PS-1.4)

Further explanation:

1. Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of models could include drawings, 3D ball and stick structures, or computer representations.
2. Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.

Assessment limits:

1. Assessment does not include valence electrons and bonding energy, the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.

Instructional Grouping 2: Chemical Reactions

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
MS-PS-1.2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS-1.2, MS-PS-1.3) Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS-1.2, MS-PS-1.3, MSPS-1.5)
MS-PS-1.5 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.	Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS-1.2, MS-PS-1.3, MSPS-1.5) The total number of each type of atom is conserved, and thus the mass does not change. (MSPS-1.5)
	Supporting Standard: MS-PS-1.6 Undertake a design project to construct, test, and/or modify a device that either releases or absorbs thermal energy by chemical processes.
	Supporting Standard: MS-PS-1.3 Construct a scientific explanation, based on evidence, to describe that synthetic materials come from natural resources.

Further explanation:

1. Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.
2. Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.

Assessment limits:

1. Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.
2. Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.

Instructional Grouping 3: Energy

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
MS-PS-3.3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.	Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS-3.3, MS-PS-3.4) Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS-3.3) The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (MS-PS-3.3) A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (MS-PS-3.3)
	Supporting Standard: MS-PS-3.4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

Further explanation:

1. Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.

Assessment limits:

1. Assessment does not include calculating the total amount of thermal energy transferred.

Instructional Grouping 4: Waves

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
MS-PS-4.1 Use diagrams of a simple wave to explain that (1) a wave has a repeating pattern with a specific amplitude, frequency, and wavelength, and (2) the amplitude of a wave is related to the energy in the wave.	A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS-4.1) Waves transfer energy. (MS-PS-4.1)
MS-PS-4.2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	A sound wave needs a medium through which it is transmitted. (MS-PS-4.2) When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS-4.2) The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4.2) A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS-4.2) However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS-4.2)

Additional Standards **If time allows, these standards may be taught and/or assessed with Instructional Group 4.**
MS-PS-4.3 Students who demonstrate understanding can: Present qualitative scientific and technical information to support the claim that digitized signals (0s and 1s) can be used to encode and transmit information.

Further explanation:

1. Emphasis is on describing waves with both qualitative and quantitative thinking.
2. Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.

Assessment limits:

1. Assessment does not include electromagnetic waves and is limited to standard repeating waves.
2. Assessment is limited to qualitative applications pertaining to light and mechanical waves.

Instructional Grouping 5: Non-Contact Forces

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
MS-PS-2.4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and dependent the masses of interacting objects.	Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the Sun. (MS-PS-2.4)
MS-PS-2.5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS-2.5)
	Supporting Standard: MS-PS-2.3 Students who demonstrate understanding can: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

Further explanation:

1. Examples of evidence for arguments could include data generated from simulations or digital tools, and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.
2. Examples of this phenomenon could include the interactions of magnets, electrically charged strips of tape, and electrically charged pith balls. Examples of investigations could include first-hand experiences or simulations.

Assessment Limit:

1. Assessment does not include Newton's Law of Gravitation or Kepler's Laws.
2. Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.

Instructional Grouping 6: Contact Forces and Motion

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
MS-PS-2.1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.	For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS-2.1)
MS-PS-2.2 Plan and conduct an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.	The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS-2.2) All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS-2.2)
MS-PS-3.1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.	Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS-3.1)
MS-PS-3.2 Develop a model to describe the relationship between the relative positions of objects interacting at a distance and the relative potential energy in the system.	A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS-3.2) When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS-3.2)
MS-PS-3.5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.	When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS-3.5)

Further explanation:

1. Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.

2. Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.
3. Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.
4. Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.
5. Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.

Assessment Limit:

1. Assessment is limited to vertical or horizontal interactions in one dimension.
2. Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to changes in one variable at a time. Assessment does not include the use of trigonometry.
3. Assessment is limited to two objects and electric, magnetic, and gravitational interactions.
4. Assessment does not include calculations of energy.

For Questions Contact

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