New York City

# PK–8

# Science Scope & Sequence 2018

NYC Department of Education

*Carmen Fariña, Chancellor*

# NYC Department of Education

## PK–8 Science Scope & Sequence 2018




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# Table of Contents

# The New York City Department of Education

## PK–8 Science Scope and Sequence (2018)

*(Aligned to the Next Generation Science Standards and the new NYS P-12 Science Learning Standards)*

Science is everywhere and our students are instinctively curious, which makes them natural scientists. A strong science program helps children make sense of the physical world around them. In NYC, we live in a learning laboratory made up of a combination of unique ecosystems in which our students can connect to the nature that is all around them from city parks, gardens, green spaces, beaches, and waterways to our amazing built environment. The vision for science in New York City public schools is that science education is for all students and that all students are actively engaged in investigations to explore scientific and engineering phenomena, posing questions, theorizing, hypothesizing, predicting, conducting experiments, reaching conclusions, and communicating their discoveries. Science education should provide students with opportunities to engage with science in ways that are personally relevant, allowing them to construct a scientific worldview and a sense of agency in understanding and improving their local and global communities. These skills will help them develop into scientifically literate and responsible adults. To achieve these goals, students should work collaboratively in their classrooms, listening to and questioning their peers as they develop an understanding of core scientific ideas. The focus of science instruction has shifted from learning content and disconnected facts to sense-making through authentic study and involvement with investigations and tasks that mimic the work of scientists and engineers. By engaging in investigations that challenge students' current thinking and understanding, children can construct new knowledge based on empirical evidence and, thus, experience conceptual shifts in their thinking. This leads to an ever-deepening understanding of science and its impact on their lives.

The new *PK–8 Science Scope and Sequence* is a re-design of the Science Scope and Sequence published in 2015. The *PK–8 Science Scope and Sequence* includes the current *New York State P–12 Science Learning Standards* that all schools should follow as well as additional information, including:

- an explanation of new concepts and language—Performance Expectations, Phenomena, Three Dimensional Learning and the inclusion of Engineering in the new science standards.
- an alignment to the *Excellence in Environmental Education: Guidelines for Learning (K–12)* published by The North American Association of Environmental Education to support the environmental education of NYC students and to encourage them to find innovative solutions to environmental problems and issues within their communities.
- descriptions of the New York State Education Law: Article 17, Sections 809 *(Instructions for the Humane Treatment of Animals)* and 810 *(Conservation Day)*.

## Background

In 2012, the National Research Council published *A Framework for K–12 Science Education.* This research-based document outlined a plan of action for science education that included the 21st Century skills needed by students to prepare them for college and careers. The Next Generation Science Standards (NGSS) were developed from the *Framework* document through the collaboration of Achieve, the National Research Council, the National Science Teachers Association and the American Association for the Advancement of Science. After multiple reviews from stakeholders, including two public drafts, the Next Generation Science Standards were released in April 2013. Additionally, there are several supporting documents explaining the structure of the NGSS and a number of appendices, accessible online at http://www.nextgenscience.org/next-generation-science-standards.

The NGSS writing team was comprised of 40 members from a group of twenty-six lead states. Each state provided feedback to the writing team which was incorporated into later drafts. The Next Generation Science Standards were the basis for the "new" NYS P-12 Science Learning Standards (NYSP-12SLS), adapted with advisement from the Statewide Science Leadership Team, the Science Education Steering Committee, the Science Education Consortium, and feedback from two statewide public surveys. New York State added a number of new performance expectations (standards) and modified the language of some of the science content. The NYSP-12SLS were approved by the Board of Regents in December 2016, effective beginning July 1, 2017. The NYSP-12SLS uses the same format as the NGSS and to ensure that all students succeed, the NGSS and NYSP-12SLS were written with the needs of all students in mind.

NGSS was designed to address all students including the four accountability groups "defined in No Child Left Behind (NCLB) Act of 2001 and the reauthorized Elementary and Secondary Education Act (ESEA), Section 1111(b)(2)(C)(v):

- economically disadvantaged students,
- students from major racial and ethnic groups,

- students with disabilities, and
- students with limited English proficiency." *(NGSS Lead States, 360)*

In addition NGSS added 3 other traditionally underrepresented groups:

- girls
- students in alternative education programs, and
- gifted and talented students.

The NYSP-12SLS represents a significant change in the way science education is designed and enacted for all students. Student learning in science should be driven by making sense of phenomena and developing solutions to authentic problems. This enables students to blend new skills and knowledge with the ability to make connections to prior knowledge and to understand the relationships between science, technology, and society, preparing them to be productive twenty-first century citizens.

# Overview

## Performance Expectations (PEs)

The Performance Expectations (the standards) are statements of what students should be able to know and do at the end of instruction in any given year in Grades Pre-K to 5, or at the end of the 6–8 grade band in middle school. This means that the performance expectations are not to be taught or learned in isolation; rather the performance expectations are understood to be an integration of the science and engineering practices, the content from the disciplinary core ideas and the crosscutting concepts that apply.

## Evidence Statements

Evidence statements provided by the NGSS (2013) are explicit expressions of the expectations for student learning in the development of science and engineering practices, crosscutting concepts, and disciplinary core ideas. These are useful in creating instructional supports such as assessments, leading students to understand and reflect on the development of all three dimensions of learning over time. The *New York State P–12 Science Learning Standards* contain additional performance expectations, preserving some critical content that best support disciplinary core ideas. The codes for these new performance expectations are highlighted in the units of study in which they are addressed. The New York City Department of Education is providing teachers with evidence statements for these new performance expectations in Appendix B of the new *Scope and Sequence*.

## Three-Dimensional Learning

Three-dimensional learning is the foundation of the NGSS and the NYSSLS. Three-dimensional learning is a conceptual shift in how science and engineering are taught. Subsequently, students will learn that science and engineering are not simply bodies of knowledge, but an integration of Science and Engineering Practices (SEPs), Crosscutting Concepts (CCCs), and Disciplinary Core Ideas (DCIs).

### Dimension 1: Science and Engineering Practices (SEPs)

The eight practices of science and engineering that the *Framework* identifies are listed below. The term "practices" was selected to convey the idea that both knowledge and skill are involved in engaging in the work of scientists. The *Framework* and NGSS Appendix F further describe each practice and detail the specific elements of the practices that should be addressed at each grade level.

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Dimension 2: Crosscutting Concepts (CCCs)

Crosscutting concepts are ways of thinking, or lenses, used by scientists in making sense of the natural world. Taken together as a scientific worldview, they are also a set of larger ideas that connect the different science disciplines. The seven crosscutting concepts identified in the *Framework* are listed below. The *Framework* and NGSS Appendix G further describe each crosscutting concept and detail the specific elements of the CCCs that should be addressed at each grade level.

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation

6. Structure and function
7. Stability and change

### Dimension 3: Disciplinary Core Ideas (DCIs)

The *Framework* identifies a limited number of core ideas in each of the science disciplines: physical sciences; life sciences; and Earth and space sciences. Sub-ideas (or component ideas) and detailed descriptions, as well as grade-level specific elements of the DCIs can be found in the *Framework* and NGSS Appendix E.

**Physical Sciences (PS)**

Core Idea PS1: Matter and Its Interactions

Core Idea PS2: Motion and Stability: Forces and Interactions

Core Idea PS3: Energy

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

**Life Sciences (LS)**

Core Idea LS1: From Molecules to Organisms: Structures and Processes

Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics

Core Idea LS3: Heredity: Inheritance and Variation of Traits

Core Idea LS4: Biological Evolution: Unity and Diversity

**Earth and Space Sciences (ESS)**

Core Idea ESS1: Earth's Place in the Universe

Core Idea ESS2: Earth's Systems

Core Idea ESS3: Earth and Human Activity

By integrating these three components into a coherent systematic approach, students will learn not only content and concepts, they will develop the ability to think like a scientist or engineer by making connections across core ideas and applying higher order thinking skills and practices to construct new understandings. Three-dimensional learning can be understood as the "what" (Disciplinary Core Ideas), the "how" (Science and Engineering Practices) and the "threads" (Crosscutting Concepts) that weave the standards together. Each Performance Expectation (PE) incorporates the language of grade-specific elements from all three dimensions, reflecting the idea that science should be both taught and assessed three-dimensionally. The new science standards assert that science content cannot be learned in the absence of engagement in the practices of science, and practices cannot be learned without application to science content. As such, the *three dimensions* should be intentionally interwoven to "gather evidence of students' ability to apply the practices and their understanding of the crosscutting concepts in the contexts of specific applications in multiple disciplinary areas." *(National Research Council 2012, 218)*

### Phenomena & Design Challenges

The new standards call for science education to be anchored by natural phenomena and authentic design challenges. A science phenomenon refers to natural observable events that exist in the universe that science knowledge can be used to explain or predict. In engineering, the approach is to design solutions that are rooted in phenomena and then using explanations of phenomena to design solutions. By placing an emphasis on explaining phenomena, there is a shift away from students' general science knowledge and toward application. The benefits of emphasizing phenomena include:

- focusing on figuring out why or how something happens.
- developing deeper understanding that is more readily transferable.
- developing an understanding of the social relevance of science and becoming interested in using science to improve and benefit the world.

### Engineering

One of the innovations in the NYSP-12SLS is the incorporation of engineering. Engineering is described broadly as "engagement in a systematic practice of design to achieve solutions to particular human problems." *(National Research Council 2012, 11)* Engineering is a systematic and iterative approach to designing objects, processes, and systems that meet human needs and wants. Engineers and scientists create technology with the purpose of making modifications to the natural world in order to solve a problem to benefit human needs or desires. PEs that integrate the practices and/or core ideas of Engineering, Technology, and Applications of Science (ETS) with science content are marked with an asterisk. ETS standards for grade bands K–2, 3–5, and 6–8 are included in Appendix C, but should not be taught in isolation as all ETS standards are embedded within the science standards.

### Excellence in Environmental Education: Guidelines for Learning (K–12)

According to *Developing a Framework for the Assessment of Environmental Literacy,* published by the North American Association for Environmental Education (NAEE), an environmentally literate person, "both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life." Those who are environmentally literate possess, to varying degrees:

- knowledge and understanding of a wide range of environmental concepts, problems, and issues;

- a set of cognitive and affective dispositions;
- a set of cognitive skills and abilities; and
- the appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts.

In the interest of advancing environmental education and to create a growing number of informed citizens equipped to discuss, debate, mitigate and solve current and future environmental issues in our communities, the *NYC PK–8 Science Scope and Sequence* is aligned to the *Guidelines for Learning (K–12),* published in 2010 by the North American Association of Environmental Education. The connections are denoted in the Scope and Sequence below the foundation boxes.

Environmental education is not meant to promote or champion any particular viewpoints, opinions or policies; rather, it provides students with knowledge and a platform to think critically, engage in debate, and make informed decisions to act accordingly *(EPA, 2017)*. For more information on the Excellence in Environmental Education, please refer to *Excellence in Environmental Education: Guidelines for Learning (K–12)*.

### New York State Education Law: Article 17, Sections 809 and 810

The New York State Legislature passes laws that are directly related to curriculum and instruction in the area of science. Article 17 of the New York State Education Law outlines instruction in certain subject areas. Two of the sections are directly related to science instruction. They are:

**Article 17—Section 809** pertains to the instruction in the humane treatment of live vertebrate animals. Having live animals in the science classroom is encouraged because it sparks students' interest in the living world around them. The care and respect for animals and all living things must be promoted in the school setting. Section 809 of the New York State Education Law ensures that animals are treated ethically and humanely.

**Article 17—Section 810** pertains to Conservation Day, which is celebrated on the last Friday in April. Conservation of the earth's natural resources is the focus of this designated day. School communities are encouraged to heighten awareness of the natural world through lectures, tours, and plantings.

**NOTE:** Conservation Day should not be confused with Earth Day, which falls on April 22nd each year.

For further details, please see Appendix A.

## Concluding Thoughts

Although the new NYSP-12SLS engage students in many of the same topics in science as in prior standards, teachers will find that in order to teach the "three dimensions" of the new standards, they must address these topics in a way that emphasizes depth over breadth, and big ideas and ways of knowing over recall of facts. Because the science and engineering practices, disciplinary core ideas, and crosscutting concepts build progressively from P–12, missing instruction in any of the dimensions in any grade can result in significant challenges for students and teachers in later grades. Therefore, teachers must make important decisions regarding emphasis and timing in order to meet the expectation of "all standards, all students." Teachers will need to anchor their units of study in natural phenomena and design challenges that are relevant to their students and make these decisions based on their knowledge of students' backgrounds and interests, as well as their understanding of the science content. Teachers may need to differentiate and provide additional scaffolding and support based on individual student needs not limited to, but especially for, our English language learners, students with special needs, and students who are significantly below or above grade level. The NYC PK–8 Science Scope & Sequence can serve as a valuable resource for teachers in planning appropriate individual, group and whole class instruction. We trust that this resource will provide teachers with useful guidance, help them make important instructional decisions, and help them develop engaging science experiences for their students.

### References

National Research Council. (2012). *A Framework for K–12 Science Education: Practices, Crosscutting*

*Concepts, and Core Ideas.* Committee on a Conceptual Framework for New K–12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

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# Annotated Unit/Template

**Grade # | Unit #** Unit Title

**RECOMMENDED TIME: 2 WEEKS**

| **Unit Overview:** | **Essential Question(s):** |
|---|---|
| Brief summary of the unit | **An example of an essential question that ties the unit together** |

**Performance Expectations: (assessable component)**

*Students who demonstrate understanding can:*

**Highlighting indicates PE written by NYSED**

**Code:** **Each PE has a unique identifier that indicates the grade level (P–5) or band (MS), the science discipline and DCI addressed, and the order in which the statement appears in the *Framework*.**

**✱:** PE that incorporates engineering

**▲:** PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band)

**Clarification Statement:** provides examples and/or further clarifies the PE

**Assessment Boundary:** identifies the limits to large-scale assessments of the PE

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| Elements of the Science and Engineering Practices incorporated into the unit PEs. | Elements of the Disciplinary Core Ideas incorporated into the unit PEs. | Elements of the Crosscutting Concepts incorporated into the unit PEs. |
| **Connections to Engineering Design PEs:** identifies connections to the K–2 or 3-5 Engineering Design PEs (see Appendix C) | | |
| **Connections to DCIs in this grade-band (Middle School)**: identifies connections to DCIs addressed in other grades within the middle school grade band | | |
| **Articulation of DCIs across grade-levels:** connections to PEs in other grade levels that address related content | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** connections to Environmental Guidelines | | |

*The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

# PK–8 Curricula Implementation Timeline *(Based on 36 weeks of instruction)*

| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pre-K** | Welcome to Pre-K *(4 weeks)* | My Five Senses *(4 weeks)* | All About Us *(4 weeks)* | Where We Live *(4 weeks)* | Transportation *(4 weeks)* | Light *(4 weeks)* | Water *(4 weeks)* | Plants *(4 weeks)* | Babies *(4 weeks)* | Transformation *(4 weeks)* |
| **Kindergarten** | Weather Study<br>Solids and Liquids *(9 weeks)* | Push Me, Pull Me *(9 weeks)* | | | | Our Environment *(9 weeks)* | | Our Weather *(9 weeks)* | | |
| **Grade 1** | Exploring Light and Solar Patterns *(12 weeks)* | | | Light, Sound and Waves *(12 weeks)* | | | Structures and Behaviors in Living Things *(12 weeks)* | | | |
| **Grade 2** | Properties and Patterns of Water *(12 weeks)* | | | The Changes to Land Over Time *(12 weeks)* | | | Plant and Animal Interactions *(12 weeks)* | | | |
| **Grade 3** | Inheritance and Variation *(9 weeks)* | Interdependence *(9 weeks)* | | | | Change Over Time *(9 weeks)* | | Interacting Forces *(9 weeks)* | | |
| **Grade 4** | The Structure and Functions of Organisms *(7 weeks)* | Transfer of Energy and Information *(8 weeks)* | | | Energy, Motion, and Collisions *(7 weeks)* | Changes on Earth's Surface *(6 weeks)* | | Impacts of Natural Processes *(8 weeks)* | | |
| **Grade 5** | Physical and Chemical Changes *(9 weeks)* | Matter and Energy in Eco-Systems *(9 weeks)* | | | | Earth's Systems Science *(9 weeks)* | | Stars and the Solar System *(9 weeks)* | | |
| **Grade 6** | Electricity and Magnetism *(6 weeks)* | Engineering, and Energy Transformations *(8 weeks)* | | Ecosystems *(9 weeks)* | | | Investigating Weather and Climate *(8 weeks)* | | Human Impact on Earth's Climate *(5 weeks)* | |
| **Grade 7** | Structures and Properties of Matter *(8 weeks)* | Changing Properties of Matter and Energy *(10 weeks)* | | | | Structures of Life *(6 weeks)* | Geology *(7 weeks)* | | Minimizing Human Impact Through Engineering Design *(5 weeks)* | |
| **Grade 8** | Energy, Forces and Motion *(8 weeks)* | Earth's Place in the Universe *(6 weeks)* | | Growth, Development, and Reproduction of Organisms *(6 weeks)* | | Evolution, Natural Selection, and Adaptations *(8 weeks)* | | Evolution of Technology in Science *(8 weeks)* | | |

Units of Study

Grades

# PK–2

Grade **PK**

# NYS Science Learning Standards Alignment to Pre-K for All Interdisciplinary Units of Study

## Year-Long Summary

Pre-K's research-based interdisciplinary units of study include activities that provide children with opportunities to engage in exploring the Nature of Science. These activities emphasize questioning, observing, modeling, and teaching students how to use tools for investigations. Students will begin engaging in three-dimensional learning through the model of hands-on learning centers. There are two versions of Pre-K curriculum which include the following units:

1. **Welcome to Pre-K:** Focuses on children exploring, investigating, and understanding the world around them. Students naturally explore the world by using their senses. The newly acquired science skills spark curiosity and interest within Pre-K students.
2. **My Five Senses:** In this unit exploration continues with students using their five senses to delve deeper into the natural world.
3. **All About Us:** Students learn more about themselves and the animals around them. They explore ideas of identity and belonging within the context of other people and animals.
4. **Where We Live:** Builds on unit three, *All About Us*. Students move from learning how to critically think about themselves, their classmates, and their families to exploring the living spaces they inhabit.
5. **Transportation:** Students explore various modes and aspects of transportation. They identify and analyze how people and things move from place to place using vehicles and other methods of transportation.
6. **Light:** Focuses on observing objects and phenomena in their environment with increasing complexity. Students analyze the relationship of light, darkness, and shadows of objects in their environments, which helps deepen their understanding of natural and man-made sources of light.
7. **Water:** Children engage in activities about water through hands-on explorations and provide opportunities to observe water in its various forms in their immediate environment.
8. **Plants:** This unit considers how plants are a part of their daily lives and encourages students to make observations of the changing seasons to observe how plants grow, thrive, and change over time.
9. **Babies:** Unit 9 continues with a study of living things by moving from observing and learning about different kinds of plants to the needs and characteristics of different kinds of animal babies.
10. **Transformation:** Students conclude the year by investigating change. Children explore change in a variety of ways, from changes in nature to how and why objects change. Students are given opportunities to reflect on their own growth as well as make predictions on how they will continue to change.

| UNIT 1: WELCOME TO PRE-K (4 WEEKS) | UNIT 2: MY FIVE SENSES (4 WEEKS) | UNIT 3: ALL ABOUT US (4 WEEKS) | UNIT 4: WHERE WE LIVE (4 WEEKS) | UNIT 5: TRANSPORTATION (4 WEEKS) |
|---|---|---|---|---|
| **P-PS1-1.** Ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid. ▲ | **P-PS4-1.** Plan and conduct investigations to provide evidence that sound is produced by vibrating materials. | **P-LS1-1.** Observe familiar plants and animals (including humans) and describe what they need to survive.<br>**P-LS1-2.** Plan and conduct an investigation to determine how familiar plants and/or animals use their external parts to help them survive in the environment. ▲ | **P-ESS1-1.** Observe and describe the apparent motions of the Sun, moon, and stars to recognize predictable patterns. ▲<br>**P-ESS2-1.** Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about ho w local weather conditions change daily and seasonally. ▲ | **P-PS2-1.** Use tools and materials to design and build a device that causes an object to move faster with a push or a pull. ✱ |
| **UNIT 6: LIGHT (4 WEEKS)** | **UNIT 7: WATER (4 WEEKS)** | **UNIT 8: PLANTS (4 WEEKS)** | **UNIT 9: BABIES (4 WEEKS)** | **UNIT 10: TRANSFORMATION (4 WEEKS)** |
| **P-PS3-1.** Plan and conduct an investigation to determine the effect of sunlight on Earth's surface. | **P-PS1-1.** Ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid. ▲<br>**P-ESS2-1.** Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about how local weather conditions change daily and seasonally. ▲ | **P-LS1-2.** Plan and conduct an investigation to determine how familiar plants and/or animals use their external parts to help them survive in the environment. ▲<br>**P-LS3-1.** Develop a model to describe that some young plants and animals are similar to, but not exactly like, their parents. ▲ | **P-LS3-1.** Develop a model to describe that some young plants and animals are similar to, but not exactly like, their parents. ▲ | **P-ESS1-1.** Observe and describe the apparent motions of the Sun, moon, and stars to recognize predictable patterns. ▲<br>**P-ESS2-1.** Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about how local weather conditions change daily. ▲ |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **PK** | Unit **1**

# Welcome to Pre-K

**RECOMMENDED TIME: 4 WEEKS**

## Unit Overview:

The initial Interdisciplinary Unit of Study begins the journey of learning with an exciting topic focused on the exploration, investigation, and understanding of ourselves and our world. The foundational inquiry and science skills will spark the curiosity and interest of Pre-K children as they start to use those observations to make predictions, ask questions and draw conclusions.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

## Essential Question:

**How does temperature affect solids and liquids?**

**How do we explore, investigate and understand the world around us?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

## Performance Expectations:

*Students who demonstrate understanding can:*

**P-PS1-1. Ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid. ▲**
**[Clarification Statement: Emphasis should be on observing and describing similarities and differences between solids and liquids based on their physical properties. Solids and liquids can be compared and categorized (sorted) based on those properties.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades PK–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.<br>▪ Ask questions based on observations to find more information about the designed world. (P-PS1-1)<br>**Analyzing and Interpreting Data**<br>Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Record information (observations, thoughts, and ideas). (P-PS1-1) | **PS1.A: Structure and Properties of Matter**<br>▪ (NYSED) Different kinds of matter exist and many of them can be either solid or liquid. Matter can be described, categorized, and sorted by its observable properties. (P-PS1-1) | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed and used as evidence. (P-PS1-1) |

*continued on next page*

| |
|---|
| **Connections to Engineering Design PEs:** N/A |
| **Articulation of DCIs across grades K–1: K.PS1.A** (P-PS1-1) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A |

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade PK | Unit 2 My Five Senses

**RECOMMENDED TIME: 4 WEEKS**

### Unit Overview:

The second Unit of Study continues the journey of exploration and learning with an exciting topic focused on how we use our five senses to explore, investigate, and understand ourselves and our world. Children naturally explore the world around them through their senses. Children will continue to use observations to make predictions, ask questions, and draw conclusions: key higher-level science skills that they will use in upcoming Pre-K units and in kindergarten.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

### Essential Question:

**How do we use our senses to explore, investigate and understand the world around us?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

### Performance Expectations:

*Students who demonstrate understanding can:*

**P-PS4-1. Plan and conduct investigations to provide evidence that sound is produced by vibrating materials.**
**[Clarification Statement: Examples of vibrating materials could include percussion instruments (e.g., drum, triangle), string instruments (e.g., guitar, piano), wind instruments (e.g., recorder, whistle), and audio speakers.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ With guidance, plan and conduct an investigation in collaboration with peers. (P-PS4-1) | **PS4.A: Wave Properties**<br>▪ Sound can make matter vibrate, and vibrating matter can make sound. (P-PS4-1) | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed and used as evidence. (P-PS4-1)<br>**Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (P-PS4-1) |

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| **CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>■ Scientists use different ways to study the world. (P-PS4-1) | | |

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| **Connections to Engineering Design PEs:** N/A |
| **Articulation of DCIs across grades K–1: 1.PS4.A** (P-PS4-1) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A |

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

**Grade** **PK** | **Unit** **3**

# All About Us

**RECOMMENDED TIME: 4 WEEKS**

**Unit Overview:**

In this Unit of Study the children are ready to learn more about themselves and the people in their world. The *All About Us* unit supports the objective by providing opportunities for children to explore, learn about and embrace what makes them important and unique.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

**Essential Question:**

**Who am I and who are the people in my life?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

**Performance Expectations:**

*Students who demonstrate understanding can:*

**P-LS1-1.** **Observe familiar plants and animals (including humans) and describe what they need to survive.**
**[Clarification Statement: Emphasis should be on determining what a variety of living organisms need to live and grow.]**

**P-LS1-2.** **Plan and conduct an investigation to determine how familiar plants and/or animals use their external parts to help them survive in the environment. ▲**
**[Clarification Statement: Emphasis should be on the relationships between the physical and living environment. Examples of external parts could include roots, stems, leaves for plants and eyes, ears, mouth, arms, legs for animals.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>■ With guidance, plan and conduct an investigation in collaboration with peers. (P-LS1-2) | **LS1.A: Structure and Function**<br>■ All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (P-LS1-2) | **Patterns**<br>■ Patterns in the natural and human designed world can be observed and used as evidence. (P-LS1-1)<br>**Cause and Effect**<br>■ Events have causes that generate observable patterns. (P-LS1-2)<br>**Systems and System Models**<br>■ Systems in the natural and designed world have parts that work together. (P-LS1-2) |

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|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Record information (observations, thoughts, and ideas). (P-LS1-1)<br><br>**Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in PK–2 builds on prior experiences and uses observations and texts to communicate new information.<br>▪ Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (P-LS1-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Scientific Investigations Use a Variety of Methods**<br>▪ Scientists use different ways to study the world. (P-LS1-2) | **LS1.C: Organization for Matter and Energy Flow in Organisms**<br>▪ (NYSED) All animals need food, air, and water in order to live, grow, and thrive. Animals obtain food from plants or from other animals. Plants need water, air, and light to live, grow, and thrive. (P-LS1-1)<br><br>**LS1.D: Information Processing**<br>▪ Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (P-LS1-2) | **Structure and Function**<br>▪ The shape and stability of structures of natural and designed objects are related to their function(s). (P-LS1-2) |

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grades K–1: K.LS1.C** (P-LS1-1); **K.ESS3.C** (P-LS1-1); **1.LS1.A** (P-LS1-1); **1.LS1.D** (P-LS1-2)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **PK** | Unit **4** Where We Live

**RECOMMENDED TIME: 4 WEEKS**

**Unit Overview:**

The fourth Interdisciplinary Unit of Study, *Where We Live*, builds on the third unit, *All About Us*; children explored ideas of identity and belonging as they learned about themselves and the people around them. In this unit children move from inquiring and thinking critically about themselves, their classmates, and their family to the living spaces that they inhabit. This unit is designed to reflect the diverse places where people live in neighborhoods across New York City. There are opportunities throughout the unit to tailor discussions and activities to reflect the children and their community. After children consider the different kinds of homes in which they and the people they know live, they will start to consider animals and investigate a more abstract concept of animal homes.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

**Essential Question:**

**Where do the people and animals around me live?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

**Performance Expectations:**

*Students who demonstrate understanding can:*

**P-ESS1-1. Observe and describe the apparent motions of the Sun, moon, and stars to recognize predictable patterns. ▲**
**[Clarification Statement:** Examples of patterns could include that the Sun and moon appear to move across the sky in a predictable pathway; day and night follow predictable patterns; seasons change in a cyclical pattern (e.g., summer follows spring, autumn follows summer); the moon's shape appears to change in a cyclical pattern; and stars other than our Sun can be visible at night depending on local weather conditions.]

**P-ESS2-1. Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about how local weather conditions change daily and seasonally. ▲**
[Clarification Statement: Emphasis is on daily weather conditions recorded over a period of time and how those conditions impact student activities and what clothes they wear. Examples of local weather conditions could include cloud cover (sunny, partly cloudy, cloudy, foggy), precipitation (no precipitation, snow, hail, rain), wind (no wind, some wind, strong wind), and temperature (cold, cool, warm, hot).] **[Assessment Boundary:** Assessment is limited to qualitative measures of local weather conditions.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

*continued on next page*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades PK–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.<br>▪ Ask questions based on observations to find more information about the designed world. (P-ESS2-1)<br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (P-ESS2-1)<br>**Analyzing and Interpreting Data**<br>Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (P-ESS1-1)<br>▪ Analyze data from tests of an object or tool to determine if it works as intended. (P-ESS2-1)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>▪ Scientists use different ways to study the world. (P-ESS1-1), (P-ESS2-1) | **ESS1.A: The Universe and its Stars**<br>▪ Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (P-ESS1-1)<br>**ESS2.D: Weather and Climate**<br>▪ Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (P-ESS2-1)<br>**ESS3.B: Natural Hazards**<br>▪ Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (P-ESS2-1) | **Patterns**<br>▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (P-ESS1-1), (P-ESS2-1)<br>**Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (P-ESS2-1)<br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br>**Interdependence of Science, Engineering, and Technology**<br>▪ People encounter questions about the natural world every day. (P-ESS2-1)<br>**Influence of Engineering, Technology, and Science on Society and the Natural World**<br>▪ People depend on various technologies in their lives; human life would be very different without technology. (P-ESS2-1)<br>**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**<br>▪ Science assumes natural events happen today as they happened in the past. (P-ESS1-1)<br>▪ Many events are repeated. (P-ESS1-1) |

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grades K–1: K.ESS2.D** (P-ESS2-1); **K.ESS3.B** (P-ESS2-1); **1.ESS1.A** (P-ESS1-1); **1.ESS1.B** (P-ESS1-1)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **PK** | Unit **5** Transportation

**RECOMMENDED TIME: 4 WEEKS**

## Unit Overview:

The fifth Unit of Study, *Transportation*, has the children move from inquiring and thinking critically about the places where animals and people live to exploring how people move from place to place using vehicles and other methods of transportation. This unit, like all Pre-K for All units, provides opportunities for children to observe objects and phenomena in their environment with increasing complexity through hands-on activities in the classroom and in the community.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

## Essential Question:

**How does my community use various modes of transportation?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

## Performance Expectations:

*Students who demonstrate understanding can:*

**P-PS2-1. Use tools and materials to design and build a device that causes an object to move faster with a push or a pull. ✱**

**[Clarification Statement: Emphasis should be on developing an interest in investigating forces (pushes or pulls). Examples of forces could include a string attached to an object being pulled or a ramp to increase the speed of an object.] [Assessment Boundary: Assessment is limited to relative measures of speed (slower, faster).]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ With guidance, plan and conduct an investigation in collaboration with peers. (P-PS2-1) | **PS2.A: Forces and Motion**<br>▪ Pushes and pulls can have different strengths and directions. (P-PS2-1)<br>▪ Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (P-PS2-1)<br>**PS3.C: Relationship Between Energy and Forces**<br>▪ (NYSED) A push or a pull may cause stationary objects to move, and a stronger push or pull in the same or opposite direction makes an object in motion speed up or slow down more quickly. (secondary to P-PS2-1) | **Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (P-PS2-1) |

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|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Analyze data from tests of an object or tool to determine if it works as intended. (P-PS2-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>▪ Scientists use different ways to study the world. (P-PS2-1) | **ETS1.A: Defining Engineering Problems**<br>▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (P-PS2-1) | |
| **Connections to Engineering Design PEs: K–2-ETS1-1** (P-PS2-1) | | |
| **Articulation of DCIs across grades K–1: K.PS2.A** (P-PS2-1); **K.PS2.B** (P-PS2-1); **K.PS3.C** (P-PS2-1) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A | | |

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

# Grade PK | Unit 6 Light

**RECOMMENDED TIME: 4 WEEKS**

**Unit Overview:**

The sixth Interdisciplinary Unit of Study has the children move from exploring various modes and aspects of transportation to inquiring and thinking critically about light, darkness, and shadows. In this unit, children have the opportunity to deepen their understanding of natural and man-made sources of light. Activities throughout the unit prompt children to explore light, darkness and shadows with hands-on materials as well as provide opportunities for children to make predictions and think about their world in increasingly abstract ways.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

**Essential Question:**

**How and why do we use different kinds of light?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

**Performance Expectations:**

*Students who demonstrate understanding can:*

**P-PS3-1.** Plan and conduct an investigation to determine the effect of sunlight on Earth's surface. ▲
**[Clarification Statement: Examples of effects could include illumination, shadows cast, and the warming effect on living organisms and nonliving things.]**
**[Assessment Boundary: Assessment of effects is limited to relative measures: e.g., warm/cool, bright/dark.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ With guidance, plan and conduct an investigation in collaboration with peers. (P-PS3-1) | **PS3.B: Conservation of Energy and Energy Transfer**<br>▪ Sunlight warms Earth's surface. (P-PS3-1)<br>**PS4.B: Electromagnetic Radiation**<br>▪ Objects can be seen if light is available to illuminate them or if they give off their own light. (P-PS3-1) | **Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (P-PS3-1) |

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|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Analyze data from tests of an object or tool to determine if it works as intended. (P-PS3-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>▪ Scientists use different ways to study the world. (P-PS3-1) | | |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grades K–1: K.PS3.B** (P-PS3-1) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A | | |

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*PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

**Grade** **Unit**

# PK | 7 Water

**RECOMMENDED TIME: 4 WEEKS**

**Unit Overview:**

In this unit of study the children explore the properties and uses of water. Activities throughout the unit prompt children to learn about water through hands-on explorations and provide opportunities to observe water in their immediate environment. Students consider how water is a part of their daily lives. Additionally, students observe the weather and seasonal changes.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

**Essential Question:**

**What does water do?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

**Performance Expectations:**

*Students who demonstrate understanding can:*

**P-PS1-1. Ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid. ▲**
**[Clarification Statement: Emphasis should be on observing and describing similarities and differences between solids and liquids based on their physical properties. Solids and liquids can be compared and categorized (sorted) based on those properties.**

**P-ESS2-1. Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about how local weather conditions change daily and seasonally. ▲**
**[Clarification Statement: Emphasis is on daily weather conditions recorded over a period of time and how those conditions impact student activities and what clothes they wear. Examples of local weather conditions could include cloud cover (sunny, partly cloudy, cloudy, foggy), precipitation (no precipitation, snow, hail, rain), wind (no wind, some wind, strong wind), and temperature (cold, cool, warm, hot).] [Assessment Boundary: Assessment is limited to qualitative measures of local weather conditions.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades PK–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.<br>▪ Ask questions based on observations to find more information about the designed world. (P-PS1-1), (P-ESS2-1) | **PS1.A: Structure and Properties of Matter**<br>▪ (NYSED) Different kinds of matter exist and many of them can be either solid or liquid. Matter can be described, categorized, and sorted by its observable properties. (P-PS1-1) | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (P-PS1-1), (P-ESS2-1)<br>**Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (P-ESS2-1) |

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**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Make observations (firsthand or from media) to collect data that can be used to make comparisons. (P-ESS2-1)

**Analyzing and Interpreting Data**

Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Record information (observations, thoughts, and ideas). (P-PS1-1)
- Analyze data from tests of an object or tool to determine if it works as intended. (P-ESS2-1)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Investigations Use a Variety of Methods**

- Scientists use different ways to study the world. (P-ESS2-1)

**ESS2.D: Weather and Climate**

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (P-ESS2-1)

**ESS3.B: Natural Hazards**

- Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (P-ESS2-1)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Interdependence of Science, Engineering, and Technology**

- People encounter questions about the natural world every day. (P-ESS2-1)

**Influence of Engineering, Technology, and Science on Society and the Natural World**

- People depend on various technologies in their lives; human life would be very different without technology. (P-ESS2-1)

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grades K–1: K.PS1.A** (P-PS1-1); **K.ESS2.D** (P-ESS2-1); **K.ESS3.B** (P-ESS2-1)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

**Grade** **Unit**

# PK | 8 Plants

**RECOMMENDED TIME: 4 WEEKS**

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|---|---|
| **Unit Overview:**<br>This Unit of Study, Plants, has children observing and learning about different kinds of plants. Activities throughout the unit prompt children to engage in explorations and provide opportunities to observe plants in their immediate environment. Students consider how different kinds of plants are a part of their daily lives. Additionally, students use the changing seasons to discuss and observe how plants grow and change over time.<br>Adapted from *Pre-K for All Interdisciplinary Units of Study* | **Essential Question:**<br>**How do plants grow and why are they important?**<br>Retrieved from *Pre-K for All Interdisciplinary Units of Study* |

## Performance Expectations:

*Students who demonstrate understanding can:*

**P-LS1-2.** **Plan and conduct an investigation to determine how familiar plants and/or animals use their external parts to help them survive in the environment. ▲**
**[Clarification Statement: Emphasis should be on the relationships between the physical and living environment. Examples of external parts could include roots, stems, leaves for plants and eyes, ears, mouth, arms, legs for animals.]**

**P-LS3-1.** **Develop a model to describe that some young plants and animals are similar to, but not exactly like, their parents. ▲**
**[Clarification Statement: Emphasis is on observation and pictorial representations of familiar plants and animals.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in PK–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>▪ Compare models to identify common features and differences. (P-LS3-1)<br>▪ Develop a simple model based on evidence to represent a proposed object or tool. (P-LS3-1) | **LS1.A: Structure and Function**<br>▪ All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (P-LS1-2) | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed and used as evidence. (P-LS3-1)<br>**Cause and Effect**<br>▪ Events have causes that generate observable patterns. (P-LS1-2)<br>**Systems and System Models**<br>▪ Systems in the natural and designed world have parts that work together. (P-LS1-2) |

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| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>■ With guidance, plan and conduct an investigation in collaboration with peers. (P-LS1-2)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>■ Scientists use different ways to study the world. (P-LS1-2) | **LS1.D: Information Processing**<br>■ Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (P-LS1-2)<br>**LS3.A: Inheritance of Traits**<br>■ (NYSED) Some young animals are similar to, but not exactly, like their parents. Some young plants are also similar to, but not exactly, like their parents. (P-LS3-1)<br>**LS3.B: Variation of Traits**<br>■ Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (P-LS3-1) | **Structure and Function**<br>■ The shape and stability of structures of natural and designed objects are related to their function(s). (P-LS1-2) |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grades K–1: 1.LS1.D** (P-LS1-2); **1.LS3.A** (P-LS3-1)**; 1.LS3.B** (P-LS3-1) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A | | |

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **PK** | Unit **9** Babies

# Grade PK | Unit 9 Babies

**RECOMMENDED TIME: 4 WEEKS**

## Unit Overview:

The ninth Interdisciplinary Unit of Study, *Babies*, allows the children to continue to study living things by moving from observing and learning about different kinds of plants to the needs and characteristics of different kinds of animal babies. Since humans are members of the animal kingdom, this includes the opportunity to study human babies. The study of babies has high interest and relevance for children in Pre-K, as they may have younger family members or experiences with younger children or babies in their daily lives. Pre-K children themselves are developing increasing independence and awareness of who they are and what they can do.

Adapted from *Pre-K for All Interdisciplinary Units of Study*

**Essential Question:**

**What are babies?**

Retrieved from *Pre-K for All Interdisciplinary Units of Study*

## Performance Expectations:

*Students who demonstrate understanding can:*

**P-LS3-1. Develop a model to describe that some young plants and animals are similar to, but not exactly like, their parents. ▲**
**[Clarification Statement: Emphasis is on observation and pictorial representations of familiar plants and animals.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in PK–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>▪ Compare models to identify common features and differences. (P-LS3-1)<br>▪ Develop a simple model based on evidence to represent a proposed object or tool. (P-LS3-1) | **LS3.A: Inheritance of Traits**<br>▪ (NYSED) Some young animals are similar to, but not exactly, like their parents. Some young plants are also similar to, but not exactly, like their parents. (P-LS3-1)<br>**LS3.B: Variation of Traits**<br>▪ Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (P-LS3-1) | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed and used as evidence. (P-LS3-1) |

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|---|
| **Connections to Engineering Design PEs:** N/A |
| **Articulation of DCIs across grades K–1: : 1.LS3.A** (P-LS3-1); **1.LS3.B** (P-LS3-1) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A |

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade PK | Unit 10 Transformation

**RECOMMENDED TIME: 4 WEEKS**

| Unit Overview: | Essential Question: |
|---|---|
| The tenth and last Interdisciplinary Unit of Study, *Transformation*, has children conclude the year by investigating how things change over time. This final Pre-K unit is an opportunity to apply knowledge and skills children learned in previous units, and to help children prepare for upcoming transitions. To transform means to make a thorough or dramatic change in form, appearance or character. Children will continue to explore how things change in a variety of ways. <br> Adapted from *Pre-K for All Interdisciplinary Units of Study* | **What is transformation and how do things change?** <br> Retrieved from *Pre-K for All Interdisciplinary Units of Study* |

## Performance Expectations:

*Students who demonstrate understanding can:*

**P-ESS1-1. Observe and describe the apparent motions of the Sun, moon, and stars to recognize predictable patterns. ▲**

**[Clarification Statement: Examples of patterns could include that the Sun and moon appear to move across the sky in a predictable pathway; day and night follow predictable patterns; seasons change in a cyclical pattern (e.g., summer follows spring, autumn follows summer); the moon's shape appears to change in a cyclical pattern; and stars other than our Sun can be visible at night depending on local weather conditions.]**

**P-ESS2-1. Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about how local weather conditions change daily and seasonally. ▲**

**[Clarification Statement: Emphasis is on daily weather conditions recorded over a period of time and how those conditions impact student activities and what clothes they wear. Examples of local weather conditions could include cloud cover (sunny, partly cloudy, cloudy, foggy), precipitation (no precipitation, snow, hail, rain), wind (no wind, some wind, strong wind), and temperature (cold, cool, warm, hot).] [Assessment Boundary: Assessment is limited to qualitative measures of local weather conditions.]**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems** <br> Asking questions and defining problems in grades PK–2 builds on prior experiences and progresses to simple descriptive questions that can be tested. <br> ▪ Ask questions based on observations to find more information about the designed world. (P-ESS2-1) | **ESS1.A: The Universe and its Stars** <br> ▪ Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (P-ESS1-1) | **Patterns** <br> ▪ Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (P-ESS1-1), (P-ESS2-1) |

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**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Make observations (firsthand or from media) to collect data that can be used to make comparisons. (P-ESS2-1)

**Analyzing and Interpreting Data**

Analyzing data in PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (P-ESS1-1)
- Analyze data from tests of an object or tool to determine if it works as intended. (P-ESS2-1)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Investigations Use a Variety of Methods**

- Scientists use different ways to study the world. (P-ESS1-1), (P-ESS2-1)

**ESS2.D: Weather and Climate**

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (P-ESS2-1)

**ESS3.B: Natural Hazards**

- Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and to these events. (P-ESS2-1)

**Cause and Effect**

- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (P-ESS2-1)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Interdependence of Science, Engineering, and Technology**

- People encounter questions about the natural world every day. (P-ESS2-1)

**Influence of Engineering, Technology, and Science on Society and the Natural World**

- People depend on various technologies in their lives; human life would be very different without technology. (P-ESS2-1)

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

- Science assumes natural events happen today as they happened in the past. (P-ESS1-1)
- Many events are repeated. (P-ESS1-1)

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grades K–1: K.ESS2.D** (P-ESS2-1); **K.ESS3.B** (P-ESS2-1); **1.ESS1.A** (P-ESS1-1); **1.ESS1.B** (P-ESS1-1)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A

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# Grade K | Kindergarten Year-Long Summary

In Kindergarten students are expected to assume the role of scientist in a classroom setting. Students bring many life experiences that will define how they interact with phenomena they are exposed to throughout the year. They begin to use quantitative observations to assist them in making sense of their world. With this gathering and application of data, students develop their scientific vocabulary and begin to develop explanations that allow them to better understand themselves and the natural world.

The year-long *Weather Study* is interwoven throughout the four units of study. Throughout the year, students collect weather data as a part of the daily classroom routine, and describe weather conditions such as sunny, cloudy, rainy or windy. Additionally, students collect data on the number of sunny, windy, and rainy days in a month, and over the course of the year. Unit One, *Solids and Liquids*, introduces matter in which students investigate the effects of temperature on different types of matter. The second unit, *Push Me, Pull Me*, introduces design projects related to motion. The third unit, *Our Environment*, studies the relationship between living things and where they live and the impact humans have on the environment. The final unit, *Our Weather* requires students to employ weather data gathered throughout the school year to identify methods of preparing for daily and severe weather.

| YEAR-LONG UNIT: WEATHER STUDY (YEAR-LONG) | UNIT 1: SOLIDS AND LIQUIDS (9 WEEKS) | UNIT 2: PUSH ME, PULL ME (9 WEEKS) | UNIT 3: OUR ENVIRONMENT (9 WEEKS) | UNIT 4: OUR WEATHER (9 WEEKS) |
|---|---|---|---|---|
| **K-ESS2-1.** Use and share observations of local weather conditions to describe patterns over time. ▲ | **K-PS1-1.** Plan and conduct an investigation to test the claim that different kinds of matter exist as either solid or liquid, depending on temperature. | **K-PS2-1.** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.<br><br>**K-PS2-2.** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. ✱ | **K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive.<br><br>**K-ESS2-2.** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.<br><br>**K-ESS3-1.** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. | **K-ESS2-1.** Use and share observations of local weather conditions to describe patterns over time. ▲<br><br>**K-ESS3-2.** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. ✱<br><br>**K-PS3-2.** Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area. ✱ |

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| YEAR-LONG UNIT: WEATHER STUDY (YEAR-LONG) | UNIT 1: SOLIDS AND LIQUIDS (9 WEEKS) | UNIT 2: PUSH ME, PULL ME (9 WEEKS) | UNIT 3: OUR ENVIRONMENT (9 WEEKS) | UNIT 4: OUR WEATHER (9 WEEKS) |
|---|---|---|---|---|
| | | | **K-ESS3-3.** Communicate solutions that will reduce the impact of humans on living organisms and nonliving things in the local environment. ✱<br>**K-ESS2-1.** Use and share observations of local weather conditions to describe patterns over time. | |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea..*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **K** | Year-Long Unit

# Weather Study

**RECOMMENDED TIME: YEAR-LONG**

## Unit Overview:

This year-long unit, which culminates in unit four, "*Our Weather*," is intended to introduce students to data collection and pattern analysis. Students observe and document daily weather patterns, explaining what they notice in terms of sunny, cloudy, windy, rainy, warm, cool, and hot, as well as the number of said days over given time periods. The expectation of this unit is to establish daily routines and expectations to be followed over the course of the year.

**Essential Question:**

**How and why do we collect weather data?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**K-ESS2-1.** **Use and share observations of local weather conditions to describe patterns over time.** ▲
**[Clarification Statement:** Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] **[Assessment Boundary:** Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>■ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Science Knowledge is Based on Empirical Evidence**<br>■ Scientists look for patterns and order when making observations about the world. (K-ESS2-1) | **ESS2.D: Weather and Climate**<br>■ Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1) | **Patterns**<br>■ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1) |

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|---|
| **Connections to Engineering Design PEs:** N/A |
| **Articulation of DCIs across grade-levels: 2.ESS2.A** (K-ESS2-1); **3.ESS2.D** (K-ESS2-1); **4.ESS2.A** (K-ESS2-1) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (K-ESS2-1); **1.E** (K-ESS2-1); **2.1.A** (K-ESS2-1) |

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **K** | Unit **1**

# Solids and Liquids

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

Students apply prior knowledge about solids and liquids from life experiences with water and other substances. Cause and effect is at the core of this unit, as students gather evidence to explain that a solid may be a liquid at a higher temperature and a liquid may be a solid at a lower temperature. Kindergarten students are expected to use qualitative terms such as hot, warm and cool when differentiating between temperatures. This unit also allows for the opportunity to introduce the concept of properties of matter, which can be challenging for young learners. Students engage in testing and analyzing data to evaluate the effectiveness of various objects or tools. Students are introduced to the nature of science as a way of making sense of the world, rather than a prescribed set of steps and beliefs.

**Essential Question:**

**How does temperature affect solids and liquids?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**K-PS1-1.** Plan and conduct an investigation to test the claim that different kinds of matter exist as either solid or liquid, depending on temperature.
**[Clarification Statement:** Emphasis should be on solids and liquids at a given temperature and that a solid may be a liquid at higher temperature and a liquid may be a solid at a lower temperature.] **[Assessment Boundary:** Only a qualitative description of temperature, such as hot, warm, and cool, is expected.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ With guidance, plan and conduct an investigation in collaboration with peers. (K-PS1-1) | **PS1.A: Structure and Properties of Matter**<br>▪ 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. (K-PS1-1) | **Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS1-1)<br>**Energy and Matter**<br>▪ Students observe objects may break into smaller pieces, be put together into larger pieces, or change shapes. (K-PS1-1) |

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| | | |
|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Record information (observations, thoughts, and ideas). (K-PS1-1)<br>▪ Analyze data from tests of an object or tool to determine if it works as intended. (K-PS1-1)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>▪ Scientists use different ways to study the world. (K-PS1-1) | | |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grades K–1: 2.PS1.A** (K-PS1-1); **5.PS1.A** (K-PS1-1) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.B** (K-PS1-1); **1.C** (K-ESS2-1); **1.E** (K-ESS2-1); **2.1.A** (K-ESS2-1) | | |

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Grade **K** | Unit **2**

# Push Me, Pull Me

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In Unit 2 students compare the effects of pushes and pulls on an object and learn how to use evidence to develop explanations. This is achieved by having students draw upon life experiences such as bouncing a ball, playing with toy cars, and getting up and down from a chair. When students engage in explorations they will discover how forces influence the speed and/or direction of an object, what causes an object to start and stop, and what happens when objects collide. This allows students to continue learning how scientists use a variety of methods to examine the world.

**Essential Question:**

**How do pushes and pulls influence the way an object moves?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**K-PS2-1.** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
[**Clarification Statement:** Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [**Assessment Boundary:** Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]

**K-PS2-2**. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. ∗
[**Clarification Statement:** Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [**Assessment Boundary:** Assessment does not include friction as a mechanism for change in speed.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
| --- | --- | --- |
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1) | **PS2.A: Forces and Motion**<br>▪ Pushes and pulls can have different strengths and directions. (K-PS2-1), (K-PS2-2)<br>▪ Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2) | **Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1), (K-PS2-2) |

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| | | |
|---|---|---|
| **Analyzing and Interpreting Data**<br>▪ Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>▪ Scientists use different ways to study the world. (K-PS2-1) | **PS2.B: Types of Interactions**<br>▪ When objects touch or collide, they push on one another and can change motion. (K-PS2-1)<br>**PS3.C: Relationship Between Energy and Forces**<br>▪ (NYSED) A push or a pull may cause stationary objects to move, and a stronger push or pull in the same or opposite direction makes an object in motion speed up or slow down more quickly. (secondary to K-PS2-1)<br>**ETS1.A: Defining Engineering Problems**<br>▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to K-PS2-2) | |

**Connections to Engineering Design PEs: K–2-ETS1-1** (K-PS2-2)

**Articulation of DCIs across grades K–1: 2.ETS1.B** (K-PS2-2); **3.PS2.A** (K-PS2-1), (K-PS2-2); **3.PS2.B** (K-PS2-1); **4.PS3.A** (K-PS2-1); **4.ETS1.A** (K-PS2-2)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (K-ESS2-1); **1.E** (K-ESS2-1); **2.1.A** (K-ESS2-1)

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

Grade **K** | Unit **3**

# Our Environment

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

Students study systems in the natural world in order to discover relationships among living things and their environments. This offers students the opportunity to look for patterns and engage in argument from evidence. Real world examples of living things interacting with their local environments include, but are not limited to: a squirrel digging holes in the ground to bury acorns; a beaver building a dam; plant roots breaking the ground; plants appearing differently with or without sufficient water. Additionally, students are encouraged to objectively view the human impact on the local environment and consider ways to reduce negative alterations to the land, air, water, plants and animals. Students communicate information using scientific ideas as they learn that scientific knowledge is based on empirical evidence.

**Essential Question:**

**What do living things need to live and grow, and how might they change their environments to survive?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive.
[**Clarification Statement:** Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and that all living things need water and other materials to live, grow, and thrive.]

**K-ESS2-2.** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
[**Clarification Statement:** Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

**K-ESS3-1.** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
[**Clarification Statement:** Examples of relationships could include that deer eat buds and leaves, that therefore, they usually live in forested areas, and that grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.]

**K-ESS3-3.** Communicate solutions that will reduce the impact of humans on living organisms and nonliving things in the local environment. ✱
[**Clarification Statement:** Examples of human impact on the environment (land, water, air, plants, and animals) could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>▪ Use a model to represent relationships in the natural world. (K-ESS3-1)<br>**Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)<br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).<br>▪ Construct an argument with evidence to support a claim. (K-ESS2-2)<br>**Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.<br>▪ Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3) | **LS1.C: Organization for Matter and Energy Flow in Organisms**<br>▪ (NYSED) All animals need food, air, and water in order to live, grow, and thrive. Animals obtain food from plants or from other animals. Plants need water, air, and light to live, grow, and thrive. (K-LS1-1)<br>**ESS2.E: Biogeology**<br>▪ Plants and animals can change their environment. (K-ESS2-2)<br>**ESS3.A: Natural Resources**<br>▪ Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1)<br>**ESS3.C: Human Impacts on Earth Systems**<br>▪ Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (secondary to K-ESS2-2), (K-ESS3-3)<br>**ETS1.B: Developing Possible Solutions**<br>▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to K-ESS3-3) | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1)<br>**Cause and Effect**<br>▪ Events have causes that generate observable patterns. (K-ESS3-3)<br>**Systems and System Models**<br>▪ Systems in the natural and designed world have parts that work together. (K-ESS2-2), (K-ESS3-1) |

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| | | |
|---|---|---|
| **CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Scientists look for patterns and order when making observations about the world. (K-LS1-1) | | |

**Connections to Engineering Design PEs: K–2-ETS1-1** (K-ESS3-3)

**Articulation of DCIs across grades K-1: 1.LS1.A** (K-LS1-1), (K-ESS3-1); **2.LS2.A** (K-LS1-1); **2.ETS1.B** (K-ESS3-3); **3.LS2.C** (K-LS1-1); **3.LS4.B** (K-LS1-1); **4.ESS2.E** (K-ESS2-2); **4.ESS3.A** (K-ESS3-3); **5.LS1.C** (K-LS1-1); **5.LS2.A** (K-LS1-1), (K-ESS3-1); **5.ESS2.A** (K-ESS2-2), (K-ESS3-1); **5.ESS3.C** (K-ESS3-3)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (K-ESS2-1); 1.E (K-ESS2-1); **1.F** (K-ESS3-1); **1.G** (K-ESS2-2), (K-ESS3-3); 2.1.A (K-ESS2-1); **2.2.A** (K-LS1-1); **2.2.C** (K-ESS2-2), (K-ESS3-1); **2.4.A** (K-ESS2-2), (K-ESS3-1); **2.4.B** (K-ESS3-1); **3.1.C** (K-LS1-1)

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

# Grade K | Unit 4 Our Weather

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

Unit 4 is a culmination of the year's work in gathering weather data and discovering patterns. Simple qualitative observation terms are expected when describing weather (e.g., sunny, cloudy, snowy, and cool), accompanied by quantitative observation data (e.g., the number of sunny, windy, cloudy, and snowy days in a month and/or the school year), as well as the patterns observed on a daily, weekly, and monthly basis. The purpose of weather forecasting is introduced as a necessity for preparing for both common and severe weather conditions. Students revisit temperature as they study the effect of sunlight on Earth's surface, and design structures to protect against the heat and light from the Sun. Students practice asking questions and defining problems, in addition to planning and carrying out investigations when looking at ways to lessen the impact of the weather on one's community. This unit stresses the many ways that humans depend on technologies in their daily lives.

### Essential Question:

**How can we analyze and interpret weather data to best protect ourselves from sunlight and severe weather?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**K-PS3-1.** Make observations to determine the effect of sunlight on Earth's surface.
[**Clarification Statement:** Examples of Earth's surface could include sand, soil, rocks, and water] [**Assessment Boundary:** Assessment of temperature is limited to relative measures such as warmer/cooler.]

**K-PS3-2.** Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area. ∗
[**Clarification Statement:** Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.]

**K-ESS2-1.** Use and share observations of local weather conditions to describe patterns over time. ▲
[**Clarification Statement:** Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [**Assessment Boundary:** Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.]

**K-ESS3-2.** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. ∗
[**Clarification Statement:** Emphasis is on local forms of severe weather and local resources available for preparedness measures.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.<br>▪ Ask questions based on observations to find more information about the designed world. (K-ESS3-2)<br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (K-PS3-1)<br>**Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1)<br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.<br>▪ Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem. (K-PS3-2) | **PS3.B: Conservation of Energy and Energy Transfer**<br>▪ Sunlight warms Earth's surface. (K-PS3-1), (K-PS3-2)<br>**ESS2.D: Weather and Climate**<br>▪ Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1)<br>**ESS3.B: Natural Hazards**<br>▪ Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2)<br>**ETS1.A: Defining and Delimiting an Engineering Problem**<br>▪ Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2) | **Patterns**<br>▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1)<br>**Cause and Effect**<br>▪ Events have causes that generate observable patterns. (K-PS3-1), (K-PS3-2), (K-ESS3-2)<br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY AND APPLICATIONS OF SCIENCE**<br>**Interdependence of Science, Engineering, and Technology**<br>▪ People encounter questions about the natural world every day. (K-ESS3-2)<br>**Influence of Engineering, Technology, and Science on Society and the Natural World**<br>▪ People depend on various technologies in their lives; human life would be very different without technology. (K-ESS3-2) |

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| **Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.<br>■ Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world. (K-ESS3-2)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>■ Scientists use different ways to study the world. (K-PS3-1)<br>**Science Knowledge is Based on Empirical Evidence**<br>■ Scientists look for patterns and order when making observations about the world. (K-ESS2-1) | | |
| **Connections to Engineering Design PEs: K.ETS1-1** (K-PS3-2), (K-ESS3-2); **K.ETS1-2** (K-PS3-2) | | |
| **Articulation of DCIs across grade-levels: 1.PS4.B** (K-PS3-1), (K-PS3-2); **2.ESS1.C** (K-ESS3-2); **2.ESS2.A** (K-ESS2-1); **2.ETS1.B** (K-PS3-2); **3.ESS2.D** (K-PS3-1), (K-ESS2-1); **3.ESS3.B** (K-ESS3-2); **4.ESS2.A** (K-ESS2-1); **4.ESS3.B** (K-ESS3-2); **4.ETS1.A** (K-PS3-2) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.A** (K-ESS3-2); **1.B** (K-PS3-2); **1.C** (K-PS3-1), (K-ESS2-1); **1.E** (K-ESS2-1); **2.1.A** (K-ESS2-1); **2.1.C** (K-PS3-1), (K-PS3-2); **2.4.A** (K-PS3-2), (K-ESS3-2) | | |

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade
# 1 First Grade Year-Long Summary

Grade 1 provides opportunities for students to observe patterns—of light and sound, the moon, sun, and stars, and in the behavior of living things. Furthermore, they begin to notice that plant and animal parents are similar to their offspring. In Unit 1, students begin to investigate patterns of daylight, an investigation that will continue throughout the year. They also make observations about how light illuminates objects to make them visible. Unit 2 builds on the concept of light by introducing students to light and sound waves. The final unit introduces the basics of heredity, and the structures and characteristics of living things that help them survive in their environment.

| UNIT 1: EXPLORING LIGHT AND SOLAR PATTERNS (12 WEEKS) | UNIT 2: LIGHT, SOUND, AND WAVES (12 WEEKS) | UNIT 3: STRUCTURES AND BEHAVIORS IN LIVING THINGS (12 WEEKS) |
|---|---|---|
| **1-PS4-2.** Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated. ▲<br>**1-PS4-3.** Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.<br>**1-ESS1-2.** Make observations at different times of year to relate the amount of daylight to the time of year. | **1-PS4-1.** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.<br>**1-PS4-2.** Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated. ▲<br>**1-PS4-4.** Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.✱<br>**1-ESS1-1.** Use observations of the Sun, moon, and stars to describe patterns that can be predicted.<br>**1-ESS1-2.** Make observations at different times of year to relate the amount of daylight to the time of year. ▲ | **1-LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. ✱<br>**1-LS1-2.** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.<br>**1-LS3-1.** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.<br>**1-ESS1-2.** Make observations at different times of year to relate the amount of daylight to the time of year. ▲ |

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# Grade 1 | Unit 1 Exploring Light and Solar Patterns

**RECOMMENDED TIME: 12 WEEKS**

## Unit Overview:

In this unit, students observe objects using sight. Students develop an understanding of the relationship between the availability of light and our ability to see objects. Students explore the idea that light travels from place to place. They plan and carry out investigations to observe the effect of placing objects of different materials in the path of a beam of light.

**Essential Question:**

**Why do we see objects?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**1-PS4-2.** Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated. ▲
**[Clarification Statement:** Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]

**1-PS4-3.** Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.
**[Clarification Statement:** Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).] **[Assessment Boundary:** Assessment does not include the speed of light.]

**1-ESS1-2.** Make observations at different times of year to relate the amount of daylight to the time of year. ▲
**[Clarification Statement:** Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.]
**[Assessment Boundary:** Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question. (1-PS4-3) | **PS4.B: Electromagnetic Radiation**<br>▪ Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2) | **Patterns**<br>▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-2)<br>**Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (1-PS4-2), (1-PS4-3) |

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|---|---|---|
| ▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.<br>▪ Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-PS4-2) | ▪ 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.) (1-PS4-3)<br><br>**ESS1.B: Earth and the Solar System**<br>▪ Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2) | |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grade-levels: 2.PS1.A** (1-PS4-3); **4.PS4.B** (1-PS4-2); **5.PS2.B (**1-ESS1-2); **5.ESS1.B** (1-ESS1-2) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (1-ESS1-2); **2.1.A** (1-ESS1-2) | | |

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 1 | Unit 2 Light, Sound, and Waves

**RECOMMENDED TIME: 12 WEEKS**

## Unit Overview:

Unit 2 extends the exploration of light by illuminating the relationship between sound and light waves. As students develop an understanding of the relationship between sound and vibrating materials, the concept of structure and function is reinforced. Additional investigations reinforce the idea that sight is dependent on light. The ongoing exploration of the patterns of objects in the sky allows students to make predictions about the sun, moon, and stars. Students apply knowledge of sound waves and vibration by designing, building and improving upon a device to solve a communication problem.

**Essential Question:**

**How do we see objects and hear sounds?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**1-PS4-1.** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
[**Clarification Statement:** Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]

**1-PS4-2.** Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated. ▲
[**Clarification Statement:** Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]

**1-PS4-4.** Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance. ✱
[**Clarification Statement:** Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.]
[**Assessment Boundary:** Assessment does not include technological details for how communication devices work.]

**1-ESS1-1.** Use observations of the Sun, moon, and stars to describe patterns that can be predicted.
[**Clarification Statement:** Examples of patterns could include that the Sun and moon appear to rise along the eastern horizon, move in a predictable pathway across the sky, and set along the western horizon; and stars other than our Sun are visible at night depending on weather and other conditions such as light pollution but not visible during the day.] [**Assessment Boundary:** Assessment of star patterns is limited to stars being seen at night and not during the day.]

**1-ESS1-2.** Make observations at different times of year to relate the amount of daylight to the time of year. ▲
[**Clarification Statement:** Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.]
[**Assessment Boundary:** Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>■ Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question. (1-PS4-1)<br>■ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2)<br>**Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1-1)<br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.<br>■ Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena (1-PS4-2)<br>■ Use tools and materials provided to design a device that solves a specific problem. (1-PS4-4) | **PS4.A: Wave Properties**<br>■ Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4-1)<br>**PS4.B: Electromagnetic Radiation**<br>■ Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2)<br>**PS4.C: Information Technologies and Instrumentation**<br>■ People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4-4)<br>**ESS1.A: The Universe and its Stars**<br>■ Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1)<br>**ESS1.B: Earth and the Solar System**<br>■ Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2) | **Patterns**<br>■ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-1), (1-ESS1-2)<br>**Cause and Effect**<br>■ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (1-PS4-1), (1-PS4-2)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**<br>■ Science assumes natural events happen today as they happened in the past. (1-ESS1-1)<br>■ Many events are repeated. (1-ESS1-1)<br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br>**Influence of Engineering, Technology, and Science, on Society and the Natural World**<br>■ People depend on various technologies in their lives; human life would be very different without technology. (1-PS4-4) |

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| **CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Investigations Use a Variety of Methods**<br>▪ Science investigations begin with a question. (1-PS4-1)<br>▪ Scientists use different ways to study the world. (1-PS4-1) | | |

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| **Connections to Engineering Design PEs: K–2-ETS1-1** (1-PS4-4); **K-2-ETS1-3** (1-PS4-4) |
| **Articulation of DCIs across grade-levels: K.ETS1.A** (1-PS4-4); **2.ETS1.B** (1-PS4-4); **3.PS2.A** (1-ESS1-1); **4.PS4.B** (1-PS4-2); **4.PS4.C** (1-PS4-4); **4.ETS1.A** (1-PS4-4); **5.PS2.B** (1-ESS1-1), (1-ESS1-2); **5.ESS1.B** (1-ESS1-1), (1-ESS1-2) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (1-ESS1-2); **2.1.A** (1-ESS1-2) |

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Grade 1 | Unit 3

# Structures and Behaviors in Living Things

**RECOMMENDED TIME: 12 WEEKS**

## Unit Overview:

Students develop an understanding of how plants and animals use their external parts to help them survive, grow, and meet their needs. They obtain information to determine patterns of behaviors of parents and offspring that help the offspring survive. Students build upon concepts from previous units to develop connections between light and sound and how they are essential for the survival of living things. To demonstrate their understanding of structure and function, students design a solution to a human problem by mimicking how organisms make use of their external parts.

**Essential Question:**

**What structures and behaviors help plants and animals survive?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**1-LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. ✱

**[Clarification Statement:** Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

**1-LS1-2.** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

**[Clarification Statement:** Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]

**1-LS3-1.** Make observations to construct an evidence-based account that some young plants and animals are similar to, but not exactly like, their parents.

**[Clarification Statement:** Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.]

**[Assessment Boundary:** Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.]

**1-ESS1-2.** Make observations at different times of year to relate the amount of daylight to the time of year. ▲

**[Clarification Statement:** Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.]

**[Assessment Boundary:** Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2)

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)
- Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1)

**Obtaining, Evaluating, and Communicating Information**

Obtaining, evaluating, and communicating information in K– 2 builds on prior experiences and uses observations and texts to communicate new information.

- Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Knowledge Is Based on Empirical Evidence**

- Scientists look for patterns and order when making observations about the world. (1-LS1-2)

## DISCIPLINARY CORE IDEAS

**LS1.A: Structure and Function**

- All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)

**LS1.B: Growth and Development of Organisms**

- Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)

**LS1.D: Information Processing**

- Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)

**LS3.A: Inheritance of Traits**

- (NYSED) Some young animals are similar to, but not exactly, like their parents. Some young plants are also similar to, but not exactly, like their parents. (1-LS3-1)

**LS3.B: Variation of Traits**

- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)

**ESS1.B: Earth and the Solar System**

- Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)

## CROSSCUTTING CONCEPTS

**Patterns**

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS1-2), (1-LS3-1), (1-ESS1-2)

**Structure and Function**

- The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Influence of Engineering, Technology, and Science on Society and the Natural World**

- Every human-made product is designed by applying some knowledge of the natural world and is built by using materials derived from the natural world. (1-LS1-1)

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| **Connections to Engineering Design PEs: K-2-ETS1-2** (1-LS1-1) |
| **Articulation of DCIs across grade-levels: K.ETS1.A** (1-LS1-1); **3.LS2.D** (1-LS1-2) **3.LS3.A** (1-LS3-1); **3.LS3.B** (1-LS3-1); **4.LS1.A** (1-LS1-1); **4.LS1.D** (1-LS1-1); **4.ETS1.A** (1-LS1-1); **5.PS2.B** (1-ESS1-2); **5.ESS1.B** (1-ESS1-2) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (1-LS1-2), (1-LS3-1), (1-ESS1-2); **2.1.A** (1-ESS1-2); **2.2.A** (1-LS1-1); **2.2.B** (1-LS3-1); **2.2.C** (1-LS1-2); **3.1.C** (1-LS1-1) |

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Grade

# 2 Second Grade Year-Long Summary

In Grade 2 students focus on the properties of land and water, and how they relate to life on Earth. Students explore the properties of water, water's role in shaping our planet and its biodiversity. In Unit 1, *Properties and Patterns of Water*, students begin by describing and classifying different materials according to observable properties, develop models of land and water, and observe living things. In the second unit, *The Changes to Land Over Time*, students focus on processes that change land over time by studying natural events which precipitate change to the Earth's surface. In the third and final unit, *Plant and Animal Interactions*, students examine the relationship between organisms and the world around them by investigating the interdependence among plants and animals within their habitats.

| UNIT 1:<br>PROPERTIES AND PATTERNS OF WATER<br>(12 WEEKS) | UNIT 2:<br>THE CHANGES TO LAND OVER TIME<br>(12 WEEKS) | UNIT 3:<br>PLANT AND ANIMAL INTERACTIONS<br>(12 WEEKS) |
|---|---|---|
| **2-PS1-1.** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.<br>**2-PS1-4.** Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.<br>**2-LS4-1.** Make observations of plants and animals to compare the diversity of life in different habitats.<br>**2-ESS2-2.** Develop a model to represent the shapes and kinds of land and bodies of water in an area. ▲<br>**2-ESS2-3.** Obtain information to identify where water is found on Earth and that it can be solid or liquid. | **2-PS1-2.** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. ✱<br>**2-PS1-3.** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.<br>**2-ESS1-1.** Use information from several sources to provide evidence that Earth events can occur quickly or slowly.<br>**2-ESS2-1.** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. ✱<br>**2-ESS2-2.** Develop a model to represent the shapes and kinds of land and bodies of water in an area. ▲ | **2-LS2-1.** Plan and conduct an investigation to determine if plants need sunlight and water to grow.<br>**2-LS2-2.** Develop a simple model that illustrates how plants and animals depend on each other for survival. ✱ |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 2 | Unit 1 Properties and Patterns of Water

**RECOMMENDED TIME: 12 WEEKS**

## Unit Overview:

This unit is an exploration of the properties of water and other earth materials as well as their connections to life on Earth. Students plan and carry out investigations to explore how matter can be either solid or liquid. They construct arguments from evidence to explain that heating or cooling a substance may cause changes that can be observed. Students look for patterns to discover where water can be found and that it exists on Earth in both solid and liquid form. Students develop and use models to show representations of landforms on Earth. This can be used to express an understanding of the diversity of life in different habitats.

### Essential Question:

**How do the properties of water and other Earth materials affect life on Earth?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.**
**[Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]**

**2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.**
**[Clarification Statement: An example of a reversible change could include freezing and melting. An example of an irreversible change could include cooking an egg.]**

**2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.**
**[Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]**

**2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. ▲**
**[Assessment Boundary: Assessment does not include quantitative scaling in models.]**

**2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
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| **Developing and Using Models**<br>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>▪ Develop a model to represent patterns in the natural world. (2-ESS2-2)<br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)<br>▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (2-LS4-1)<br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).<br>▪ Construct an argument with evidence to support a claim. (2-PS1-4) | **PS1.A: Structure and Properties of Matter**<br>▪ 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. (2-PS1-1)<br>**PS1.B: Chemical Reactions**<br>▪ Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)<br>**LS4.D: Biodiversity and Humans**<br>▪ There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)<br>**ESS2.B: Plate Tectonics and Large-Scale System Interactions**<br>▪ Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)<br>**ESS2.C: The Roles of Water in Earth's Surface Processes**<br>▪ Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. | **Patterns**<br>▪ Patterns in the natural and human designed world can be observed. (2-PS1-1), (2-ESS2-2), (2-ESS2-3)<br>▪ Similarities and differences in patterns can be used to sort and classify organisms. (2-LS4-1)<br>**Cause and Effect**<br>▪ Events have causes that generate observable patterns. (2-PS1-4) |

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| **Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.<br>▪ Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question. (2-ESS2-3)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Scientists look for patterns and order when making observations about the world. (2-LS4-1)<br>**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**<br>▪ Scientists search for cause and effect relationships to explain natural events. (2-PS1-4) | | |

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grade-levels: K.PS1.A** (2-PS1-1); **3.LS4.C** (2-LS4-1); **3.LS4.D** (2-LS4-1); **4.ESS2.B** (2-ESS2-2); **5.PS1.A** (2-PS1-1); **5.PS1.B** (2-PS1-4); **5.LS2.A** (2-LS4-1); **5.ESS2.C** (2-ESS2-2), (2-ESS2-3)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.B** (2-PS1-1); **1.C** (2-LS4-1), (2-ESS2-3); **1.F** (2-ESS2-2); **1.G** (2-PS1-4); **2.1.A** (2-ESS2-2), (2-ESS2-3); **2.1.B** (2-PS1-1), (2-PS1-4); **2.2.A** (2-LS4-1); **2.2.C** (2-LS4-1)

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **2** | Unit **2**

# The Changes to Land Over Time

**RECOMMENDED TIME: 12 WEEKS**

## Unit Overview:

This unit focuses on the processes that change land over time, emphasizing the effects of wind and water. Students explore stability and change and patterns as they examine various forms and rates of change on Earth's surface. They demonstrate the effects of erosion and weathering on land as they develop and use models. Students investigate the relationship between these changes and the properties of land and water and design solutions that can slow down or prevent changes by wind or water. They analyze and interpret data to evaluate their designs. Students begin to develop their understanding of the concepts of energy and matter as they construct evidence based explanations for the breakdown or reconfiguration of materials, including landforms.

**Essential Question:**

**How do wind and water change land?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**2-PS1-2.** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. ∗
[**Clarification Statement:** Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [**Assessment Boundary:** Assessment of quantitative measurements is limited to length.]

**2-PS1-3.** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
[**Clarification Statement:** Examples of pieces could include blocks, building bricks, or other assorted small objects.]

**2-ESS1-1.** Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
[**Clarification Statement:** Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and weathering and erosion of rocks, which may occur slowly.] [**Assessment Boundary:** Assessment does not include quantitative measurements of timescales.]

**2-ESS2-1.** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. ∗
[**Clarification Statement:** Examples of solutions could include different designs for using rocks, shrubs, grass, and trees to hold back wind, water, and land.]

**2-ESS2-2.** Develop a model to represent the shapes and kinds of land and bodies of water in an area. ▲
[**Assessment Boundary:** Assessment does not include quantitative scaling in models.]

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>▪ Develop a model to represent patterns in the natural world. (2-ESS2-2)<br><br>**Analyzing and Interpreting Data**<br>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.<br>▪ Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.<br>▪ Make observations (firsthand or from media) from several sources to construct an evidence-based account for natural phenomena. (2-PS1-3), (2-ESS1-1)<br>▪ Compare multiple solutions to a problem. (2-ESS2-1) | **PS1.A: Structure and Properties of Matter**<br>▪ Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)<br>▪ A great variety of objects can be built up from a small set of pieces. (2-PS1-3)<br><br>**ESS1.C: The History of Planet Earth**<br>▪ Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)<br><br>**ESS2.A: Earth Materials and Systems**<br>▪ Wind and water can change the shape of the land. (2-ESS2-1)<br><br>**ESS2.B: Plate Tectonics and Large-Scale System Interactions**<br>▪ Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2) | **Patterns**<br>▪ Patterns in the natural world can be observed. (2-ESS2-2)<br><br>**Cause and Effect**<br>▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)<br><br>**Energy and Matter**<br>▪ Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)<br><br>**Stability and Change, and Patterns**<br>▪ Things may change slowly or rapidly. (2-ESS1-1), (2-ESS2-1)<br><br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY AND APPLICATIONS OF SCIENCE**<br><br>**Influence of Engineering, Technology, and Science on Society and the Natural World**<br>▪ Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (2-PS1-2)<br>▪ Developing and using technology has impacts on the natural world. (2-ESS2-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Science Addresses Questions About the Natural and Material World**<br>▪ Scientists study the natural and material world. (2-ESS2-1) |

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| **Connections to Engineering Design PEs: K-2-ETS1-2** (2-PS1-2); **K-2-ETS1-3** (2-PS1-2) |
| **Articulation of DCIs across grade-levels: K.ETS1.A** (2-ESS2-1); **3.LS2.C** (2-ESS1-1); **4.ESS1.C** (2-ESS1-1); **4.ESS2.A** (2-PS1-3), (2-ESS1-1), (2-ESS2-1); **4.ESS2.B** (2-ESS2-2); **4.ETS1.A** (2-ESS2-1); **4.ETS1.B** (2-ESS2-1); **4.ETS1.C** (2-ESS2-1); **5.PS1.A** (2-PS1-2), (2-PS1-3); **5.LS2.A** (2-PS1-3); **5.ESS2.A** (2-ESS2-1); **5.ESS2.C** (2-ESS2-2) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):): 1.C** (2-ESS1-1); **1.E** (2-PS1-2); **1.F** (2-ESS2-2); **2.1.A** (2-ESS1-1), (2-ESS2-1), (2-ESS2-2); **2.1.B** (2-PS1-2); **2.4.A (2-ESS2-1); 3.1.C** (2-ESS2-1) |

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# Grade 2 | Unit 3 Plant and Animal Interactions

**RECOMMENDED TIME: 12 WEEKS**

## Unit Overview:

In this unit students plan and carry out investigations to explore the needs of plants. They develop models to illustrate how plants and animals depend on each other. Students also investigate how the needs of plants are affected by both living and nonliving elements. The concept of structure and function is also explored as students learn how the shape of structures found in nature relate to their function. Students apply this understanding by developing models that provide examples of plant structures that improve function.

**Essential Question:**

**How do plants and animals depend on each other?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.**
**[Assessment Boundary: Assessment is limited to testing one variable at a time.]**

**2-LS2-2. Develop a simple model that illustrates how plants and animals depend on each other for survival. ∗**
**[Clarification Statement: Examples could include animals dispersing seeds or pollinating plants, and plants providing food, shelter, and other materials for animals.]**

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>▪ Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) | **LS2.A: Interdependent Relationships in Ecosystems**<br>▪ Animals depend on plants or other animals for food. (2-LS2-2)<br>▪ (NYSED) Plants depend on water, light and air to grow. (2-LS2-1)<br>▪ (NYSED) Some plants depend on animals for pollination and for dispersal of seeds from one location to another. (2-LS2-2) | **Cause and Effect**<br>▪ Events have causes that generate observable patterns. (2-LS2-1)<br>**Structure and Function**<br>▪ The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2) |

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| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.<br>▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1) | | |
| **Connections to Engineering Design PEs: K-2-ETS1-2** (2-LS2-2) | | |
| **Articulation of DCIs across grade-levels: K.LS1.C** (2-LS2-1); **K-ESS3.A** (2-LS2-1); **K.ETS1.A** (2-LS2-2); **5.LS1.C** (2-LS2-1); **5.LS2.A** (2-LS2-2) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.B** (2-LS2-1); **1.F** (2-LS2-2); **2.2.A** (2-LS2-1); **2.2.C** (2-LS2-2); **2.2.D** (2-LS2-1) | | |

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# Units of Study

# Grades 3–5

# Grade 3 | Third Grade Year-Long Summary

Grade 3 unit coherence is achieved through the use of the crosscutting concepts of patterns and cause and effect. Unit 1 introduces life cycles, inherited traits, and diversity among organisms. Unit 2 builds upon the understanding of traits to explore how organisms' survival is dependent on how well-suited they are to their environment. This focus is extended into Unit 3 as students learn how Earth systems, climate, and the environment affect populations of organisms over long periods of time. Unit 4 shifts the focus to the physical sciences, where students apply their understanding of patterns and cause and effect to explore forces and motion.

| UNIT 1: INHERITANCE AND VARIATION (9 WEEKS) | UNIT 2: INTERDEPENDENCE (9 WEEKS) | UNIT 3: CHANGE OVER TIME (9 WEEKS) | UNIT 4: INTERACTING FORCES (9 WEEKS) |
|---|---|---|---|
| **3-LS1-1.** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.<br><br>**3-LS2-1.** Construct an argument that some animals form groups that help members survive. ▲<br><br>**3-LS3-1.** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.<br><br>**3-LS3-2.** Use evidence to support the explanation that traits can be influenced by the environment.<br><br>**3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. ▲ | **3-LS2-1.** Construct an argument that some animals form groups that help members survive. ▲<br><br>**3-LS4-2.** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.<br><br>**3-LS4-3.** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.<br><br>**3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. ▲<br><br>**3-ESS3-1.** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. ✱ | **3-LS4-1.** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.<br><br>**3-LS4-4.** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. ✱<br><br>**3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. ▲<br><br>**3-ESS2-2.** Obtain and combine information to describe climates in different regions of the world.<br><br>**3-ESS2-3.** Plan and conduct an investigation to determine the connections between weather and water processes in Earth systems. | **3-PS2-1.** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.<br><br>**3-PS2-2.** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.<br><br>**3-PS2-3.** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.<br><br>**3-PS2-4.** Define a simple design problem that can be solved by applying scientific ideas about magnets. ✱ |

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# Grade 3 | Unit 1 Inheritance and Variation

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

Unit 1 focuses on inheritance and variations of traits as they relate to life cycles and environmental influences. Students explore diverse life cycles and examine how traits are inherited but can also be affected by the environment. They use evidence to show how the environment influences the expression of traits in plants and animals. They construct arguments to explain how animals may also form groups to survive. Students explore cause and effect relationships between organisms and their environment in order to develop an understanding of patterns that exist in nature through the use of models. Students analyze and interpret data to determine the similarities of traits between parents and offspring. Students also document findings based on recognizing patterns in the environment that relate to climate and its effects on the diversity of organisms.

**Essential Question:**

**Why do offspring resemble their parents?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**3-LS1-1.** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. [**Clarification Statement:** Changes organisms go through during their life form a pattern.] [**Assessment Boundary:** Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.]

**3-LS2-1.** Construct an argument that some animals form groups that help members survive. ▲
[**Clarification Statement:** Examples of groups could include a herd of cattle, a swarm of bees, a flock of geese, a pod of whales, etc.]

**3-LS3-1.** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. [**Clarification Statement:** Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [**Assessment Boundary:** Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.]

**3-LS3-2.** Use evidence to support the explanation that traits can be influenced by the environment.
[**Clarification Statement:** Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]

**3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [**Clarification Statement:** Examples of data could include average temperature, precipitation, and wind direction.] [**Assessment Boundary:** Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.<br>▪ Develop models to describe phenomena. (3-LS1-1)<br><br>**Analyzing and Interpreting Data**<br>Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations.<br>▪ When possible and feasible, digital tools should be used.<br>▪ Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1)<br><br>**Constructing Explanations and Designing Solutions**<br>▪ Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.<br>▪ Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)<br><br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed worlds.<br>▪ Construct an argument with evidence, data, and/or a model. (3-LS2-1) | **LS1.B: Growth and Development of Organisms**<br>▪ Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)<br><br>**LS2.D: Social Interactions and Group Behavior**<br>▪ (NYSED) Being part of a group helps some animals obtain food, defend themselves, and survive. Groups may serve different functions and vary dramatically in size. *(Note: Moved from K–2) (3-LS2-1)*<br><br>**LS3.A: Inheritance of Traits**<br>▪ Many characteristics of organisms are inherited from their parents. (3-LS3-1)<br>▪ Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. (3-LS3-2)<br>▪ (NYSED) Some characteristics result from the interactions of both inheritance and the effect of the environment. (3-LS3-2)<br><br>**LS3.B: Variation of Traits**<br>▪ Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)<br>▪ The environment also affects the traits that an organism develops. (3-LS3-2) | **Patterns**<br>▪ Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1)<br>▪ Patterns of change can be used to make predictions. (3-LS1-1)<br><br>**Cause and Effect**<br>▪ Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1), (3-LS3-2) |

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| **CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Science findings are based on recognizing patterns. (3-LS1-1) | | |

**Connections to Engineering Design PEs: 3-5-ETS1-2** (3-ESS3-1)

**Articulation of DCIs across grade-levels: K.ESS2.D** (3-ESS2-1); **1.LS1.B** (3-LS2-1); **1.LS3.A** (3-LS3-1); **1.LS3.B** (3-LS3-1); **MS.LS1.B** (3-LS1-1), (3-LS3-2); **MS.LS2.A** (3-LS2-1); **MS.LS3.A** (3-LS3-1); **MS.LS3.B** (3-LS3-1)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.E** (3-LS3-1), (3-ESS2-1); **1.F** (3-LS1-1); **1.G** (3-LS2-1), (3-LS3-2); **2.1.A** (3-ESS2-1); **2.2.A** (3-LS1-1), (3-LS2-1), (3-LS3-1); **2.2.B** (3-LS3-1), (3-LS3-2); **2.2.C** (3-LS3-2)

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

**Grade** **Unit**

# 3 | 2 Interdependence

**RECOMMENDED TIME: 9 WEEKS**

**Unit Overview:**

Unit 2 addresses environmental interactions and their effect on organisms in diverse environments. Students use evidence to explain relationships between an organism's traits and its survival. They construct arguments that living in groups may help members survive and that variations in characteristics among the same species can provide advantages to some members of the species. Evidence is used to argue how particular habitats can help or hurt an organism's chances at survival. Students also analyze weather data to examine patterns to make a claim about the merit of a design solution that reduces the impact of a weather-related hazard.

**Essential Question:**

**How do the traits of an organism help it to survive in its environment?**

**Performance Expectations:**

*Students who demonstrate understanding can:*

**3-LS2-1.** Construct an argument that some animals form groups that help members survive. **[Clarification Statement:** Examples of groups could include a herd of cattle, a swarm of bees, a flock of geese, a pod of whales, etc.]

**3-LS4-2.** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. **[Clarification Statement:** Examples of cause and effect relationships could include plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to produce offspring.]

**3-LS4-3.** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **[Clarification Statement:** Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

**3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. ▲ **[Clarification Statement:** Examples of data could include average temperature, precipitation, and wind direction.] **[Assessment Boundary:** Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]

**3-ESS3-1.** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. ✱ **[Clarification Statement:** Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.<br>▪ Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.<br>▪ Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2)<br><br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed worlds.<br>▪ Construct an argument with evidence, data, and/or a model. (3-LS2-1)<br>▪ Construct an argument with evidence. (3-LS4-3)<br>▪ Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-ESS3-1) | **LS2.D: Social Interactions and Group Behavior**<br>▪ (NYSED) Being part of a group helps some animals obtain food, defend themselves, and survive. Groups may serve different functions and vary dramatically in size. *(Note: Moved from K–2)* (3-LS2-1)<br><br>**LS4.B: Natural Selection**<br>▪ Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)<br><br>**LS4.C: Adaptation**<br>▪ For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)<br><br>**ESS2.D: Weather and Climate**<br>▪ Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)<br><br>**ESS3.B: Natural Hazards**<br>▪ A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) *(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)* | **Patterns**<br>▪ Patterns of change can be used to make predictions. (3-ESS2-1)<br><br>**Cause and Effect**<br>▪ Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1), (3-LS4-2), (3-LS4-3), (3-ESS3-1)<br><br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br><br>**Influence of Engineering, Technology, and Science on Society and the Natural World**<br>▪ (NYSED) Engineers improve existing technologies or develop new ones to increase their benefits (e.g., improved Doppler radar), decrease known risks (e.g., severe weather alerts), and meet societal demands (e.g., cell phone applications). (3-ESS3-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Science Is a Human Endeavor**<br>▪ Science affects everyday life. (3-ESS3-1) |

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| **Connections to Engineering Design PEs:** N/A |
| **Articulation of DCIs across grade-levels: K.ESS2.D** (3-ESS2-1); **K.ESS3.A** (3-LS4-3); **K.ESS3.B** (3-ESS3-1); **K.ETS1.A** (3-ESS3-1); **1.LS1.B** (3-LS2-1); **2.LS2.A** (3-LS4-3); **1.LS3.A** (3-LS4-2); **2.LS4.D** (3-LS4-3); **4.ESS2.A** (3-ESS2-1); **4.ESS3.B** (3-ESS3-1); **4.ETS1.A** (3-ESS3-1); **MS.LS2.A** (3-LS2-1), (3-LS4-2), (3-LS4-3); **MS.LS3.B** (3-LS4-2); **MS.LS4.B** (3-LS4-2), (3-LS4-3); **MS.LS4.C** (3-LS4-3); **MS.ESS1.C** (3-LS4-3); **5.ESS2.A** (3-ESS2-1); **MS.ESS2.C** (3-ESS2-1); **MS.ESS2.D** (3-ESS2-1); **MS.ESS3.B** (3-ESS3-1) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.E** (3-ESS2-1); **1.G** (3-LS4-2), (3-LS4-3); **2.1.A** (3-ESS2-1); **2.2.A** (3-LS4-2), (3-LS4-3); **2.2.B** (3-LS4-2), (3-LS4-3); **2.2.C** (3-LS4-2), (3-LS4-3); **2.4.A** (3-ESS3-1); **2.4.D** (3-ESS3-1); **3.1.C** (3-ESS3-1) |

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 3 | Unit 3 Change Over Time

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In this unit, students explore how environments change over time. They analyze and interpret data from fossil records to understand how weather and climate determine the particular characteristics of an area and the variety and diversity of organisms that live there. Students gather evidence to support an argument that there may be a correlation between plants and animals that no longer exist and environmental changes that affect a location's physical characteristics, temperature, and availability of resources. They make evidence based claims that some organisms survive and reproduce while others move to new locations, adapt to the environment, or die. Students ask questions and define solutions to problems that are caused when the environment changes. Using data, students analyze and interpret weather and climate conditions to discover patterns of weather and make predictions about how it affects the environment.

**Essential Question:**

**How do environments change over time?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**3-LS4-1.** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
[**Clarification Statement:** Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [**Assessment Boundary:** Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.]

**3-LS4-4.** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. ∗
[**Clarification Statement:** Examples of environmental changes could include both natural and human-influenced changes in land characteristics, water distribution, temperature, food, and other organisms.] [**Assessment Boundary:** Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]

**3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. ▲
[**Clarification Statement:** Examples of data could include average temperature, precipitation, and wind direction.] [**Assessment Boundary:** Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]

**3-ESS2-2.** Obtain and combine information to describe climates in different regions of the world.
[**Clarification Statement:** Emphasis should be on various climates in different regions rather than on localized weather conditions.]

**3-ESS2-3.** Plan and conduct an investigation to determine the connections between weather and water processes in Earth systems.
[**Clarification Statement:** Emphasis should be on the processes that connect the water cycle and weather patterns.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-ESS2-3)
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-ESS2-3)

**Analyzing and Interpreting Data**

Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1)
- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1)

**Engaging in Argument from Evidence**

Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed worlds.

- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4)

## DISCIPLINARY CORE IDEAS

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**

- When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)

**LS4.A: Evidence of Common Ancestry and Diversity**

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. *(Note: Moved from K–2) (3-LS4-1)*
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)

**LS4.D: Biodiversity and Humans**

- Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)

**ESS2.D: Weather and Climate**

- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)
- (NYSED) Earth's processes continuously cycle water, contributing to weather and climate. (3-ESS2-3)

## CROSSCUTTING CONCEPTS

**Patterns**

- Patterns of change can be used to make predictions. (3-ESS2-1), (3-ESS2-2)

**Cause and Effect**

- Cause and effect relationships are routinely identified, tested, and used to explain change. (3-ESS2-3)

**Scale, Proportion, and Quantity**

- Observable phenomena exist from very short to very long time periods. (3-LS4-1)

**Systems and System Models**

- A system can be described in terms of its components and their interactions. (3-LS4-4)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Interdependence of Science, Engineering, and Technology**

- Knowledge of relevant scientific concepts and research findings is important in engineering. (3-LS4-4)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

- Science assumes consistent patterns in natural systems. (3-LS4-1)

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|---|---|---|
| **Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.<br>■ Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2) | | |
| **Connections to Engineering Design PEs: 3-5ETS-1-1** (3-LS4-4) | | |
| **Articulation of DCIs across grade-levels: K.ESS2.D** (3-ESS2-1); **K.ESS3.A** (3-LS4-4); **K.ETS1.A** (3-LS4-4); **2.LS2.A** (3-LS4-4); **2.LS4.D** (3-LS4-4); **4.ESS1.C** (3-LS4-1); **4.ESS2.A** (3-ESS2-1); **4.ESS3.B** (3-LS4-4); **4.ETS1.A** (3-LS4-4); **5.ESS2.A** (3-ESS2-1); **MS.LS2.A** (3-LS4-1), (3-LS4-4); **MS.LS2.C** (3-LS4-4); **MS.LS4.A** (3-LS4-1); **MS.LS4.C** (3-LS4-4)**; MS.ESS1.C** (3-LS4-1), (3-LS4-4); **MS.ESS2.B** (3-LS4-1); **MS.ESS2.C** (3-ESS2-1), (3-ESS2-2); **MS.ESS2.D** (3-ESS2-1), (3-ESS2-2); **MS.ESS3.C** (3-LS4-4) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (3-ESS2-2); **1.E** (3-ESS2-1), (3-ESS2-2); **2.1.A** (3-ESS2-1), (3-ESS2-2); **2.2.A** (3-LS4-4); **2.2.B** (3-LS4-4); **2.2.C** (3-LS4-4); **2.4.A** (3-ESS2-3); **2.4.D** (3-ESS2-3); **3.1.C** (3-LS4-4), (3-ESS2-3) | | |

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **3** | Unit **4**

# Interacting Forces

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In this unit, students investigate what happens when different objects interact while building understanding of the forces that objects exert on each other. Investigations are conducted utilizing one variable to provide evidence about the effects of balanced and unbalanced forces on the motion of an object. Students make observations and measure an object's motion to determine patterns and predict future motion. In addition, they investigate cause and effect relationships of electricity and magnetic interactions between two objects. Students define problems that can be solved by applying knowledge of magnetism.

**Essential Question:**

**What happens when objects interact?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**3-PS2-1.** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
[**Clarification Statement:** Examples could include an unbalanced force on one side of an object can make it start moving; and, balanced forces (including friction) acting on a stationary object from both sides will not produce any motion at all.] [**Assessment Boundary:** Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]

**3-PS2-2.** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
[**Clarification Statement:** Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [**Assessment Boundary:** Assessment does not include technical terms such as period and frequency.]

**3-PS2-3.** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
[**Clarification Statement:** Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.]
[**Assessment Boundary:** Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]

**3-PS2-4.** Define a simple design problem that can be solved by applying scientific ideas about magnets. ∗
[**Clarification Statement:** Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

**Asking Questions and Defining Problems**

Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Ask questions that can be investigated based on patterns such as cause and effect relationships. (3-PS2-3)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4)

**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1)
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS2-2)

**CONNECTIONS TO NATURE OF SCIENCE**

**Science Knowledge is Based on Empirical Evidence**

- Science findings are based on recognizing patterns. (3-PS2-2)

**Scientific Investigations Use a Variety of Methods**

- Science investigations use a variety of methods, tools, and techniques. (3-PS2-1)

## DISCIPLINARY CORE IDEAS

**PS2.A: Forces and Motion**

- 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.) (3-PS2-1)
- 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.) (3-PS2-2)

**PS2.B: Types of Interactions**

- Objects in contact exert forces on each other. (3-PS2-1)
- 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. (3-PS2-3), (3-PS2-4)

## CROSSCUTTING CONCEPTS

**Patterns**

- Patterns of change can be used to make predictions. (3-PS2-2)

**Cause and Effect**

- Cause and effect relationships are routinely identified. (3-PS2-1)
- Cause and effect relationships are routinely identified, tested, and used to explain change. (3-PS2-3)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Interdependence of Science, Engineering, and Technology**

- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-4)

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| **Connections to Engineering Design PEs: : 3-5-ETS1-1** (3PS2-4) |
| **Articulation of DCIs across grade-levels: K.PS2.A** (3-PS2-1); **K.PS2.B** (3-PS2-1); **K.PS3.C** (3-PS2-1); **K.ETS1.A** (3-PS2-4); **1.ESS1.A** (3-PS2-2); **4.PS4.A** (3-PS2-2); **4.ETS1.A** (3-PS2-4); **5.PS2.B** (3-PS2-1); **MS.PS2.A** (3-PS2-1), (3-PS2-2); **MS.PS2.B** (3-PS2-3), (3-PS2-4); **MS.ESS1.B** (3-PS2-1), (3-PS2-2); **MS.ESS2.C** (3-PS2-1) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.B** (2-LS2-1); **1.F** (2-LS2-2); **2.2.A** (2-LS2-1); **2.2.C** (2-LS2-2); **2.2.D** (2-LS2-1) |

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Grade **4**

# Fourth Grade Year-Long Summary

The Grade 4 units are aligned thematically around the concept of energy and energy transfer. In Unit 1, students explore light energy and how structure and function are related to how organisms process information from their senses, particularly sight. Units 2 and 3 build on the concepts of energy and information transfer by applying these ideas to physical science and mechanical systems. In Unit 4, students investigate waves, weathering, and erosion and their impacts on Earth's surface over long periods of time. Finally, Unit 5 has students further investigating the relationships between energy, natural resources, and Earth's processes with the goal of designing solutions that minimize the negative effects of natural processes on humans.

| UNIT 1: THE STRUCTURE AND FUNCTIONS OF ORGANISMS (7 WEEKS) | UNIT 2: TRANSFER OF ENERGY AND INFORMATION (8 WEEKS) | UNIT 3: ENERGY, MOTION, AND COLLISIONS (7 WEEKS) | UNIT 4: CHANGES ON EARTH'S SURFACE (6 WEEKS) | UNIT 5: IMPACTS OF NATURAL PROCESSES (8 WEEKS) |
|---|---|---|---|---|
| **4-PS4-2.** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.<br>**4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.<br>**4-LS1-2.** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. | **4-PS3-2.** Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another.<br>**4-PS3-4.** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. ✱<br>**4-PS4-3.** Generate and compare multiple solutions that use patterns to transfer information. ✱ | **4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.<br>**4-PS3-3.** Ask questions and predict outcomes about the changes in energy that occur when objects collide. | **4-PS4-1.** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. ▲<br>**4-ESS1-1.** Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.<br>**4-ESS2-1.** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. | **4-PS4-1.** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. ▲<br>**4-ESS2-2.** Analyze and interpret data from maps to describe patterns of Earth's features.<br>**4-ESS3-1.** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.<br>**4-ESS3-2.** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. ✱ |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 4 | Unit 1 The Structure and Function of Organisms

**RECOMMENDED TIME: 7 WEEKS**

## Unit Overview:

In unit 1, students ask and define questions about the relationships between organism structures and their function. Students explore ways that both internal and external structures of plants and animals support their survival within their environments. Using models, students investigate ways that animals use their senses to gather, process, and respond to information in different ways. They develop and use models that demonstrate an understanding that reflected light allows objects to be seen by the eye, which relates to animals use of sense receptors. Using evidence from models and investigations to support their analysis, students construct arguments that support an understanding of the relationship between structures and survival, growth, behavior, and reproduction.

**Essential Question:**

**How do the structures of plants and animals help them to survive in their environment?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**4-PS4-2.** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
**[Assessment Boundary:** Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

**4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
**[Clarification Statement:** Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.]
**[Assessment Boundary:** Assessment is limited to macroscopic structures within plant and animal systems.]

**4-LS1-2.** Use a model to describe that animals receive different types of information through their senses, process the information in their brain and respond to the information in different ways.
**[Clarification Statement:** Emphasis is on systems of information transfer.] **[Assessment Boundary:** Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.<br>▪ Develop a model to describe phenomena. (4-PS4-2)<br>▪ Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2)<br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).<br>▪ Construct an argument with evidence, data, and/or a model. (4-LS1-1) | **PS4.B: Electromagnetic Radiation**<br>▪ An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)<br>**LS1.A: Structure and Function**<br>▪ Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)<br>**LS1.D: Information Processing**<br>▪ Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2) | **Cause and Effect**<br>▪ Cause and effect relationships are routinely identified. (4-PS4-2)<br>**Systems and System Models**<br>▪ A system can be described in terms of its components and their interactions. (4-LS1-1), (LS1-2) |
| **Connections to Engineering Design PEs: 3-5-ETS1-1** (4-PS4-2) | | |
| **Articulation of DCIs across grade-levels: 1.PS4.B** (4-PS4-2); **1.LS1.A** (4-LS1-1); **1.LS1.D** (4-LS1-2); **3.LS3.B** (4-LS1-1); **MS.PS4.B** (4-PS4-2); **MS.LS1.A** (4-LS1-1), (4-LS1-2); **MS.LS1.D** (4-PS4-2), (4-LS1-2) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.F** (4-LS1-2); **1.G** (4-LS1-1); **2.2.A** (4-LS1-1), (4-LS1-2); **2.2C** (4-LS1-2) | | |

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# Grade 4 | Unit 2 Transfer of Energy and Information

**RECOMMENDED TIME: 8 WEEKS**

## Unit Overview:

Building on the understanding that light is a means of transferring information developed in Unit 1, students plan and carry out investigations to explore the transfer of energy through matter and how understanding patterns can be used to transfer information. Students make observations about energy transfer and transformation which provides evidence to help construct explanations about conservation of energy. Student understanding is applied by designing and testing a device that converts energy from one form to another. Using their knowledge of patterns, students generate multiple solutions to demonstrate the transfer of information.

**Essential Question:**

**How do we know energy is conserved as it is transformed from one form to another?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**4-PS3-2.** Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another.
**[Clarification Statement:** Examples of forms of energy could include sound, light, heat, and electrical.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

**4-PS3-4.** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. ∗
**[Clarification Statement:** Examples of devices could include electric circuits that convert electrical energy into energy of motion of a vehicle, light, or sound; batteries that convert chemical energy to electrical energy; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

**4-PS4-3.** Generate and compare multiple solutions that use patterns to transfer information. ∗
**[Clarification Statement:** Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K– 2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.<br>▪ Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.<br>▪ Apply scientific ideas to solve design problems. (4-PS3-4)<br>▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3) | **PS3.A: Definitions of Energy**<br>▪ (NYSED) Energy can be transferred by moving objects or by sound, light, heat, or electric currents. (4-PS3-2)<br><br>**PS3.B: Conservation of Energy and Energy Transfer**<br>▪ 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. (4-PS3-2)<br>▪ (NYSED) Energy can also be transferred by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4)<br><br>**PS3.D: Energy in Chemical Processes and Everyday Life**<br>▪ The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4)<br><br>**PS4.C: Information Technologies and Instrumentation**<br>▪ 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. (4-PS4-3) | **Energy and Matter**<br>▪ Energy can be transferred in various ways and between objects. (4-PS3-2), (4-PS3-4)<br><br>**Patterns**<br>▪ Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3)<br><br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br><br>**Interdependence of Science, Engineering, and Technology**<br>▪ Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)<br><br>**Influence of Engineering, Technology, and Science on Society and the Natural World**<br>▪ Engineers improve existing technologies or develop new ones. (4-PS3-4)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Science Is a Human Endeavor**<br>▪ Most scientists and engineers work in teams. (4-PS3-4)<br>▪ Science affects everyday life. (4-PS3-4) |

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| | **ETS1.A: Defining Engineering Problems**<br>■ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.<br><br>**ETS1.C: Optimizing The Design Solution**<br>■ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. | |

**Connections to Engineering Design PEs: 3-5-ETS1-1** (4-PS4-3); **3-5-ETS1-3** (4-PS4-3)

**Articulation of DCIs across grade-levels: K.ETS1.A** (4-PS3-4), (4-PS4-3); **1.PS4.C** (4-PS4-3); **2.ETS1.B** (4-PS3-4), (4-PS4-3); **2.ETS1.C** (4-PS4-3); **3.PS2.A** (4-PS4-3); **5.PS3.D** (4-PS3-4); **5.LS1.C** (4-PS3-4); **MS.PS2.B** (4-PS3-2); **MS.PS3.A** (4-PS3-2), (4-PS3-4); **MS.PS3.B** (4-PS3-2), (4-PS3-4); **MS.PS4.B** (4-PS3-2); **MS.PS4.C** (4-PS4-3); **MS.ETS1.B** (4-PS3-4), (4-PS4-3); **MS.ETS1.C** (4-PS3-4)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (4-PS3-2); **2.1.C** (4-PS3-2), (4-PS3-4)

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

**Grade** 4 | **Unit** 3

# Energy, Motion, and Collisions

**RECOMMENDED TIME: 7 WEEKS**

## Unit Overview:

Students further develop their understanding of energy and matter by examining the relationship between energy and motion. This helps them to ask and define testable questions about changes in energy when objects collide. Students plan and carry out investigations about energy transfer following collisions. Using evidence about energy and forces, students construct explanations and design solutions relating the speed of an object to the energy of that object.

## Essential Question:

**What happens to energy when objects collide?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
[**Assessment Boundary:** Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]

**4-PS3-3.** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
[**Clarification Statement:** Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.]
[**Assessment Boundary:** Assessment does not include quantitative measurements of energy.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.<br>■ Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) | **PS3.A: Definitions of Energy**<br>■ (NYSED) A given object possesses more energy of motion when it is moving faster. (4-PS3-1)<br>■ (NYSED) Energy can be transferred by moving objects or by sound, light, heat, or electric currents. (4-PS3-3) | **Energy and Matter**<br>■ Energy can be transferred in various ways and between objects. (4-PS3-1), (4-PS3-3) |

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|---|---|---|
| **Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.<br>▪ Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) | **PS3.B: Conservation of Energy and Energy Transfer**<br>▪ 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. (4-PS3-3)<br>**PS3.C: Relationship Between Energy and Forces**<br>▪ When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) | |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grade-levels: K.PS2.B** (4-PS3-3); **3.PS2.A** (4-PS3-3); **MS.PS2.A** (4-PS3-3); **MS.PS3.A** (4-PS3-1), (4-PS3-3); **MS.PS3.B** (4-PS3-3); **MS.PS3.C** (4-PS3-3) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A | | |

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**Grade 4 | Unit 4**

# Changes on Earth's Surface

**RECOMMENDED TIME: 6 WEEKS**

## Unit Overview:

After students build an understanding of energy and motion through collisions, they develop models to examine how waves can cause objects to move. Students further explore rock formations and fossils found in rock layers. This evidence can be used to support an explanation for changes in a landscape over time. Cause and effect is explored through the idea that rainfall, water, ice, wind, and organisms help to shape the land. Students plan and carry out investigations to deepen their understanding of waves, weathering and erosion. Using evidence from their explorations, students construct explanations to share their understanding about how natural processes and organisms change the land over time.

**Essential Question:**

**How do Earth processes, natural forces, and organisms change land over time?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**4-PS4-1.** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. ▲
**[Clarification Statement:** Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.]
**[Assessment Boundary:** Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

**4-ESS1-1.** Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.
**[Clarification Statement:** Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; tilted rock layers indicate past crustal movement; glacial scratches on rock formations indicating glacier movement; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] **[Assessment Boundary:** Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]

**4-ESS2-1.** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
**[Clarification Statement:** Examples of variables to test could include angle of slope in the downhill movement of water and/or loose Earth materials due to gravity, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.]
**[Assessment Boundary:** Assessment is limited to a single form of weathering or erosion.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.<br>▪ Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1)<br><br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.<br>▪ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.<br>▪ Identify the evidence that supports particular points in an explanation. (4-ESS1-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Science findings are based on recognizing patterns. (4-PS4-1) | **PS4.A: Wave Properties**<br>▪ 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. *(Note: This grade band endpoint was moved from K–2).* (4-PS4-1)<br>▪ Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)<br><br>**ESS1.C: The History of Planet Earth**<br>▪ Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)<br><br>**ESS2.A: Earth Materials and Systems**<br>▪ Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)<br><br>**ESS2.E: Biogeology**<br>▪ Living things affect the physical characteristics of their regions. (4-ESS2-1) | **Patterns**<br>▪ Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1)<br>▪ Patterns can be used as evidence to support an explanation. (4-ESS1-1)<br><br>**Cause and Effect**<br>▪ Events have causes that generate observable patterns. (2-LS2-1)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**<br>▪ Science assumes consistent patterns in natural systems. (4-ESS1-1) |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grade-levels: 2.ESS1.C** (4-ESS1-1), (4-ESS2-1); **2.ESS2.A** (4-ESS2-1); **3.LS4.A** (4-ESS1-1); **5.ESS2.A** (4-ESS2-1); **MS.PS4.A** (4-PS4-1); **MS.LS4.A** (4-ESS1-1); **MS.ESS1.C** (4-ESS1-1); **MS.ESS2.A** (4-ESS1-1); **MS.ESS2.B** (4-ESS1-1) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (4-ESS1-1); **2.1.A** (4-ESS1-1); **2.1.B** (4-ESS1-1); **1.C** (4-ESS2-1); **2.1.A** (4-ESS2-1) | | |

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **4** | Unit **5**

# Impact of Natural Processes

**RECOMMENDED TIME: 8 WEEKS**

## Unit Overview:

In Unit 5, students build on their understandings of changes to land by examining ways that Earth's processes impact people and how humans' use of natural resources affects the environment in multiple ways. They develop and use models to explore patterns that occur as result of wave movement. Patterns are further investigated as students analyze and interpret data from maps to describe Earth's features with a particular focus on plate tectonics. Students explore the natural hazards that result from the earthquakes and volcanoes that are explained by plate tectonics and analyze their effect on human life. They design and evaluate multiple solutions to reduce the impact of these natural processes on humans. Students construct explanations about the derivation and use of fuels from natural resources by researching and obtaining, evaluating, and communicating new information.

**Essential Question:**

**How can people affect the impact of natural processes and resources?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**4-PS4-1.** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. ▲
**[Clarification Statement:** Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.]
**[Assessment Boundary:** Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

**4-ESS2-2.** Analyze and interpret data from maps to describe patterns of Earth's features.

**[Clarification Statement:** Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

**4-ESS3-1**. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
**[Clarification Statement:** Examples of renewable energy resources could include wind, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

**4-ESS3-2.** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. ✱
**[Clarification Statement:** Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

### Developing and Using Models

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1)

### Analyzing and Interpreting Data

Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2)

### Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3– 5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)

### Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.

- Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)

## DISCIPLINARY CORE IDEAS

### PS4.A: Wave Properties

- 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. *(Note: This grade band endpoint was moved from K–2).* (4-PS4-1)
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)

### ESS2.B: Plate Tectonics and Large-Scale System Interactions

- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)

### ESS3.A: Natural Resources

- Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1)

### ESS3.B: Natural Hazards

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) *(Note: This Disciplinary Core Idea can also be found in 3.WC.)*

## CROSSCUTTING CONCEPTS

### Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1)
- Patterns can be used as evidence to support an explanation. (4-ESS2-2)

### Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS3-1), (4-ESS3-2)

## CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE

### Interdependence of Science, Engineering, and Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1)

### Influence of Engineering, Technology, and Science on Society and the Natural World

- Over time, people's needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)

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| **CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Science findings are based on recognizing patterns. (4-PS4-1) | **ETS1.B: Designing Solutions to Engineering Problems**<br>▪ Testing a solution involves investigating how well it performs under a range of likely conditions. (Secondary to 4-ESS3-2) | |
| **Connections to Engineering Design PEs: 3-5-ETS1-2** (4-ESS3-2) | | |
| **Articulation of DCIs across grade-levels: K.ETS1.A** (4-ESS3-2); **2.ESS2.B** (4-ESS2-2); **2.ESS2.C** (4-ESS2-2); **2.ETS1.B** (4-ESS3-2); **2.ETS1.C** (4-ESS3-2); **5.ESS2.C** (4-ESS2-2); **5.ESS3.C** (4-ESS3-1); **MS.PS3.D** (4-ESS3-1); **MS.PS4.A** (4-PS4-1); **MS.ESS1.C** (4-ESS2-2); **MS.ESS2.A** (4-ESS2-2), (4-ESS3-1), (4-ESS3-2); **MS.ESS2.B** (4-ESS2-2); **MS.ESS3.A** (4-ESS3-1); **MS.ESS3.B** (4-ESS3-2); **MS.ESS3.C** (4-ESS3-1); **MS.ESS3.D** (4-ESS3-1); **MS.ETS1.B** (4-ESS3-2) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (4-ESS3-1); **1.E** (4-ESS2.2), (4-ESS3-1); **2.1.A** (4-ESS2.2); **2.4.A** (4-ESS3-1), (4-ESS3-2); **2.4.C** (4-ESS3-1), (4-ESS3-2); **2.4.E** (4-ESS3-1), (4-ESS3-2); **3.1.C** (4-ESS3-2) | | |

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade
# 5 Fifth Grade Year-Long Summary

Grade 5 introduces students to the particulate nature of matter and develops their understanding of that concept through the lens of complex systems and interactions in Life, Earth, and Space Sciences. In Unit 1, students develop models of matter and provide evidence that matter is conserved when undergoing changes. Unit 2 focuses on the cycling of matter and flow of energy in organisms and ecosystems. The scale of the systems being studied is larger in Unit 3, as students describe and model how matter and energy interact in Earth systems, such as the water cycle. In Unit 4, students again expand the scale of the systems under study, as they investigate stars and the solar system.

| UNIT 1: PHYSICAL AND CHEMICAL CHANGES (9 WEEKS) | UNIT 2: MATTER AND ENERGY IN ECOSYSTEMS (9 WEEKS) | UNIT 3: EARTH SYSTEMS SCIENCE (9 WEEKS) | UNIT 4: STARS AND THE SOLAR SYSTEM (9 WEEKS) |
|---|---|---|---|
| **5-PS1-1.** Develop a model to describe that matter is made of particles too small to be seen. ▲<br>**5-PS1-2.** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances the total amount of matter is conserved.<br>**5-PS1-3.** Make observations and measurements to identify materials based on their properties.<br>**5-PS1-4.** Conduct an investigation to determine whether the mixing of two or more substances results in new substances. | **5-PS1-1.** Develop a model to describe that matter is made of particles too small to be seen. ▲<br>**5-PS3-1.** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the Sun.<br>**5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water.<br>**5-LS2-1.** Develop a model to describe the movement of matter among plants (producers), animals (consumers), decomposers, and the environment. | **5-PS1-1.** Develop a model to describe that matter is made of particles too small to be seen. ▲<br>**5-PS2-1.** Support an argument that the gravitational force exerted by Earth on objects is directed down.<br>**5-ESS2-1.** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.<br>**5-ESS2-2.** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.<br>**5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment. | **5-ESS1-1.** Support an argument that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth.<br>**5-ESS1-2.** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. |

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

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# Grade 5 | Unit 1 Physical and Chemical Changes

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In the first unit, students gain a conceptual understanding of the particle nature of matter and the idea that regardless of physical or chemical change, the total amount of matter is conserved. Students make observations and measurements to identify materials based on their properties and conduct investigations to determine whether the mixing of two or more substances results in new substances. Students plan and carry out fair tests, using controlled variables and identifying failure points to improve aspects of a model or prototype.

**Essential Question:**

**How much does air weigh?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**5-PS1-1.** Develop a model to describe that matter is made of particles too small to be seen. ▲
[**Clarification Statement:** Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [**Assessment Boundary:** Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

**5-PS1-2.** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances the total amount of matter is conserved.
[**Clarification Statement:** Examples of reactions or changes could include **phase changes, dissolving, and mixing that form new substances. Assume that reactions with any gas production are conducted in a closed system.]** [Assessment Boundary: Assessment does not include distinguishing between mass and weight.]

**5-PS1-3.** Make observations and measurements to identify materials based on their properties.
[**Clarification Statement:** Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [**Assessment Boundary:** Assessment does not include density or distinguishing between mass and weight.]

**5-PS1-4.** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
[**Clarification Statement:** Examples could include mixing baking soda and water compared to mixing baking soda and vinegar.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.<br>■ Develop a model to describe phenomena. (5-PS1-1)<br><br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.<br>■ Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)<br>■ Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3)<br><br>**Using Mathematics and Computational Thinking**<br>Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.<br>■ Measure and graph quantities such as weight to address scientific and engineering questions and problems. (5-PS1-2) | **PS1.A: Structure and Properties of Matter**<br>■ 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 and the effects of air on larger particles or objects. (5-PS1-1)<br>■ (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)<br>■ 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.) (5-PS1-3)<br><br>**PS1.B: Chemical Reactions**<br>■ When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)<br>■ 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.) (5-PS1-2) | **Cause and Effect**<br>■ Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4)<br><br>**Scale, Proportion, and Quantity**<br>■ Natural objects exist from the very small to the immensely large. (5-PS1-1)<br>■ Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-2), (5-PS1-3)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**<br>■ Science assumes consistent patterns in natural systems. (5-PS1-2) |

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grade-levels: 2.PS1.A** (5-PS1-1), (5-PS1-2), (5-PS1-3); **2.PS1.B** (5-PS1-2), (5-PS1-4); **MS.PS1.A** (5-PS1-1), (5-PS1-2), (5-PS1-3), (5-PS1-4); **MS.PS1.B** (5-PS1-2), (5-PS1-4)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (5-PS1-3); **2.1.B** (5-PS1-3)

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 5 | Unit 2 Matter and Energy in Ecosystems

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In this unit, students expand their understanding of the dynamic nature of matter and energy as life scientists. Specifically, students use models to describe the path that energy takes from the Sun to the Earth, where it is converted into food by producers. They use evidence to support arguments about where plants obtain materials needed for their growth. Students further develop and use models to demonstrate how matter and energy continue to travel throughout ecosystems, in complex food web pathways, from producers to consumers, decomposers, and back into the environment.

**Essential Question:**

**How do matter and energy flow through ecosystems?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**5-PS1-1.** Develop a model to describe that matter is made of particles too small to be seen. ▲
**[Clarification Statement:** Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] **[Assessment Boundary:** Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

**5-PS3-1.** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the Sun.
**[Clarification Statement:** Emphasis should be on plants converting light energy by photosynthesis into usable energy. Examples of models could include diagrams and flow charts.]

**5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water.
**[Clarification Statement:** Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

**5-LS2-1.** Develop a model to describe the movement of matter among plants (producers), animals (consumers), decomposers, and the environment.
**[Clarification Statement:** Emphasis is on the flow of energy and cycling of matter in systems such as organisms, ecosystems, and/or Earth.]
**[Assessment Boundary:** Assessment does not include molecular explanations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.<br>▪ Develop a model to describe phenomena. (5-PS1-1), (5-LS2-1)<br>▪ Use models to describe phenomena. (5-PS3-1)<br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).<br>▪ Support an argument with evidence, data, or a model. (5-LS1-1)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**<br>▪ Science explanations describe the mechanisms for natural events. (5-LS2-1) | **PS1.A: Structure and Properties of Matter**<br>▪ 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 and the effects of air on larger particles or objects. (5-PS1-1)<br>**PS3.D: Energy in Chemical Processes and Everyday Life**<br>▪ The energy released [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). (5-PS3-1)<br>**LS1.C: Organization for Matter and Energy Flow in Organisms**<br>▪ Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(Secondary to 5-PS3-1)*<br>▪ Plants acquire their material for growth chiefly from air and water. (5-LS1-1) | **Scale, Proportion, and Quantity**<br>▪ Natural objects exist from the very small to the immensely large. (5-PS1-1)<br>**Systems and System Models**<br>▪ A system can be described in terms of its components and their interactions. (5-LS2-1)<br>**Energy and Matter**<br>▪ Matter is transported into, out of, and within systems. (5-LS1-1)<br>▪ Energy can be transferred in various ways and between objects. (5-PS3-1) |

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**LS2.A: Interdependent Relationships in Ecosystems**

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)

**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**

- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)

**Connections to Engineering Design PEs:** N/A

**Articulation of DCIs across grade-levels: K.LS1.C** (5-PS3-1), (5-LS1-1); **2.PS1.A** (5-PS1-1), (5-LS2-1); **2.LS2.A** (5-PS3-1), (5-LS1-1); **2.LS4.D** (5-LS2-1); **4.PS3.A** (5-PS3-1); **4.PS3.B** (5-PS3-1); **4.PS3.D** (5-PS3-1); **4.ESS2.E** (5-LS2-1); **MS.PS1.A** (5-PS1-1); **MS.PS3.D** (5-PS3-1), (5-LS2-1); **MS.PS4.B** (5-PS3-1); **MS.LS1.C** (5-PS3-1), (5-LS1-1), (5-LS2-1); **MS.LS2.A** (5-LS2-1); **MS.LS2.B** (5-PS3-1), (5-LS2-1)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.F** (5-PS3-1), (5-LS2-1); **1.G** (5-LS1-1); **2.1.C** (5-PS3-1); **2.2.C** (5-LS2-1); **2.2.D** (5-PS3-1), (5-LS1-1), (5-LS2-1)

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**Grade** | **Unit**

# 5 | 3 Earth Systems Science

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In this unit, students continue investigating the particle nature of matter and energy within the interactions of larger systems occurring on Earth. These systems include the geosphere, biosphere, hydrosphere, and/or the atmosphere. Students support arguments that the gravitational force exerted by the Earth on objects is directed down. Students obtain and combine information about Earth's systems and how humans use science to protect Earth's resources and environment. Students use mathematical and computational thinking as they describe and graph the amounts of saltwater and freshwater available in various reservoirs. Using evidence, they define problems regarding human use of resources on Earth.

**Essential Question:**

**Where does rain come from?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**5-PS1-1.** Develop a model to describe that matter is made of particles too small to be seen. ▲
[**Clarification Statement:** Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [**Assessment Boundary:** Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

**5-PS2-1.** Support an argument that the gravitational force exerted by Earth on objects is directed down.
[**Clarification Statement:** "Down" is a local description of the direction that points toward the center of the spherical Earth.]
[**Assessment Boundary:** Assessment does not include mathematical representation of gravitational force.]

**5-ESS2-1.** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
[**Clarification Statement:** Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [**Assessment Boundary:** Assessment is limited to the interactions of two systems at a time.]

**5-ESS2-2.** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
[**Assessment Boundary:** Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]

**5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment.
[**Clarification Statement:** Emphasis should be on how communities use information to sustain resources and the environment locally, regionally, nationally, and/or internationally.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

**Developing and Using Models**

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model to describe phenomena. (5-PS1-1)
- Develop a model using an example to describe a scientific principle. (5-ESS2-1)

**Using Mathematics and Computational Thinking**

Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.

- Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)

**Engaging in Argument from Evidence**

Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Support an argument with evidence, data, or a model. (5-PS2-1)

**Obtaining, Evaluating, and Communicating Information**

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.

- Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

## DISCIPLINARY CORE IDEAS

**PS1.A: Structure and Properties of Matter**

- 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 and the effects of air on larger particles or objects. (5-PS1-1)

**PS2.B: Types of Interactions**

- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)

**ESS2.A: Earth Materials and Systems**

- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

**ESS2.C: The Roles of Water in Earth's Surface Processes**

- Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

## CROSSCUTTING CONCEPTS

**Cause and Effect**

- Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)

**Scale, Proportion, and Quantity**

- Natural objects exist from the very small to the immensely large. (5-PS1-1)
- Standard units are used to measure and describe physical quantities such as weight, and volume. (5-ESS2-2)

**Systems and System Models**

- A system can be described in terms of its components and their interactions. (5-ESS2-1), (5-ESS3-1)

### CONNECTIONS TO NATURE OF SCIENCE

**Science Addresses Questions About the Natural and Material World**

- Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

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| | | |
|---|---|---|
| | **ESS3.C: Human Impacts on Earth Systems**<br>▪ Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) | |
| **Connections to Engineering Design PEs: 3-5-ETS1-1** (5-ESS3-1) | | |
| **Articulation of DCIs across grade-levels: 2.PS1.A** (5-PS1-1); **2.ESS2.A** (5-ESS2-1); **2.ESS2.C** (5-ESS2-2); **3.PS2.A** (5-PS2-1); **3.PS2.B** (5-PS2-1); **3.ESS2.D** (5-ESS2-1); **4.ESS2.A** (5-ESS2-1); **MS.PS1.A** (5-PS1-1); **MS.PS2.B** (5-PS2-1); **MS.ESS1.B** (5-PS2-1); **MS.ESS2.A** (5-ESS2-1); **MS.ESS2.C** (5-PS2-1), (5-ESS2-1), (5-ESS2-2); **MS.ESS2.D** (5-ESS2-1); **MS.ESS3.A** (5-ESS2-2), (5-ESS3-1); **MS.ESS3.C** (5-ESS3-1); **MS.ESS3.D** (5-ESS3-1) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (5-ESS3-1); **1.E** (5-ESS2-2); **1.F** (5-ESS2-1), (5-ESS2-2); **2.1.A** (5-ESS2-1); **2.1.B** (5-ESS2-1); **2.3.A** (5-ESS3-1); **2.4.C** (5-ESS2-2); **2.4.E** (5-ESS3-1) | | |

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▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 5 | Unit 4 Stars and the Solar System

**RECOMMENDED TIME: 9 WEEKS**

## Unit Overview:

In the final unit, students analyze and interpret data to represent how the Earth's position in the universe, relative to other celestial objects, affects observable phenomena. They identify patterns of phenomena including daily changes in length and direction of shadows, the day-night cycle, and the seasonal appearance of some stars in the night sky. Students also investigate and use evidence to support arguments that the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth.

**Essential Question:**

**How far away are the stars?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**5-ESS1-1. Support an argument that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth.**
**[Assessment Boundary:** Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).]

**5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.**
**[Clarification Statement:** Examples of patterns could include the position and motion of Earth with respect to the Sun, moon, and some stars that are visible only in particular months.] **[Assessment Boundary:** Assessment does not include causes of seasons.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.<br>▪ Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. (5-ESS1-2) | **ESS1.A: The Universe and its Stars**<br>▪ The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) | **Patterns**<br>▪ Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2)<br>**Scale, Proportion, and Quantity**<br>▪ Natural objects exist from the very small to the immensely large. (5-ESS1-1) |

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| | | |
|---|---|---|
| **Engaging in Argument from Evidence**<br>▪ Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).<br>▪ Support an argument with evidence, data, or a model. (5-ESS1-1) | **ESS1.B: Earth and the Solar System**<br>▪ The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2) | |
| **Connections to Engineering Design PEs:** N/A | | |
| **Articulation of DCIs across grade-levels: 1.ESS1.A** (5-ESS1-2); **1.ESS1.B** (5-ESS1-2); **3.PS2.A** (5-ESS1-2); **MS.ESS1.A** (5-ESS1-1), (5-ESS1-2); **MS.ESS1.B** (5-ESS1-1), (5-ESS1-2) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.E** (5-ESS1-2); **2.1.A** (5-ESS1-2) | | |

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Units of Study

Middle School

**6–8**

# Grade 6 | Sixth Grade Year-Long Summary

Energy and matter make life possible on Earth. The transfer and transformation of energy maintain and preserve life as we know it. Grade 6 provides students with a basic understanding of energy, which will deepen in Grade 7 while investigating the flow of energy at the atomic and cellular level, and in Grade 8 while studying forces and motion on Earth and in the universe. Through their exploration of energy, students will understand that living and nonliving things are connected by energy. They will investigate the energy of electric circuits and magnetism, the flow of energy in ecosystems, and the relationship of energy to weather and climate. Students will use their knowledge of energy to engage in engineering design projects that minimize or maximize energy transfer, maintain biodiversity or ecosystem stability, or develop technologies to lessen the effects of catastrophic events. The study of ecosystems will provide an understanding of how all living things are connected to the flow of energy and matter, and how nonliving things, such as water in the atmosphere and weather conditions, become factors for either changing or sustaining that flow of energy.

Unit 1, *Electricity and Magnetism*, develops student understanding of electromagnetic forces. Students ask questions, conduct investigations, and make observations in order to deepen this understanding of magnetic and electrical forces that are not directly observable. The crosscutting concepts that will be addressed in this unit are scale, proportion and quantity, systems and system models, energy and matter, and stability and change.

Students will then shift their focus to study thermal energy transformations through the lens of crosscutting concepts like scale, proportion, quantity, and energy and matter. Unit 2, *Engineering and Energy Transformations,* provides an opportunity for students to undertake various design challenges based upon the principles of insulation and minimization of heat loss. Students construct products using materials that help keep students (or their lunches!) warm in the winter or cool in the summer. The science and engineering practices emphasized in this unit are designing solutions, developing and using models, planning and carrying out investigations, and constructing explanations.

In Unit 3, *Ecosystems*, students will now construct evidence-based explanations and arguments about how matter and energy are cycled through the living and nonliving parts of ecosystems. This is driving students to be able to evaluate the best solution for preserving biodiversity by the end of the unit. Students will have the opportunity to further develop their science and engineering practices by analyzing and interpreting data in order to construct more detailed explanations. The crosscutting concepts of energy and matter, cause and effect, patterns, and stability and change will be specifically addressed in this unit.

Unit 4, *Investigating Weather and Climate*, students develop an understanding of observable phenomena (weather and climate) that they can further apply in Unit 5, where the focus is on understanding climate change, and developing technology and solutions to lessen the human impact on this change. In Unit 4, students apply their learning about the flow of matter and energy from previous units in the context of weather and climate. Students develop models, and collect, analyze, and interpret data about weather in order to understand changes in the atmosphere.

In Unit 5, *Human Impact on Earth's Climate*, students ask questions, analyze and interpret historical global weather data and patterns, and begin understanding the applicability of scientific principles necessary to design methods for minimizing human impact on Earth's climate. Students reflect on the causes of climate change while analyzing and interpreting data to propose solutions that may reverse some of the causes of climate change.

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| UNIT 1: ELECTRICITY AND MAGNETISM (6 WEEKS) | UNIT 2: ENGINEERING AND ENERGY TRANSFORMATIONS (8 WEEKS) | UNIT 3: ECOSYSTEMS (9 WEEKS) | UNIT 4: INVESTIGATING WEATHER AND CLIMATE (8 WEEKS) | UNIT 5: HUMAN IMPACT ON EARTH'S CLIMATE (5 WEEKS) |
|---|---|---|---|---|
| **MS-PS2-3:** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.<br>**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.<br>**MS-PS3-6:** Make observations to provide evidence that energy can be transferred by electric currents. | **MS-PS1-6.** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy during a chemical and/or physical process. ✱<br>**MS-PS3-3.** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. ✱<br>**MS-PS3-4.** Plan and conduct an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the temperature of the sample of matter. | **MS-LS2-1:** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.<br>**MS-LS2-2:** Construct an explanation that predicts patterns of interactions among organisms in a variety of ecosystems.<br>**MS-LS2-3:** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.<br>**MS-LS2-4:** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.<br>**MS-LS2-5:** Evaluate competing design solutions for maintaining biodiversity and protecting ecosystem stability. ✱ | **MS-PS1-7.** Use evidence to illustrate that density is a property that can be used to identify samples of matter.<br>**MS-ESS2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy from the Sun and the force of gravity.<br>**MS-ESS2-5.** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.<br>**MS-ESS2-6.** Develop and use a model to describe how unequal heating and rotation of Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. | **MS-ESS3-2** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. ▲<br>**MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ▲ ✱<br>**MS-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **6** | Unit **1**

# Electricity and Magnetism

**RECOMMENDED TIME: 6 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

Students investigate the transfer and transformation of energy in electricity and magnetism. During this unit, students develop an understanding of electric and magnetic forces within series and parallel circuits. Students will begin by conducting investigations and evaluating experimental designs to deepen their understanding of the relationship between electricity and magnetism. Using qualitative observations, students will be able to develop questions that can be investigated regarding the transfer and flow of energy through matter. By the end of this unit students can then predict changes in natural phenomena related to matter and energy.

**Essential Question:**

**How does energy flow through electrical systems and magnetic fields?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**
[**Clarification Statement:** Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [**Assessment Boundary:** Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

**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.**
[**Clarification Statement:** 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. Emphasis should be on using arrows to represent the directions of forces.] [**Assessment Boundary:** Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]

**MS-PS3-6. Make observations to provide evidence that energy can be transferred by electric currents.**
[**Clarification Statement:** Emphasis should be on arrangements of circuit components in series and parallel circuits.] [**Assessment Boundary:** Assessment will be limited to qualitative analysis and reasoning.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.<br>■ Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3)<br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.<br>■ Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)<br>■ Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-PS3-6) | **PS2.B: Types of Interactions**<br>■ 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. (MS-PS2-3)<br>■ 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-PS2-5)<br>**PS3.B: Conservation of Energy and Energy Transfer**<br>■ (NYSED) An electric circuit is a closed path in which an electric current can exist. (MS-PS3-6) | **Cause and Effect**<br>■ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5)<br>**Energy and Matter**<br>■ The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-6) |

**Connections to DCIs in this grade-band:** N/A

**Articulation of DCIs across grade-bands: Elementary: 3.PS2.B** (MS-PS2-3), (MS-PS2-5); **High School: HS.PS2.B** (MS-PS2-3), (MS-PS2-4), (MS-PS2-5); **HS.PS3.A** (MS-PS2-5)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.A** (MS-PS2-3); **2.1.C** (MS-PS2-3)

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

Grade 6 | Unit 2

# Engineering and Energy Transformations

**RECOMMENDED TIME: 8 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

Students, as engineering apprentices, learn about temperature and use their knowledge of energy transformations to create devices that regulate the transfer of energy. Students plan and conduct investigations to determine the relationships between energy transferred, and the type, mass, or temperature of matter. Students undertake design projects to construct and test a device that controls the transfer of energy to the environment. This unit presents an opportunity to build skills in measurement, proportional reasoning, and data analysis.

**Essential Question:**

**How can we minimize or maximize the transfer of heat?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**MS-PS1-6.** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy during a chemical and/or physical process. ∗
[**Clarification Statement:** Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and amount of a substance. Examples of designs could include combining vinegar and baking soda, activating glow sticks at various temperatures, and dissolving ammonium chloride or calcium chloride.] [**Assessment Boundary:** Assessment is limited to the criteria of substance amounts, reaction time, and observed temperature changes.]

**MS-PS3-3.** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. ∗
[**Clarification Statement:** Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [**Assessment Boundary:** Assessment does not include calculating the total amount of thermal energy transferred.]

**MS-PS3-4.** Plan and conduct an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the temperature of the sample of matter.
[**Clarification Statement:** Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [**Assessment Boundary:** Assessment does not include calculating the total amount of thermal energy transferred.]

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.<br>▪ Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.<br>▪ Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)<br>▪ Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br><br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS3-4) | **PS1.B: Chemical Reactions**<br>▪ (NYSED) Some chemical reactions release energy, others absorb energy. (MS-PS1-6)<br><br>**PS3.A: Definitions of Energy**<br>▪ (NYSED) 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, phases (states), and amounts of matter present. (MS-PS3-3), (MS-PS3-4)<br><br>**PS3.B: Conservation of Energy and Energy Transfer**<br>▪ (NYSED) The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the mass of the sample, and the environment. (MS-PS3-4)<br>▪ Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)<br><br>**ETS1.A: Defining and Delimiting an Engineering Problem**<br>▪ 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. (secondary to MS-PS3-3)<br><br>**ETS1.B: Developing Possible Solutions**<br>▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6)<br>▪ There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(Secondary to MS-PS3-3)* | **Scale, Proportion, and Quantity**<br>▪ Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-4)<br><br>**Energy and Matter**<br>▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6), (MS-PS3-3) |

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|---|---|---|
| | **ETS1.C: Optimizing the Design Solution**<br>▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)<br>▪ The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.<br>(secondary to MS-PS1-6) | |
| **Connections to DCIs in this grade-band: 6th Grade: MS.LS2.B** (MS-PS1-5); **MS.PS2.A** (MS-PS3-4); **8MS.ESS2.A** (MS-PS3-3); **MS.PS1.B** (MS-PS3-3); **MS.PS1.A** (MS-PS3-4); **7th Grade: 7MS.PS3.D** (MS-PS1-6); **MS.ESS3.D** (MS-PS3-4); **MS.ESS2.D** (MS-PS3-3), (MS-PS3-4); **MS.ESS2.C** (MS-PS3-3), (MS-PS3-4); **MS.PS1.A** (MS-PS3-4)**; 8th Grade: MS.ESS2.A** (MS-PS1-5); **MS.ESS2.C** (MS-PS3-3), (MS-PS3-4) | | |
| **Articulation of DCIs across grade-bands: Elementary: 4.PS3.B** (MS-PS3-3); **4.PS3.C** (MS-PS3-4); **High School: HS.PS3.A** (MS-PS3-3); **HS.PS1.B** (MS-PS1-6); **HS.PS3.A** (MS-PS1-6); **HS.PS3.B** (MS-PS1-6)**; HS.PS3.D** (MS-PS1-6) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.A** (MS-PS3-3), (MS-PS3-4); **1.B** (MS-PS1-6), (MS-PS3-3), (MS-PS3-4); **1.C** (MS-PS1-6); **1.D** (MS-PS1-6); **1.E** (MS-PS1-6); **1.G** (MS-PS1-6); **2.1.C** (MS-PS1-6), (MS-PS3-3), (MS-PS3-4); **3.1.C** (MS-PS1-6) | | |

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

# Grade 6 | Unit 3 Ecosystems

**RECOMMENDED TIME: 9 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

In this unit students explore Earth's ecosystems. Students begin by analyzing and interpreting data in order to understand the relationships among organisms, populations, and their resources. Students narrow their focus even more to construct explanations about specific organism interactions. Students develop models to represent the flow of energy and cycling of matter within ecosystems. Students should be able to develop arguments about how changes in the ecosystem affect the populations in these ecosystems, understanding that some communities need more energy than others to maintain stability. This unit also presents multiple opportunities for students to understand these concepts through a mathematical lens by analyzing data and creating graphs and mathematical models to represent these ecosystem interactions. The learning opportunities in this unit add a layer of understanding about predicting changes in our world.

**Essential Question:**

**Why does the Earth never run out of matter or energy?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
[**Clarification Statement:** Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

**MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms in a variety of ecosystems.
[**Clarification Statement:** Emphasis is on predicting patterns of interactions such as competition, predation, mutualism, and parasitism in different ecosystems in terms of the relationships among and between organisms.]

**MS-LS2-3.** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
[**Clarification Statement:** Emphasis is on describing the conservation of matter and flow of energy associated with ecosystem, and on defining the boundaries of the ecosystem.] [**Assessment Boundary:** Assessment does not include the use of chemical reactions to describe the processes.]

**MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
[**Clarification Statement:** Emphasis is on recognizing patterns in data and making warranted inferences about shifts in populations due to changes in the ecosystem.]

**MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and protecting ecosystem stability. ∗
[**Clarification Statement:** Examples of ecosystem protections could include water purification, waste management, nutrient recycling, prevention of soil erosion, and eradication of invasive species. Examples of design solution constraints could include scientific, economic, and social considerations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop a model to describe phenomena. (MS-LS2-3)<br><br>**Analyzing and Interpreting Data**<br>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>▪ Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.<br>▪ Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) | **LS2.A: Interdependent Relationships in Ecosystems**<br>▪ Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)<br>▪ In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)<br>▪ Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)<br>▪ Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)<br><br>**LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**<br>▪ Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) | **Patterns**<br>▪ Patterns can be used to identify cause and effect relationships. (MS-LS2-2)<br><br>**Cause and Effect**<br>▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)<br><br>**Energy and Matter**<br>▪ The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)<br><br>**Stability and Change**<br>▪ Small changes in one part of a system might cause large changes in another part. (MS-LS2-4), (MS-LS2-5)<br><br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br><br>**Influence of Science, Engineering, and Technology on Society and the Natural World**<br>▪ The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5) |

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**Engaging in Argument from Evidence**

Engaging in argument from evidence in 6–8 builds on K– 5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Knowledge Is Based on Empirical Evidence**

- Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)
- (NYSED) Biodiversity describes the variety of species found in Earth's ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)

**LS4.D: Biodiversity and Humans**

- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5)
- (NYSED) Humans impact biodiversity both positively and negatively. (secondary to MS-LS2-5)

**ETS1.B: Developing Possible Solutions**

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)

**Science Addresses Questions About the Natural and Material World**

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

**Connections to DCIs in this grade-band: 6th Grade: MS.ESS3.A** (MS-LS2-1), (MS-LS2-4); **MS.ESS2.C** (MS-PS2-4); **MS.ESS3.C** (MS-LS2-1), (MS-LS2-4); **MS.LS1.B** (MS-LS2-2); **MS.PS1.B** (MS-LS2-3); **MS.LS4.C** (MS-LS2-4); **MS.LS4.D** (MS-LS2-4); **MS.ESS2.A** (MS-LS2-4); **MS.ESS3.A** (MS-LS2-4); **MS.ESS3.C** (MS-LS2-4); **MS. ESS3.C** (MS-LS2-5)

**Articulation of DCIs across grade-bands: Elementary: 3.LS2.C** (MS-LS2-1), (MS-LS2-4)**; 3.LS4.D** (MS-LS2-1), (MS-LS2-4); **High School: HS.LS2.A** (MS-LS2-2), (MS-LS2-5); **HS.LS4.D** (MS-LS2-1), (MS-LS2-4)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.D** (MS-LS2-4); **1.E** (MS-LS2-1); **1.F** (MS-LS2-3); **1.G** (MS-LS2-1), (MS-LS2-2), (MS-LS2-4), (MS-LS2-5); **2.1.B** (MS-LS2-3); **2.1.C** (MS-LS2-3); **2.2.A** (MS-LS2-1), (MS-LS2-2), (MS-LS2-4), (MS-LS2-5); **2.2.C** (MS-LS2-1), (MS-LS2-2), (MS-LS2-4), (MS-LS2-5); **2.2.D** (MS-LS2-3); **2.4.A** (MS-LS2-4), (MS-LS2-5); **2.4.C** (MS-LS2-1); **3.1.C** (MS-LS2-5)

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

Grade **6** | Unit **4**

# Investigating Weather and Climate

**RECOMMENDED TIME: 8 WEEKS (ASSUMING 5 PERIODS/WEEK)**

### Unit Overview:

*Investigating Weather and Climate* presents an opportunity for students to apply their learning about the flow of energy and matter from the previous unit. Students ask questions and collect data about the weather to understand why changes in weather and climate occur. They develop models to explain how complex interactions driven by energy cause changes in weather conditions and the patterns of atmospheric and oceanic circulation that determine regional climates. This unit presents additional opportunities to build skills in graphing, measurement, data analysis, and mathematical modeling.

### Essential Question:

**If the climate is warming, then why do we still have such cold winters?**

### Performance Expectations:

*Students who demonstrate understanding can:*

**MS-PS1-7.** Use evidence to illustrate that density is a property that can be used to identify samples of matter. **[Clarification Statement: Emphasis should be on students measuring the masses and volumes of regular and irregular shaped objects, calculating their densities, and identifying the samples of matter.]**

**MS-ESS2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy from the Sun and the force of gravity.
[**Clarification Statement:** Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models could include conceptual or physical models.] [**Assessment Boundary:** A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

**MS-ESS2-5.** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
[**Clarification Statement:** Emphasis is on how air flows from regions of high pressure to low pressure, the complex interactions at air mass boundaries, and the movements of air masses affect weather (defined by temperature, pressure, humidity, precipitation, and wind at a fixed location and time). Emphasis is on how weather can be predicted within probabilistic ranges. Data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [**Assessment Boundary:** Assessment includes the application of weather data systems but does not include recalling the names of cloud types, weather symbols used on weather maps, the reported diagrams from weather stations, or the interrelationship of weather variables.]

**MS-ESS2-6.** Develop and use a model to describe how unequal heating and rotation of Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
[**Clarification Statement:** Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis is on the sunlight-driven latitudinal banding causing differences in density that create convection currents in the atmosphere, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the coastlines of continents. Examples of models could include diagrams, maps and globes, or digital representations.] [**Assessment Boundary:** Assessment does not include the dynamics of the Coriolis effect.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
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| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop and use a model to describe phenomena. (MS-ESS2-6)<br>▪ Develop a model to describe unobservable mechanisms. (MS-ESS2-4)<br><br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.<br>▪ Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5) | **PS1.A: Structure and Properties of Matter**<br>▪ (NYSED) Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3), (MS-PS1-7) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)*<br><br>**ESS2.C: The Roles of Water in Earth's Surface Processes**<br>▪ (NYSED) Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, sublimation, deposition, precipitation, infiltration, and runoff. (MS-ESS2-4)<br>▪ The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)<br>▪ (NYSED) Global movements of water and its changes in form are driven by sunlight and gravity. (MS-ESS2-4)<br>▪ Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)<br><br>**ESS2.D: Weather and Climate**<br>▪ Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)<br>▪ Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)<br>▪ The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6) | **Cause and Effect**<br>▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)<br><br>**Systems and System Models**<br>▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)<br><br>**Energy and Matter**<br>▪ Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4) |

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| **Connections to DCIs in this grade-band: MS.PS1.A** (MS-ESS2-5); **MS.PS2.B** (MS-ESS2-4); **MS.PS3.A** (MS-ESS2-4), (MS-ESS2-5); **MS.PS3.B** (MS-ESS2-5), (MS-ESS2-6); **MS.PS3.D** (MS-ESS2-4); **MS.PS2.A** (MS-ESS2-5), (MS-ESS2-6) ; **MS.PS4.B** (MS-ESS2-6) |
| **Articulation of DCIs across grade-bands: Elementary: 3.PS2.A** (MS-ESS2-4), (MS-ESS2-6); **4.PS3.B** (MS-ESS2-4); **5.ESS2.A** (MS-ESS2-5), (MS-ESS2-6)<br>**High School: HS.ESS2.A** (MS-ESS2-4) (MS-ESS2-6); **HS.ESS2.C** (MSESS2-4); **3.ESS2.D** (MS-ESS2-5), (MS-ESS2-6); **HS.ESS2.D** (MS-ESS2-5), (MS-ESS2-6) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (MS-ESS2-5); **1.F** (MS-ESS2-4), (MS-ESS2-6); **2.1.A** (MS-ESS2-4), (MS-ESS2-5), (MS-ESS2-6); **2.1.B** (MS-ESS2-4); **2.1.C** (MS-ESS2-4) |

*The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

# Grade 6 | Unit 5 Human Impact on Earth's Climate

**RECOMMENDED TIME: 5 WEEKS (ASSUMING 5 PERIODS/WEEK)**

**Unit Overview:**

Unit 5 leads students to ask questions, analyze and interpret historical global weather data in order to understand how energy affects Earth's global and regional temperatures, and how such energy transfer is impacted by human activities. Students also have opportunities to identify patterns and use technology as a means to forecast and prepare for future severe weather events. Upon defining problems pertaining to Earth's changing climate, students apply scientific principles to design solutions for minimizing human impact on the environment.

**Essential Question:**

**Can humans change Earth's climate?**

**Performance Expectations:**

*Students who demonstrate understanding can:*

**MS-ESS3-2.** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. ▲ [**Clarification Statement:** Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards could include those resulting from interior processes (such as earthquakes and volcanic eruptions) and surface processes (such as mass wasting and tsunamis), or from severe weather events (such as blizzards, hurricanes, tornadoes, floods, and droughts). Examples of data could include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies could include global technologies (such as satellite images to monitor hurricanes or forest fires) or local technologies (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

**MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ∗ ▲ [**Clarification Statement:** Examples of the design process could include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts could include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

**MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [**Clarification Statement:** Examples of factors could include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence could include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

### Asking Questions and Defining Problems

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

### Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)

### Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)

## DISCIPLINARY CORE IDEAS

### ESS3.B: Natural Hazards

- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)

### ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3)

### ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

## CROSSCUTTING CONCEPTS

### Patterns

- Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

### Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)

### Stability and Change

- Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

### CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE

### Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2), (MS-ESS3-3)

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| **Connections to DCIs in this grade-band: 7th grade: MS.PS3.C** (MS-ESS3-2); **MS.LS2.A** (MS-ESS3-3); **MS.LS2.C** (MS-ESS3-3); **MS.LS4.D** (MS-ESS3-3); **MS.PS3.A** (MS-ESS3-5); **8th grade: MS.PS3.C** (MS-ESS3-2); **MS.LS2.A** (MS-ESS3-3); **MS.LS2.C** (MS-ESS3-3); **MS.LS4.D** (MS-ESS3-3) |
| **Articulation of DCIs across grade-bands: Elementary: 3.LS2.C** (MS-ESS3-3); **3.LS4.D** (MS-ESS3-3); **5.ESS3.C** (MS-ESS3-3); **High School: HS.ESS2.D** (MS-ESS3-2), (MS-ESS3-3); **HS.ESS2.E** (MS-ESS3-3); **HS.ESS3.C** (MS-ESS3-3); **HS.ESS3.D** (MS-ESS3-3) **HS.ESS2.A** (MS-ESS3-5); **HS.ESS2.D** (MS-ESS3-5) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.A** (MS-ESS3-3), (MS-ESS3-5); **1.B** (MS-ESS3-3); **1.C** (MS-ESS3-3); **1.D** (MS-ESS3-2), (MS-ESS3-3); **1.E** (MS-ESS3-2), (MS-ESS3-3); **1.G** (MS-ESS3-3); **2.1.A** (MS-ESS3-2), (MS-ESS3-5); **2.4.B** (MS-ESS3-2); **2.4.A** (MS-ESS3-3), (MS-ESS3-5); **2.4.C** (MS-ESS3-5); **2.4.D** (MS-ESS3-2), (MS-ESS3-3); **2.4.E** (MS-ESS3-5); **3.1.A** (MS-ESS3-5); **3.1.C** (MS-ESS3-3) |

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

Grade **7**

# Seventh Grade Year-Long Summary

Scale, proportion, and quantity is an essential crosscutting concept necessary to make sense of changes over short and long periods of time. An understanding of this crosscutting concept is important in deciding the appropriate scale of the phenomenon being investigated, and to make sense of changes over space and time. In seventh grade, students study the properties of matter, and begin at the atomic level, moving towards an understanding of how matter and energy interact at the cellular level. As we move into the final two units of study, the scale for time and space increases as students study the history of the Earth and changes in the Earth's surface. Grade 7 students connect their observations and new learnings to the theory of plate tectonics as they investigate natural hazards such as earthquakes and volcanoes. While learning about geology, students will apply their understanding of the flow of energy to the biogeochemical cycles on Earth. Geologic processes can result in permanent changes to the surface or landscape, often making the distribution of natural resources such as minerals, water, and energy uneven. The unit of study *Impact of Changes to Earth and Engineering Design* is an opportunity to promote positive social change at a local and global scale. After analyzing and interpreting data of the amount and distribution of natural resources, students plan and design solutions to balance the human consumption of resources or to equitably manage these resources.

In Unit 1, *Structure and Properties of Matter*, students develop models in order to explain and represent the structure and properties of matter. This unit provides an opportunity for students to make discoveries about the physical properties of matter and how matter can change. Students will engage in investigations to explore density, and use this property as a tool to identify unknown substances.

Unit 2, *Changing Properties of Matter*, students learn how the properties of matter may change when substances are combined. Students engage in learning about the conservation of mass and energy at the atomic level, and study chemical reactions at the cellular level by investigating photosynthesis and cellular respiration. The crosscutting concepts of energy and matter, patterns, analyzing and interpreting data, scale and proportion will continue to be explored throughout this unit.

Unit 3, *Structures of Life*, students continue exploring cells as the basic structure of living things. Students realize that cells are systems of organelles that work together to support cell functions. The study of organ systems provides students with the knowledge to explain how organisms maintain homeostasis and respond to changes in internal and external environments.

In Unit 4, *Geology*, working within the time scale of Earth's 4.6-billion-year-old history, students construct a scientific explanation based on evidence from rock strata as to how the Earth has transformed, and consider how geologic processes generated that transformation. They develop a model to describe the cycling of Earth's materials and the flow of energy that results in the change in the distribution of those materials over time. The analysis and interpretation of data on plate tectonics and natural hazards allow students to make predictions about potential future catastrophic events.

Finally, in Unit 5, *Minimizing Human Impact Through Engineering Design*, students apply scientific principles to design a method for modeling human exploitation of natural resources and engage in arguments based on evidence of how a growing human population affects Earth's systems. Along with the overarching theme of scale, proportion, and quantity, students conduct investigations in this unit focusing on the crosscutting concepts of cause and effect, finding ways to model time, space, and energy phenomena in various ways. Student learning provides an anchor point in how change is an inevitable component of all natural systems, which is foundational to the year-long study of science in Grade 8.

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| UNIT 1: STRUCTURE AND PROPERTIES OF MATTER (8 WEEKS) | UNIT 2: CHANGING PROPERTIES OF MATTER (10 WEEKS) | UNIT 3: STRUCTURES OF LIFE (6 WEEKS) | UNIT 4: GEOLOGY (7 WEEKS) | UNIT 5: MINIMIZING HUMAN IMPACT THROUGH ENGINEERING DESIGN (5 WEEKS) |
|---|---|---|---|---|
| **MS-PS1-1.** Develop models to describe the atomic composition of simple molecules and extended structures.<br><br>**MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and phase (state) of a substance when thermal energy is added or removed.<br><br>**MS-PS1-7.** Use evidence to illustrate that density is a property that can be used to identify samples of matter.<br><br>**MS-PS1-8.** Plan and conduct an investigation to demonstrate that mixtures are combinations of substances. | **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.<br><br>**MS-PS1-3.** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.<br><br>**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.<br><br>**MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.<br><br>**MS-LS1-7**. Develop a model to describe how food is rearranged through chemical reactions to release energy during cellular respiration and/or forming new molecules that support growth and/or release energy as this matter moves through an organism. | **MS-LS1-1.** Plan and conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.<br><br>**MS-LS1-2.** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.<br><br>**MS-LS1-3.** Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.<br><br>**MS-LS1-8.**Gather and synthesize information that sensory receptors respond to stimuli, resulting in immediate behavior and/or storage as memories. | **MS-ESS1-4.** Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.<br><br>**MS-ESS2-1.** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.<br><br>**MS-ESS2-2.** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying temporal and spatial scales.<br><br>**MS-ESS2-3.** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. | **MS-ESS3-1.** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geologic processes.<br><br>**MS-ESS3-2.** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. ▲<br><br>**MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ✱ ▲<br><br>**MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

**Grade 7 | Unit 1**

# Structure and Properties of Matter

**RECOMMENDED TIME: 8 WEEKS (ASSUMING 5 PERIODS/WEEK)**

**Unit Overview:**

The exploration of structure and properties of matter is a launch for understanding structure and function of matter at different scales. Students look for patterns in order to predict particle behavior as they continue to hone their modeling skills. Lastly, students will use evidence to construct an argument about density as an identifiable property of matter. There are many opportunities within this unit for students to strategically use scientific tools for measuring properties of matter.

**Essential Question:**

**How do properties, such as density, help us to classify and identify matter?**

**Performance Expectations:**

*Students who demonstrate understanding can:*

**MS-PS1-1.** Develop models to describe the atomic composition of simple molecules and extended structures.
[**Clarification Statement:** Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of particulate-level models could include drawings, 3D ball and stick structures, or computer representations showing different substances with different types of atoms.] [**Assessment Boundary**: Assessment does not include valence electrons and bonding energy, discussing the individual ions composing complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]

**MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and phase (state) of a substance when thermal energy is added or removed.
[**Clarification Statement:** Emphasis is on qualitative particulate-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 phase occurs. Examples of models could include drawings and diagrams. Examples of particles could include ions, molecules, or atoms. Examples of substances could include sodium chloride, water, carbon dioxide, and helium.]

**MS-PS1-7.** Use evidence to illustrate that density is a property that can be used to identify samples of matter.
[**Clarification Statement:** Emphasis should be on students measuring the masses and volumes of regular and irregular shaped objects, calculating their densities, and identifying the samples of matter.]

**MS-PS1-8.** Plan and conduct an investigation to demonstrate that mixtures are combinations of substances.
[**Clarification Statement:** Emphasis should be on analyzing the physical changes that occur as mixtures are formed and/or separated. Examples of common mixtures could include salt water, oil and vinegar, and air.] [**Assessment Boundary:** Assessment is limited to separation by evaporation, filtration, and magnetism.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
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| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop a model to predict and/or describe phenomena. (MS-PS1-1), (MS-PS1-4)<br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.<br>▪ Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS1-8)<br>▪ Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-PS1-8)<br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.<br>▪ Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS1-7) | **PS1.A: Structure and Properties of Matter**<br>▪ (NYSED) Substances are made of one type of atom or combinations of different types of atoms. Individual atoms are particles and can combine to form larger particles that range in size from two to thousands of atoms. (MS-PS1-1)<br>▪ (NYSED) Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-7) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-3.)*<br>▪ (NYSED) In a solid, the particles are closely spaced and vibrate in position but do not change their relative locations. In a liquid, the particles are closely spaced but are able to change their relative locations. In a gas, the particles are widely spaced except when they happen to collide and constantly change their relative locations. (MS-PS1-4)<br>▪ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)<br>▪ (NYSED) The changes of state that occur with variations in temperature and/or pressure can be described and predicted using these models of matter. (MS-PS1-4)<br>▪ (NYSED) Mixtures are physical combinations of one or more samples of matter and can be separated by physical means. (MS-PS1-8) | **Patterns**<br>▪ Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-1), (MS-PS1-7), (MS-PS1-8)<br>▪ Graphs, charts, and images can be used to identify patterns in data. (MS-PS1-1), (MS-PS1-4)<br>**Cause and Effect**<br>▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4)<br>**Scale, Proportion, and Quantity**<br>▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) |

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| | **PS3.A: Definitions of Energy**<br>▪ (NYSED) The term "heat" as used in everyday language refers both to thermal energy (the motion of particles 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. (secondary to MS-PS1-4)<br>▪ (NYSED) Temperature is not a form of energy. Temperature is a measurement of the average kinetic energy of the particles in a sample of matter. (secondary to MS-PS1-4) | |
| **Connection to other DCIs in this grade-band: 6th grade: MS.LS2.A** (MS-PS1-3), **MS.LS4.D** (MS-PS1-3), **MS.ESS3.A** (MS-PS1-3), **MS.ESS3.C** (MS-PS1-3), **MS.ESS2.C** (MS-PS1-4) | | |
| **Articulation of DCIs across grade-bands: High School: HS.PS1.B** (MS-PS1-4); **HS.PS3.A** (MS-PS1-4); **HS.PS1.A** (MS-PS1-3), (MS-PS1-4) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.F** (MS-PS1-1), (MS-PS1-4); **2.1.B** (MS-PS1-1), (MS-PS1-4); **2.1.C** (MS-PS1-4) | | |

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# Grade 7 | Unit 2 Changing Properties of Matter

**RECOMMENDED TIME: 10 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

In this unit students develop models to explain how conservation of matter is characteristic of chemical change. Energy and matter are linked to the previous unit through a study of photosynthesis and cellular respiration, learning how molecules break down or are built up within cells, and how energy is transformed in the process. Students have the opportunity to model and analyze the motion and rearrangement of particles in chemical reactions, making the invisible visible. These concepts are then applied to develop an explanation of how matter is cycled and energy flows within cells.

## Essential Question:

**How do we know if a chemical reaction has occurred during cellular processes such as photosynthesis and cellular respiration?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**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.
[**Clarification Statement:** Examples of chemical reactions could include burning of a wooden splint, souring of milk, and decomposition of sodium bicarbonate.]
[**Assessment Boundary:** Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, color change, gas production and odor.]

**MS-PS1-3.** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
[**Clarification Statement:** Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [**Assessment Boundary:** Assessment is limited to the qualitative interpretation of evidence provided.]

**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.
[**Clarification Statement:** Emphasis is on the law of conservation of matter and on physical models or drawings, including digital forms that represent atoms.]
[**Assessment Boundary:** Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]

**MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
[**Clarification Statement:** Emphasis is on tracing movement of matter and flow of energy.] [**Assessment Boundary:** Assessment does not include the biochemical mechanisms of photosynthesis.]

**MS-LS1-7.** Develop a model to describe how food molecules are rearranged through chemical reactions to release energy during cellular respiration and/or form new molecules that support growth as this matter moves through an organism.
[**Clarification Statement:** Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.]
[**Assessment Boundary:** Assessment does not include details of the chemical reactions for respiration or synthesis.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
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| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop a model to describe unobservable mechanisms. (MS-PS1-5), (MS-LS1-7)<br><br>**Analyzing and Interpreting Data**<br>Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>▪ Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.<br>▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6) | **PS1.A: Structure and Properties of Matter**<br>▪ (NYSED) Substances are made of one type of atom or combinations of different types of atoms. Individual atoms are particles and can combine to form larger particles that range in size from two to thousands of atoms. (MS-PS1-1)<br>▪ (NYSED) Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2), (MS-PS1-3) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-7.)*<br><br>**PS1.B: Chemical Reactions**<br>▪ (NYSED) Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different particles, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-3), (MS-PS1-5)<br>▪ The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)<br><br>**LS1.C: Organization for Matter and Energy Flow in Organisms**<br>▪ Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)<br>▪ Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7) | **Patterns**<br>▪ Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)<br><br>**Energy and Matter**<br>▪ Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5), (MS-LS1-7)<br>▪ Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)<br><br>**Structure and Function**<br>▪ Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)<br><br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br><br>**Interdependence of Science, Engineering, and Technology**<br>▪ Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)<br><br>**Influence of Science, Engineering, and Technology on Society and the Natural World**<br>▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3) |

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| **Obtaining, Evaluating, and Communicating Information**<br>▪ Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.<br>▪ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)<br><br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations**.** (MS-PS1-2), (MS-LS1-6)<br>**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**<br>▪ Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5) | ▪ **PS3.D: Energy in Chemical Processes and Everyday Life**<br>▪ 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 oxygen. (secondary to MS-LS1-6)<br>▪ Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7) | |

**Connections to other DCIs in this grade-band: 6th grade: MS.PS1.B** (MS-LS1-6), (MS-LS1-7); **MS.ESS2.A** (MS-LS1-6); **MS.ESS2.C** (MS-PS1-1)
**7th grade: MS.PS3.D** (MS-PS1-2); **MS.LS1.C** (MS-PS1-2), (MS-PS1-5); **MS.LS2.B** (MS-PS1-5); **MS.ESS2.A** (MS-PS1-2), (MS-PS1-5); **MS.PS1.B** (MS-LS1-6), (MS-LS1-7); **MS.ESS2.A** (MS-LS1-6); **MS.ESS2.C** (MS-PS1-1)

**Articulation of DCIs across grade-bands: Elementary: 5.PS1.B** (MS-PS1-2), (MS-PS1-5); **5.LS1.C** (MS-LS1-6), (MS-LS1-7); **5.PS3.D** (MS-LS1-6), (MS-LS1-7)
**High School: HS.PS1.B** (MS-PS1-2), (MS-PS1-5), (MS-LS1-6), (MS-LS1-7); **HS.LS1.C** (MS-LS1-6), (MS-LS1-7); **HS.LS2.B** (MS-LS1-6), (MS-LS1-7)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (MS-PS1-3); **1.D** (MS-PS1-3), (MS-LS1-6); **1.E** (MS-PS1-2), (MS-PS1-3); **1.F** (MS-PS1-1), (MS-PS1-5), (MS-LS1-7); **1.G** (MS-LS1-6); **2.1.B** (MS-PS1-1), (MS-PS1-2), (MS-PS1-3), (MS-PS1-5); **2.2.A** (MS-LS1-6); **2.2.D** (MS-LS1-7)

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

Grade **7** | Unit **3**

# Structures of Life

**RECOMMENDED TIME: 6 WEEKS (ASSUMING 5 PERIODS/WEEK)**

**Unit Overview:**

In Unit 3, students continue their study of life at different scales, by focusing on cells and other biological levels of organization. They will gain an understanding of how the structure and function of interacting systems within organisms sustain life on Earth. This unit explores observable, relevant, and engaging phenomena on the microscopic scale. Students plan and conduct investigations that identify the basic structures of life, gather and synthesize information about how these structures respond to their environment, and construct explanations for how these structures interact to maintain homeostasis. Throughout the unit, students build an understanding of how things we cannot see contribute to, and explain, what we can.

