Introduction: The focus of this document is on one of the three dimensions of the Performance Expectations (PE); the science ideas that students should have opportunities to apply in order to explain phenomena or design solutions to real-world problems. This document should be used in conjunction with a document titled *Primer on Science Instruction*. The *Primer on Science Instruction* focusses on what teaching, learning, and assessment should look like in a three-dimensional classroom.

The physical science standards blend the Disciplinary Core Ideas (DCIs) with Scientific and Engineering Practices (SEP) and Crosscutting Concepts (CCC) to support students in developing useable knowledge to explain real world phenomena in the physical, biological, and Earth and space sciences. The scientific ideas are detailed on pages 103-137 of *A Framework for K-12 Science Education* (NRC, 2012). Table 1 highlights the Core and Component Ideas in Physical Science that must be a part of the science curriculum. Beginning on page 2, each of the component ideas are described in greater detail.

Table 1: Core and Component Ideas in the Physical Sciences

Core Idea PS1: Matter and Its Interactions ← Disciplinary Core Idea

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS1.C: Nuclear Processes

← Component Ideas

Core Idea PS2: Motion and Stability: Forces and Interactions

- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- PS2.C: Stability and Instability in Physical Systems

Core Idea PS3: Energy

- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- PS3.D: Energy in Chemical Processes and Everyday Life

Core Idea PS4: Waves and Their Applications in Technologies for Information Transfer

- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

There are multiple approaches to organizing science curriculum in the middle grades. Regardless of the approach, every student needs to receive instruction in all of the Physical Science standards. The storylines are organized by Disciplinary Core Idea (DCI). The hyperlinked title provides quick access to the complete description of the Disciplinary Core Ideas, Component Ideas, and grade appropriate elements of the DCIs.

Some districts chose to base their revised curriculum on the NJ Model Science Curriculum (MSC). Each unit of instruction includes a guiding question, a unit overview, estimated number of instructional days necessary to complete the unit, and Student Learning Objectives. Sometimes the storylines in the model curriculum units have been modified from the original narratives in this document.

PS1: Matter and its Interactions (pp. 106-113, NRC, 2012)

Students formulate an answer to the question, *"How do atomic and molecular interactions explain the properties of matter that we see and feel?"* by building understanding of what occurs at the atomic and molecular scale.

Matter and its Interactions is broken down into two sub-ideas: the structure and properties of matter, and chemical reactions.

By the end of middle school, students will be able to apply understanding that pure substances have characteristic physical and chemical properties and are made from a single type of atom or molecule.

They will be able to provide molecular level accounts to explain states of matters and changes between states that chemical reactions involve regrouping of atoms to form new substances, and that atoms rearrange during chemical reactions.

Students are also able to apply an understanding of the design and the process of optimization in engineering to chemical reaction systems.

The crosscutting concepts of patterns; cause and effect; scale, proportion and quantity; energy and matter; structure and function; interdependence of science, engineering, and technology; and influence of science, engineering and technology on society and the natural world are called out as organizing concepts for these disciplinary core ideas.

Students are expected to demonstrate proficiency in developing and using models, analyzing and interpreting data, designing solutions, and obtaining, evaluating, and communicating information. Students use these scientific and engineering practices to demonstrate understandings.

Students who demonstrate understanding can:

MS-PS1-1 **Develop models to describe the atomic composition of simple molecules and extended structures.**

MS-PS1-2 **Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.**

MS-PS1-3 **Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.**

MS-PS1-4 **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.**

MS-PS1-5 **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.**

MS-PS1-6 **Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.***

(An asterisk indicates that the PE incorporates Engineering Practices.)

PS2: Motion and Stability: Forces and Interactions (pp. 113-120, NRC, 2012)

Students formulate an answer to the questions, *"How can one describe physical interactions between objects and within systems of objects?" The* focus is on helping students understand ideas related to why some objects will keep moving, why objects fall to the ground and why some materials are attracted to each other while others are not. Motion and Stability: Forces and Interactions is broken down into two sub-ideas: Forces and Motion and Types of interactions.

By the end of middle school, students will be able to apply Newton's Third Law of Motion to relate forces to explain the motion of objects.

Students also apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while others repel. In particular, students will develop understanding that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative.

Students develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields.

Students apply an engineering practice and concept to solve a problem caused when objects collide.

The crosscutting concepts of cause and effect; system and system models; stability and change; and the influence of science, engineering, and technology on society and the natural world serve as organizing concepts for these disciplinary core ideas.

Students are expected to demonstrate proficiency in asking questions, planning and carrying out investigations, and designing solutions, and engaging in argument; and to use these practices to demonstrate understandings.

Students who demonstrate understanding can:

MS-PS2-1 **Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects*.**

MS-PS2-2 **Plan 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.**

MS-PS2-3 **Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**

MS-PS2-4 **Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.**

MS-PS2-5 **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.**

(An asterisk indicates that the PE incorporates Engineering Practices.)

PS3: Energy (pp. 120-130, NRC, 2012)

Students formulate an answer to the question, "*How can energy be transferred from one object or system to another?"* Energy is broken down into four sub-core ideas: Definitions of Energy, Conservation of Energy and Energy Transfer, the Relationship between Energy and Forces, and Energy in Chemical Process and Everyday Life.

Students develop their understanding of important qualitative ideas about energy including that the interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another, and the total change of energy in any system is always equal to the total energy transferred into or out of the system.

Students understand that objects that are moving have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions.

Students will also come to know the difference between energy and temperature, and begin to develop an understanding of the relationship between force and energy.

Students are also able to apply an understanding of design to the process of energy transfer.

The crosscutting concepts of scale, proportion, and quantity; systems and system models; and energy are called out as organizing concepts for these disciplinary core ideas.

Students are expected to demonstrate proficiency in developing and using models, planning investigations, analyzing and interpreting data, and designing solutions, and engaging in argument from evidence; and to use these practices to demonstrate understandings.

Students who demonstrate understanding can:

MS-PS3-1 **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.**

MS-PS3-2 **Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**

MS-PS3-3 **Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.***

MS-PS3-4 **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.**

MS-PS3-5 **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.**

(An asterisk indicates that the PE incorporates Engineering Practices.)

PS4: Waves and Their Applications in Technologies for Information Transfer (pp. 130-137, NRC, 2012)

Students formulate an answer to the question, *"What are the characteristic properties of waves and how can they be used?"* Waves and Their Applications in Technologies for Information Transfer is broken down into Wave Properties, Electromagnetic Radiation, and Information Technologies and Instrumentation.

Students are able to describe and predict characteristic properties and behaviors of waves when the waves interact with matter.

Students can apply an understanding of waves as a means to send digital information.

The crosscutting concepts of patterns and structure and function are used as organizing concepts for these disciplinary core ideas.

Students are expected to demonstrate proficiency in developing and using models, using mathematical thinking, and obtaining, evaluating and communicating information; and to use these practices to demonstrate understandings.

Students who demonstrate understanding can:

MS-PS4-1 **Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.**

MS-PS4-2 **Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.**

MS-PS4-3 **Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.**

Physical Science Performance Expectations Checklist

PS1: Matter and its Interactions

PE	Grade and Unit
MS-PS1-1	
MS-PS1-2	
MS-PS1-3	
MS-PS1-4	
MS-PS1-5	
MS-PS1-6*	

PS2: Motion and Stability: Forces and Interactions

PE	Grade and Unit
MS-PS2-1*	
MS-PS2-2	
MS-PS2-3	
MS-PS2-4	
MS-PS2-5	

PS3: Energy

PE	Grade and Unit
MS-PS3-1	
MS-PS3-2	
MS-PS3-3*	
MS-PS3-4	
MS-PS5-5	

PS4: Waves and Their Applications in Technologies for Information Transfer

PE	Grade and Unit
MS-PS4-1	
MS-PS4-2	
MS-PS4-3	