AFK12SE/NGSS Strand Disciplinary Core Ideas	Conceptual Understandings for K-2 Teachers	Conceptual Understandings for 3-5 Teachers
PS1: Matter and Its Interactions How can one explain the structure, properties, and interactions of matter?		
PS1. A: Structure and Properties of Matter *How do particles combine to form the variety of matter one observes?* **K-2** ● Different kinds of matter exist (e.g., wood, metal, water), and many solid or liquid form depending on temperature. ● Matter can be described and classified by its observable properties, its uses, and by whether it occurs naturally or is manufactured. ● Different properties are suited to different purposes. ● Objects or substances can be weighed, and their size described and measured. *(Boundary: volume is introduced only for liquid measure.)* **Grades 3-5** ● Matter can be subdivided into particles too small to see. ● Matter that cannot be seen (e.g. gas) can still be detected by other means (e.g., by weighing or its effects on other objects). ● The amount of matter is conserved when it changes form, even in transitions where it seems to vanish (e.g., dissolving & evaporation in a closed container). ● Measurements of properties (e.g., hardness, reflectivity) can be used to identify particular materials. *(Boundary: Mass and weight are not distinguished. No attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)*	● What is matter? ● What are the characteristics of different states of matter? ● How do properties of matter make them useful for different purposes?	● What is matter? ● What are the characteristics of different states of matter? ● How do properties of matter make them useful for different purposes? ● How can matter be described at the particulate level? ● How are invisible forms of matter (e.g., gas) detected? ● What kinds of properties are useful for identifying and distinguishing between different materials?
PS1.B: Chemical Reactions	● How do heating and cooling change	● How do heating and cooling change

How do substances combine or change to make new substances? How does one characterize and explain these reactions and make predictions about them? **K-2** ● Heating or cooling a substance may cause observable changes. ● Sometimes these changes are reversible (e.g., melting and freezing), and sometimes they are not (e.g., baking a cake, burning fuel). **Grades 3-5** ● When two or more different substances are mixed, a new substance with different properties may be formed ● These occurrences depend on the substances and the temperature. ● 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.)*	substances? ● What distinguishes physical and chemical changes?	substances? ● What distinguishes physical and chemical changes? ● How does the amount of substance change when two substances are mixed together?
PS1.C: Nuclear Processes *What forces hold nuclei together and mediate nuclear processes?* **K-2** N/A **Grades 3-5** N/A		
PS2: Motion and Stability – Forces and Interactions How can one explain and predict interactions between objects and within systems of objects?		

PS2. A: Forces and Motion *How can one predict an object's continued motion, changes in motion, or stability?* **K-2** ● Objects pull or push each other when they collide or are connected. ● 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. An object sliding on a surface or sitting on a slope experiences a pull due to friction on the object from the surface that opposes the object's motion. **Grades 3-5** ● Each force acts on one particular object and has both a strength and a direction. ● Objects at rest typically have multiple forces acting on them but resulting in a net force of zero. ● 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 is used at this level.)* ● The patterns of an object's motion can be observed and measured and used to predict future motion *(Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced.)*	● What is a force? ● How do forces affect the motion of an object? ● What is friction and how does it impact the motion of objects? ● What are some ways to reduce friction between two objects?	● What is a force? ● How do forces affect the motion of an object? ● What is friction and how does it impact the motion of objects? ● What are some ways to reduce friction between two objects?
PS2.B.: Types of Interactions *What underlying forces explain the variety of interactions observed?* **K-2** ● When objects touch or collide, they push on one another and can change motion or shape. **Grades 3-5** ● Objects that come into contact with each other exert forces (e.g., friction, elastic pushes and pulls). ● Some forces exist that do not require objects to touch (e.g., electric, magnetic, and gravitational forces)	● How can an object's motion or shape change when it touches another object?	● How can an object's motion or shape change when it touches another object? ● In what ways can forces act at a distance without objects touching? ● What influences the magnitude of the force between two objects? ● How does gravity affect the motion of objects?

● 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. ● Earth's gravitational force pulls objects near the surface towards the center of Earth.		
PS2.C: Stability and Instability in Physical Systems *Why are some physical systems more stable than others?* **K-2** ● Whether an object stays still or moves often depends on the effects of multiple pushes and pulls on it. **Grades 3-5** ● A system can change as it moves in one direction, shifts back and forth, or goes through cyclical patterns. Examining forces on and within a system can help to explain the system's patterns of change. ● A system can appear to be unchanging when processes within the system are occurring at opposite but equal rates. ● Changes can happen very quickly or very slowly and are sometimes hard to see (e.g., plant growth). ● Conditions and properties of the objects within a system affect how fast or slowly a process occurs (e.g., heat conduction rates).	● How do forces affect the motion of an object?	● How do forces affect the motion of an object? ● How can systems change?
PS3: Energy How is energy transferred and conserved?		
PS3.A: Definitions of Energy	● What is energy?	● What is energy?