**Essential Question:**

**Why are cells considered the smallest unit of life?**

**Performance Expectations:**

*Students who demonstrate understanding can:*

**MS-LS1-1.** Plan and conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
[**Clarification Statement:** Emphasis is on developing evidence that living things are made of cells, distinguishing between living and nonliving things, and understanding that living things may be made of one cell or many and varied cells.]

**MS-LS1-2.** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
[**Clarification Statement:** Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [**Assessment Boundary:** Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical details related to the functions of cells or cell parts.]

**MS-LS1-3.** Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.
[**Clarification Statement:** Emphasis should be on the function and interactions of the major body systems (e.g., circulatory, respiratory, nervous, musculoskeletal).]
[**Assessment Boundary:** Assessment is focused on the interactions between systems not on the functions of individual systems.]

**MS-LS1-8.** Gather and synthesize information that sensory receptors respond to stimuli, resulting in immediate behavior and/or storage as memories.
[**Assessment Boundary:** Assessment does not include mechanisms for the transmission of this information.]

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

**Developing and Using Models**

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-LS1-2)

**Planning and Carrying Out Investigations**

Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-3)

## DISCIPLINARY CORE IDEAS

**LS1.A: Structure and Function**

- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

**LS1.D: Information Processing**

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. (MS-LS1-8)
- (NYSED) Plants respond to stimuli such as gravity (geotropism) and light (phototropism). (MS-LS1-8)

## CROSSCUTTING CONCEPTS

**Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)

**Scale, Proportion, and Quantity**

- Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

**Systems and System Models**

- Systems may interact with other systems; they may have subsystems and be a part of larger complex systems. (MS-LS1-3)

**Structure and Function**

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Interdependence of Science, Engineering, and Technology**

- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1)

**CONNECTIONS TO NATURE OF SCIENCE**

**Science Is a Human Endeavor**

- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

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|---|---|---|
| **Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.<br>▪ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and method used, and describe how they are supported or not supported by evidence. (MS-LS1-8) | | |
| **Connections to other DCIs in this grade-band: MS.LS3.A** (MS-LS1-2) | | |
| **Articulation of DCIs across grade-bands: Elementary: 4.LS1.A** (MS-LS1 2); **4.LS1.D** (MS-LS1-8); **High School: LS1.A:** (MS-LS1-1), (MS-LS1-2), (MS-LS1-3), (MS-LS1-8) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12):** N/A | | |

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# Grade 7 | Unit 4 Geology

**RECOMMENDED TIME: 7 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

After investigating how organisms need certain structures to survive in their environment, students explore how catastrophic events (earthquakes, volcanoes, meteor impacts) and small-scale changes (landslides, geochemical reactions) have shaped our planet over 4.6 billion years. Using evidence from rock strata and fossils to support their analyses, students construct a scientific explanation as to how the Earth has changed at various spatial and temporal scales and how geologic processes generated those transformations. They develop a model to describe the cycling of Earth's materials and the flow of energy that drives the processes of melting, crystallization, weathering, deformation, and sedimentation. The analysis and interpretation of data related to plate tectonics supports an understanding of how patterns can provide information about natural events that took place deep in Earth's past.

**Essential Question:**

**How does the surface of the Earth change over time?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**MS-ESS1-4.** Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. [**Clarification Statement:** Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events or evidence could include very recent events or evidence (such as the last Ice Age or the earliest fossils of Homo sapiens) to very old events or evidence (such as the formation of Earth or the earliest evidence of life). Examples of evidence could include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [**Assessment Boundary:** Assessment does not include recalling the names of specific periods or epochs and events within them, radiometric dating using half-lives, and defining index fossils.]

**MS-ESS2-1.** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [**Clarification Statement:** Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [**Assessment Boundary:** Assessment does not include the specific identification and naming of minerals and rocks but could include the general classification of rocks as igneous, metamorphic, or sedimentary.]

**MS-ESS2-2.** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying temporal and spatial scales. [**Clarification Statement:** Emphasis is on how processes change Earth's surface at temporal and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes could include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]

**MS-ESS2-3.** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [**Clarification Statement:** Examples of data could include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [**Assessment Boundary:** Paleomagnetic anomalies in oceanic and continental crust are not assessed.]

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop and use a model to describe phenomena. (MS-ESS2-1)<br><br>**Analyzing and Interpreting Data**<br>Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>▪ Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.<br>▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4), (MS-ESS2-2) | **ESS1.C: The History of Planet Earth**<br>▪ The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)<br>▪ Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (secondary to MS-ESS2-3)<br><br>**ESS2.A: Earth's Materials and Systems**<br>▪ All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)<br>▪ The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)<br><br>**ESS2.B: Plate Tectonics and Large-Scale System Interactions**<br>▪ Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)<br><br>**ESS2.C: The Roles of Water in Earth's Surface Processes**<br>▪ Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2) | **Patterns**<br>▪ Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3)<br><br>**Scale Proportion and Quantity**<br>▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-4), (MS-ESS2-2)<br><br>**Stability and Change**<br>▪ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1) |

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| **CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge is Open to Revision in Light of New Evidence**<br>▪ Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3) | | |

**Connections to DCIs in this grade-band: 6th Grade**: **MS.PS1.B** (MS-ESS2-2); **MS.LS2.B** (MS-ESS2-2); **MS.PS3.C** (MS-ESS3-2); **MS.LS2.A** (MS-ESS3-3), (MS-ESS3-4); **MS.LS2.C** (MS-ESS3-3), (MS-ESS3-4); **MS.LS4.D** (MS-ESS3-3), (MS-ESS3-4); **7th Grade: MS.PS1.B** (MS-ESS2-2); **8th Grade: MS.LS4.A** (MS-ESS1-4), (MS-ESS2-3); **MS.LS4.C** (MS-ESS1-4)

**Articulation of DCIs across grade-bands: Elementary: 4.ESS1.C** (MS-ESS1-4) (MS-ESS2-2) (MS-ESS2-3); **4.ESS2.A** (MS-ESS2-2) (MS-ESS2-1); **5.ESS2.A (**MS-ESS2-2) (MS-ESS 2-1); **High School: HS.ESS1.C** (MS-ESS1-4) (MS-ESS2-2) (MS-ESS2-3); **HS.ESS2.B** (MS-ESS2-2) (MS-ESS2-3); **HS.ESS2.A** (MS-ESS1-4) (MS-ESS2-2) (MS-ESS2-3) (MS-ESS2-1)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.D** (MS-ESS1-4), (MS-ESS2-2), (MS-ESS2-3); **1.E** (MS-ESS2-3); **1.F** (MS-ESS2-1); **1.G** (MS-ESS1-4), (MS-ESS2-2); **2.1.A** (MS-ESS1-4), (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-3); **2.1.B** (MS-ESS2-1); **2.1.C** (MS-ESS2-1)

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# Grade 7 | Unit 5 Minimizing Human Impact Through Engineering Design

**RECOMMENDED TIME: 5 WEEKS (ASSUMING 5 PERIODS/WEEK)**

**Unit Overview:**

In the last unit of the year, students investigate the consequences of natural phenomena on populations and ecosystems. Students use evidence to construct a scientific explanation for why geologic processes have led to an uneven distribution of Earth's resources. Using engineering practices, students apply scientific principles to design a method for modeling human exploitation of natural resources and engage in arguments based on evidence of how a growing human population affects Earth's systems. Subsequently, students use key practices in Engineering Design to create a method for monitoring and minimizing human impact on the environment. This unit provides an opportunity for students to build their skills in quantitative reasoning while considering real-world problems. Student learning provides an anchor point in how change is an inevitable component of all natural systems, as they transition into the units of study in Grade 8.

**Essential Question:**

**How can we prevent or minimize harm from a natural disaster?**

**Performance Expectations:**

*Students who demonstrate understanding can:*

**MS-ESS3-1.** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geologic processes.
[**Clarification Statement:** Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes could include petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

**MS-ESS3-2.** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. ▲
[**Clarification Statement:** Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards could include those resulting from interior processes (such as earthquakes and volcanic eruptions) and surface processes (such as mass wasting and tsunamis), or from severe weather events (such as blizzards, hurricanes, tornadoes, floods, and droughts). Examples of data could include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies could include global technologies (such as satellite images to monitor hurricanes or forest fires) or local technologies (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

**MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ✱ ▲
[**Clarification Statement:** Examples of the design process could include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts could include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

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**MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [**Clarification Statement:** Examples of evidence could include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts could include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>▪ Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)<br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.<br>▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)<br>▪ Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) | **ESS3.A: Natural Resources**<br>▪ Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)<br>**ESS3.B: Natural Hazards**<br>▪ Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)<br>**ESS3.C: Human Impacts on Earth Systems**<br>▪ Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)<br>▪ Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3), (MS-ESS3-4) | **Patterns**<br>▪ Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)<br>**Cause and Effect**<br>▪ Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)<br>▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS3-4)<br>**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**<br>**Influence of Science, Engineering, and Technology on Society and the Natural World**<br>▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1), (MS-ESS3-4)<br>▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2), (MS-ESS3-3) |

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|---|---|---|
| **Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).<br>▪ Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4) | | **CONNECTIONS TO NATURE OF SCIENCE**<br>**Science Addresses Questions About the Natural and Material World**<br>▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4) |

**Connections to DCIs in this grade-band: 6th Grade: MS.PS1.B** (MS-ESS2-2); **MS.LS2.B** (MS-ESS2-2); **MS.PS3.C** (MS-ESS3-2); **MS.LS2.A** (MS-ESS3-3), (MS-ESS3-4); **MS.LS2.C** (MS-ESS3-3), (MS-ESS3-4); **MS.LS4.D** (MS-ESS3-3), (MS-ESS3-4); **8th Grade: MS.LS4.A** (MS-ESS1-4), (MS-ESS2-3); **MS.LS4.C** (MS-ESS1-4)

**Articulation of DCIs across grade-bands: Elementary: 4.ESS3.B** (MS-ESS3-2); **5.ESS3.C** (MS-ESS3-3), (MS-ESS3-4)
**High School: HS.ESS2.B** (MS-ESS3-2), (MS-ESS3-1); **HS.ESS3.C** (MS-ESS3-3), (MS-ESS3-4); **HS-ESS3.D** (MS-ESS3-2), (MS-ESS3-3)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.A** (MS-ESS3-3); **1.B** (MS-ESS3-3); **1.C** (MS-ESS3-3); **1.D** (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4); **1.E** (MS-ESS3-2), (MS-ESS3-3); **1.G** (MS-ESS3-1), (MS-ESS3-3), (MS-ESS3-4); **2.1.A** (MS-ESS3-1), (MS-ESS3-2); **2.2.A** (MS-ESS3-4); **2.2.C** (MS-ESS3-4); **2.3.D** (MS-ESS3-4); **2.4.A** (MS-ESS3-3), (MS-ESS3-4); **2.4.B** (MS-ESS3-2); **2.4.C** (MS-ESS3-1), (MS-ESS3-4); **2.4.D** (MS-ESS3-2), (MS-ESS3-3); **2.4.E** (MS-ESS3-4); **3.1.C** (MS-ESS3-3)

*The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED).*

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

**Grade 8**

# Eighth Grade Year-Long Summary

Stability and change is a crosscutting concept that connects the units of study in Grade 8. Students investigate the changes in the motion of an object when forces are applied to that object. Students also learn that there are predictable patterns in the motion of planets and celestial bodies in the solar system maintained by gravitational forces. They develop models to explain phases of the moon and seasons on Earth. Students observe that when ecosystems are stable, organisms find habitats, nutrients, and weather conditions suitable for living. Changes in climate and other factors, however, may affect the ecosystem in a way that requires organisms to respond in ways to ensure this survival.

Students also learn that stability in the genetic sequence leads to continuity of life on this planet. Patterns in the genetic sequence contain encrypted instructions to form structures that will enable organisms to be successful in the habitat in which they live. Genetic codes ensure stability and the preservation of species. Changes through mutations guarantee genetic variation which leads to diversity within a species, but may also lead to the extinction of others. The study of evolution and the mechanism of natural selection provides the grounds for students to gather evidence that will help them develop an understanding of why some species are similar, and how organisms change over time.

Modern society has created technological tools that enabled a greater understanding of our world. Technology has also allowed scientists to respond to issues threatening the diversity of life on Earth, as well as helping to develop solutions to increase the quality of life for communities in need around the globe. Students have opportunities to investigate how technology has increased our ability to communicate on a global level and to compare the effectiveness of analog and digital technology tools. This knowledge will allow students to propose the design of new devices or modify current ones to solve problems or that may provide necessary and beneficial changes to communities in need.

In Unit 1, *Energy, Forces, and Motion*, students will continue exploring the energy transformations and transfer that happens when forces are applied to objects, changing patterns of motion. Through these investigations they deepen their understanding of Newton's Laws and begin to apply this understanding to real-life situations. They will also explore how changes in the amount of force affect and change the motion of objects. The crosscutting concepts that will be addressed in this unit are scale, proportion and quantity, systems and system models, energy and matter, and stability and change.

Students continue exploring forces through a deeper study of gravity. In Unit 2, *Earth's Place in the Universe*, students develop and use models to gain an understanding of gravity as one of the forces responsible for the predictable motion of the Earth, other planets, and celestial bodies in the solar system. Students begin this unit by examining observable and natural phenomena that directly affects their day-to-day lives. Investigations of the Earth-Sun-moon system provide an insight into cyclic patterns that produce lunar phases, eclipses, and seasons. This content will be rooted in the scientific practices that they will continue to develop throughout the year, including the use of models, constructing and presenting arguments, and analyzing and interpreting data.

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In Unit 3, *Growth, Development, and Reproduction of Organisms*, students are introduced to genetics by revisiting cell theory, with a focus on cell structures and functions that contribute to reproduction and inheritance. Investigations reveal how genes are directly responsible for traits that differentially support the survival of organisms and how mutations can have a positive, negative, or neutral effect on the organism. Students use evidence from investigations to help them develop arguments that support current theories on how the environment and genetics influence the growth of organisms. Crosscutting concepts covered include structure and function, cause and effect, and patterns, in addition to the overarching theme of change over time.

In Unit 4, *Evolution, Natural Selection, and Adaptations*, students explore how environmental and genetic factors are the driving forces in the change of species over time. Students begin the unit by analyzing and interpreting fossil record data to find patterns that document the existence, diversity, and extinction of species throughout Earth's history. They apply scientific ideas to construct explanations for the similarities and differences among modern organisms and between modern and fossil organisms in order to infer evolutionary relationships. Students analyze images of embryos to compare patterns in embryological development across multiple species to further build on their understanding of similarities between species and their evolutionary relationships. The unit continues to delve into the theme of change by exploring genetic variation and its role in the survival of organisms. Students engage in the topic by constructing explanations based on evidence that genetic variation in populations increases the probability of surviving and reproducing, as well as using mathematical representations to support explanations of how natural selection leads to changes in specific traits over time. The crosscutting concepts of structure and function, patterns, cause and effect, systems, and scale and proportion are highlighted in this unit.

In the last unit, *The Evolution of Technology in Science*, students explore how our understanding of the world has changed as our technological abilities have advanced. Looking first at innovations in genetic technology, students gather and synthesize information about the new ways humans are able to influence the inheritance and expression of desired traits, and evaluate and communicate information from multiple sources related to genetic practices. Switching their focus to waves and electromagnetic radiation, students explore the qualitative and quantitative patterns in waves and analyze how waves can be manipulated to develop new technologies. Crosscutting concepts include energy and matter, structure and function, cause and effect, and patterns. In addition, at least one of the four Engineering Design standards will be addressed as students explore technological innovations.

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| UNIT 1: ENERGY, FORCES, AND MOTION (8 WEEKS) | UNIT 2: EARTH'S PLACE IN THE UNIVERSE (6 WEEKS) | UNIT 3: GROWTH, DEVELOPMENT, AND REPRODUCTION OF ORGANISMS (6 WEEKS) | UNIT 4: EVOLUTION, NATURAL SELECTION, AND ADAPTATIONS (8 WEEKS) | UNIT 5: EVOLUTION OF TECHNOLOGY IN SCIENCE (8 WEEKS) |
|---|---|---|---|---|
| **MS-PS2-1:** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.<br>**MS-PS2-2.** 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.<br>**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 and the distance between them. ▲<br>**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.<br>**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-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 and the distance between them. ▲<br>**MS-ESS1-1.** Develop and use a model of the Earth-Sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and moon, and seasons.<br>**MS-ESS1-2.** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.<br>**MS-ESS1-3.** Analyze and interpret data to determine scale properties of objects in the solar system. | **MS-LS1-4.** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.<br>**MS-LS1-5.** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.<br>**MS-LS3-1.** Develop and use a model to explain structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.<br>**MS-LS3-2.** Develop and use a model to describe how asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. | **MMS-LS4-1.** Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and changes of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.<br>**MS-LS4-2.** Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between model and fossil organisms to infer evolutionary relationships.<br>**MS-LS4-3.** Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.<br>**MS-LS4-4.** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. | **MS-PS4-1.** Develop a model and use mathematical representations to describe waves that includes frequency, wavelength, and how the amplitude of a wave is related to the energy in a wave.<br>**MS-PS4-2.** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.<br>**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.<br>**MS-LS4-5.** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. |

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| UNIT 1: ENERGY, FORCES, AND MOTION (8 WEEKS) | UNIT 2: EARTH'S PLACE IN THE UNIVERSE (6 WEEKS) | UNIT 3: GROWTH, DEVELOPMENT, AND REPRODUCTION OF ORGANISMS (6 WEEKS) | UNIT 4: EVOLUTION, NATURAL SELECTION, AND ADAPTATIONS (8 WEEKS) | UNIT 5: EVOLUTION OF TECHNOLOGY IN SCIENCE (8 WEEKS) |
|---|---|---|---|---|
| **MS-PS3-5.** Construct, use, and present an argument to support the claim that when work is done on or by a system, the energy of the system changes as energy is transferred to or from the system. | | | **MS-LS4-6.** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. | |

✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

▲ *PE is partially addressed in the unit of study (and appears in another unit in the same grade level or band).*

# Grade 8 | Unit 1 Energy, Forces, and Motion

**RECOMMENDED TIME: 8 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

In Unit 1 students investigate how forces affect the motion of objects deepening their understanding of Newton's Laws of Motion. This knowledge is then used in planning and carrying out an engineering design investigation related to the collisions between objects. They also examine the relationship between the force of gravity and how it is dependent on both the masses and the distance between objects and the relationship between the speed of an object and its kinetic energy. This unit provides an opportunity for students to reason abstractly and engage in mathematical thinking.

## Essential Question:

**How do Newton's Laws help us to better understand the impact of collisions between two objects?**

## Performance Expectations:

*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. ✱
[**Clarification Statement:** 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.] [**Assessment Boundary:** Assessment is limited to vertical or horizontal interactions in one dimension.]

**MS-PS2-2.** 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.
[**Clarification Statement:** Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system (including simple machines), qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [**Assessment Boundary:** Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]

**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 and the distance between them.
[**Clarification Statement:** 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.] [**Assessment Boundary:** Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

**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.
[**Clarification Statement:** 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.]
[**Assessment Boundary:** Assessment could include both qualitative and quantitative evaluations of kinetic energy.]

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**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.
[**Clarification Statement:** 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.] [**Assessment Boundary**: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

**MS-PS3-5.** Construct, use, and present an argument to support the claim that when work is done on or by a system, the energy of the system changes as energy is transferred to or from the system.
[**Clarification Statement:** 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 Boundary:** Assessment could include calculations of work and energy.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop a model to describe unobservable mechanisms. (MS-PS3-2)<br><br>**Planning and Carrying Out Investigations**<br>Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.<br>▪ Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2) | **PS2.A: Forces and Motion**<br>▪ 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-PS2-1)<br>▪ 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-PS2-2)<br>▪ 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-PS2-2) | **Scale, Proportion, and Quantity**<br>▪ Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)<br><br>**Systems and System Models**<br>▪ Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4), (MS-PS3-2)<br><br>**Energy and Matter**<br>▪ Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion). (MS-PS3-5)<br><br>**Stability and Change**<br>▪ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2) |

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### Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

### Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)

### Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4), (MS-PS3-5)

## CONNECTIONS TO NATURE OF SCIENCE

### Scientific Knowledge Is Based on Empirical Evidence

Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2), (MS-PS2-4), (MS-PS3-5)

### PS2.B: Types of Interactions

- 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-PS2-4)

### PS3.A: Definitions of 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. (MS-PS3-1)
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

### PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)

### PS3.C: Relationship Between Energy and Forces

- 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-PS3-2)

## CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE

### Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-PS2-1)

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| **Connections to DCIs in this grade-band: 6th grade: MS.PS.2A** (MS-PS3-1), (MS-PS3-5); **MS.PS.3A** (MS-PS2-2); **MS.PS.3B** (MS-PS2-2); **MS.ESS2.C** (MS-PS2-2), (MS-PS2-4); **MS.PS.3C** (MS-PS2-1); **MS.ESS1.A** (MS-PS2-4); **MS. ESS1.B** (MS-PS2-4) |
| **Articulation of DCIs across grade-bands: Elementary: 4.PS3.B:** (MS-PS3-1); **High School: HS.PS3.B:** (MS-PS3-1), (MS-PS3-2), (MS-PS3-5); **HS.ESS1.B:** (MS-PS2-2), (MS-PS2-4) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.E** (MS-PS3-1); **1.F** (MS-PS3-2); **1.G** (MS-PS3-5); **2.1.C** (MS-PS3-1), (MS-PS3-2), (MS-PS3-5) |

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✱ *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

**Grade** **Unit**

# 8 | 2 Earth's Place in the Universe

**RECOMMENDED TIME: 6 WEEKS (ASSUMING 5 PERIODS/WEEK)**

**Unit Overview:**

*Earth's Place in the Universe* allows students to explore the Earth's size and distance from other celestial bodies, as well as the Earth-sun-moon system. Students design an accurate model (graphical, physical or conceptual) of the Solar System which demonstrates their understanding of size and scale. Students also use a model of the Earth-sun-moon system to explain cyclic patterns such as the phases of the moon. This unit presents multiple opportunities for applications of measurement as students construct their models, attending to scale and proportion.

**Essential Question:**

**What would happen if gravity did not exist?**

**Performance Expectations:**

*Students who demonstrate understanding can:*

**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 and the distance between them.
[**Clarification Statement:** 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.] [**Assessment Boundary:** Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

**MS-ESS1-1.** Develop and use a model of the Earth-Sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and moon, and seasons.
[Clarification Statement: Examples of models could include physical, graphical, or conceptual models.]

**MS-ESS1-2.** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
[**Clarification Statement:** Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models could include physical models (such as a model of the solar system scaled using various measures or computer visualizations of elliptical orbits) or conceptual models (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [**Assessment Boundary:** Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

**MS-ESS1-3.** Analyze and interpret data to determine scale properties of objects in the solar system.
[**Clarification Statement:** Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties could include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data could include statistical information, drawings and photographs, and models.] [**Assessment Boundary:** Assessment does not include recalling facts about properties of the planets and other solar system bodies.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

**Developing and Using Models**

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS1-1), (MS-ESS1-2)

**Analyzing and Interpreting Data**

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)

**Engaging in Argument from Evidence**

Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)

## DISCIPLINARY CORE IDEAS

**PS2.B: Types of Interactions**

- 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-PS2-4)

**ESS1.A: The Universe and Its Stars**

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)

**ESS1.B: Earth and the Solar System**

- (NYSED) The solar system consists of the Sun and a collection of objects, including planets, their moons, comets, and asteroids that are held in orbit around the Sun by its gravitational pull on them. (MS-ESS1-2), (MS-ESS1-3)
- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)

## CROSSCUTTING CONCEPTS

**Patterns**

- Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)

**Scale, Proportion, and Quantity**

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3)

**Systems and System Models**

- