Matter and Its Interactions (PS1)	Motion and Stability: Forces and Interactions (PS2)	Energy (PS3)	Waves and Their Applications in Technologies for Information Transfer (PS4)
			
PS1.A: Structure and Properties of Matter **PS1.B** Chemical Reactions **PS2.C:** Nuclear Processes	**PS2.A:** Forces and Motion **PS2.B:** Types of Interactions	**PS3.A:** Definitions of Energy **PS3.B:** Conservation of Energy and Energy Transfer **PS3.C:** Relationships Between Energy and Forces **PS3.D:** Energy in Chemical Processes and Everyday Life	**PS4.A:** Wave Properties **PS4.B**: Electromagnetic Radiation **PS4.C:** Information Technologies and Instrumentation

PS1: Matter and Its Interactions

PS1.A: Structure and Properties of Matter

2nd Grade	5th Grade	6th Grade	7th Grade	8th Grade	Physical Science	Chemistry
Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.	Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects.	All living things are made Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. 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.	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. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g. crystals).	Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. 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.	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. 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.

PS1: Matter and Its Interactions

PS1.A: Structure and Properties of Matter **[continued]**

2nd Grade	5th Grade	6th Grade	7th Grade	8th Grade	Physical Science	Chemistry
Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces.	The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)	The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter	Each pure substance has characteristic physical and chemical			The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. 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.

PS1: Matter and Its Interactions

PS1.B: Chemical Reactions

2nd Grade	5th Grade	7th Grade	8th Grade	Physical Science	Chemistry
Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) When two or more different substances are mixed, a new substance with different properites may be formed.	Substances react chemically in characteristi c ways. n 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.	Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change. Some chemical reactions release energy, others store energy.	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. 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. 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.	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. 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. 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. 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.

PS1: Matter and Its Interactions

PS1.C: Nuclear Processes

Chemistry	Physics
Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.	Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.

PS2: Motion and Stability: Forces and Interactions

PS2.A: Forces and Motions

Kindergarten	3rd Grade	6th Grade	8th Grade	Physical Science	Chemistry	Physics
Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.	Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)	The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter	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). 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.	Newton's second law accurately predicts changes in the motion of macroscopic objects. Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.	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.	Newton's second law accurately predicts changes in the motion of macroscopic objects. Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.

PS2: Motion and Stability: Forces and Interactions

PS2.A: Forces and Motions **[continued]**

Kindergarten	3rd Grade	6th Grade	8th Grade	Physical Science	Chemistry	Physics
	The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)		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.	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.		If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

PS2: Motion and Stability: Forces and Interactions

PS2.B: Types of Interactions

Kndgrtn	3rd Grade	5th Grade	6th Grade	7th Grade	Physical Science	Chem	Physics
When objects touch or collide, they push on one another and can change motion.	Objects in Contact exert forces on each other. Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. 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).	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.	Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.	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.	Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.

PS3: Energy

PS3.A: Definition of Energy

4th Grade	6th Grade	Physical Science	Chem	Physics
The faster a given object is moving the more energy it possesses. Energy can be moved from place to place by moving objects or through sound, light, or electric currents.	The faster a given object is moving, the more energy it possesses. 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. A system of objects may also contain stored (potential) energy, depending on their relative positions. 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.	Electrical energy may mean energy stored in a battery or energy transmitted by electric currents. Energy is a quantitative property of a system that depends on the motion and the interaction of matter and radiation within the system. That there is a single quantity called energy 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 it various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.	At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal 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. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

PS3: Energy

PS3.B: Conservation of Energy and Energy Transfer

Kndgrtn	4th Grade	6th Grade	Physical Science	Chemistry
Sunlight warms the Earth's surface	Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Light also transfers energy from place to place. Energy can also be transferred from place to place by electric currents, which can be used locally to produce motion, sound, heat, or light. The current may have been produced to begin with my transforming the energy of motion into electrical energy.	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. A system of objects may also contain stored (potential) energy, depending on their relative positions. 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.	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. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. Mathematical expressions, which quantify how 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 conservations of energy to be used to predict and describe system behavior. The availability of energy limits what can occur in any system. Uncontrolled systems always evolve toward more stable states- that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems Uncontrolled systems always evolve toward more stable states- that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

PS3: Energy

PS3.C: Relationships Between Energy and Energy Forces

KIndergarten	4th Grade	6th Grade	7th Grade	Physics
A bigger push or pull makes things speed up or slow down more quickly	When objects collide, the contact forces transfer energy so as to change the objects' motion.	When two objects interact, each one exerts a force on the other that can cause energy to be 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.	When two objects interacting through a field change relative position, the energy stored in the field is changed.

PS3: Energy

PS3.D: Energy in Chemical Processes and Everyday Life

4th Grade	5th Grade	6th Grade	8th Grade
The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.	The energy release (from) food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).	The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release energy.	Cellular respiration in plants and animals involve chemical reactions with oxygen that reaction with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.

PS4: Waves and Their Applications in Technologies for Information Transfer

PS4.A: Wave Properties

1st Grade	4th Grade	8th Grade	Physical Science	Chemistry	Physics
Sound can make matter vibrate, and vibrating matter can make sound.	Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. A sound wave needs a medium through which it is transmitted.	The fact that atoms are conserved, together with knowle	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of the peaks and troughs of the waves), but they emerge unaffected by each other. Boundary: The discussion at this grade level is quantitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up. .	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. Boundary: The discussion at this grade level is quantitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.

PS4: Waves and Their Applications in Technologies for Information Transfer

PS4.B: Electromagnetic Radiation

1st Grade	4th Grade	8th Grade	Physical Science	Chemistry	Physics
Objects can be seen if light is available to illuminate them or if they give off their own light. Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)	An object can be seen when light reflected from its surface enters the eyes.	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. 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. A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.	When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. Photoelectric materials emit electrons when they absorb light of high-enough frequency.	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. .	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. When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. Photoelectric materials emit electrons when they absorb light of high-enough frequency.

PS4: Waves and Their Applications in Technologies for Information Transfer

PS4.C: Information Technologies and Instrumentation

1st Grade	4th Grade	8th Grade	Physics
People also use a variety of devices to communicate (send and receive information) over long distances.	Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information - convert it from digitized form to voice - and vice versa.	Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.