What is energy? **K-2** N/A **Grades 3-5** ● 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. *(Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.)*		● How are speed and energy related?
PS3.B: Conservation and Transfer of Energy *What is meant by conservation of energy?* *How is energy transferred between objects or systems?* **K-2** ● Sunlight warms Earth's surface. **Grades 3-5** ● 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. These collisions also transfer energy to the surrounding air; as a result, the air gets heated and sound is produced. ● Light transfers energy from place to place. ● Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light.	● How does sunlight affect earth's temperature? ● How can energy be transferred?	● What happens to the energy of moving objects when they come into contact with each other? ● How can energy be transferred? ● What evidence can be used to identify when energy is being transferred? ● In a given system, where does energy come from and where does it go?
PS3.C: Relationship b/w Energy & Forces *How are forces related to energy?* **K-2** ● A bigger push or pull makes things go faster. ● Faster speeds during a collision can cause a bigger change in shape of the colliding objects.	● How does the magnitude of a force affect motion? ● How does the speed of objects that collide affect the outcome?	● How can forces acting on objects cause objects to change their motion? ● How can changes in the motion of colliding objects be explained in terms of energy transfer? ● What are the properties of magnets in

Grades 3-5 ● When objects collide, the contact forces transfer energy changing the objects' motions. ● Magnets can exert forces on other magnets or on materials that are magnetized, causing energy transfer even when the objects are not touching.		relation to force and energy?
PS3.D: Energy in Chemical Processes and Everyday Life *How do food and fuel provide energy?* *If energy is conserved, why do people say it is produced or used?* **K-2** ● When two objects rub against each other, this interaction is called friction. ● Friction between two surfaces can warm of both of them (e.g., rubbing hands together). ● There are ways to reduce the friction between two objects. **Grades 3-5** ● The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. ● Energy is also released through the means of other processes – e.g., digestive (food) and burning (fuel) . ● It is important to concentrate/store energy for use where and when it is needed.	● How do animals get the energy they need to live?	● How do animals get the energy they need to live? ● What are different examples seen in everyday life of energy being produced, released, and stored?
PS4: Waves and Their Applications How are waves used to transfer energy and information?		
PS4.A: Wave Properties *What are the characteristic properties and behaviors of waves?* **K-2** ● Waves are regular patterns of motion. ● With water disturbing the surface can cause waves	● What are the characteristic properties and behaviors of waves? ● How is sound produced?	● What are the characteristic properties and behaviors of waves? ● How is sound produced? ● How do waves interact?

and move objects in the direction of the wave (e.g., surfing). But if the water is deep the waves will go up and down so the object moves, or bobs, up and down. ● Sound can make matter vibrate, and vibrating matter can make sound. **<u>Grades 3-5</u>** ● Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). ● 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: This discussion should be qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.)* ● Earthquakes cause seismic waves, which are waves of motion in Earth's crust.		
PS4. B: Electromagnetic Radiation *What is light? How can one explain the varied effects that involve light? What other forms of electromagnetic radiation are there?* **<u>K-2</u>** ● Objects can be seen only when light is available to illuminate them. ● Very hot objects give off light (e.g., a fire, the sun). ● 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	● What is light? ● What happens to light what it interacts with different materials? ● How are heat and light related?	● What is light? ● What happens to light what it interacts with different materials? ● How are heat and light related? ● How are objects seen as having different colors? ● Why can't objects be seen in complete darkness?

surface beyond them where the light cannot reach. ● Mirrors and prisms 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.)* **<u>Grades 3-5</u>** ● A great deal of light travels through space to Earth from the sun and from distant stars. ● An object can be seen when light reflected from its surface enters the eyes; the color people see depends on the color of the available light sources as well as the properties of the surface. *(Boundary: This phenomenon is observed, but no attempt is made to discuss what confers the color reflection and absorption properties on a surface. The stress is on understanding that light traveling from the object to the eye determines what is seen.)* ● Lenses bend light beams and can be used singly or in combination to magnify images too small or too far away to be seen with the naked eye.		
PS4.C: Information Technologies & Instrumentation *How are instruments that transmit and detect waves used to extend human senses?* **<u>K-2</u>** ● People use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch. ● People also use a variety of devices to communicate (send and receive information) over long distances. **<u>Grades 3-5</u>** ● Lenses can be used to make eyeglasses, telescopes,	● How are waves used to facilitate communication over long distances?	● How are waves used to facilitate communication over long distances? ● How are lenses used to facilitate the ability to see really small or distant objects? ● What are some examples of how devices can be used to receive and decode information?

or microscopes in order to extend what can be seen. The design of such instruments is based on understanding how the path of light bends at the surface of a lens. ● Digitized information (e.g., the pixels of a picture) can be stored for future recovery or 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.		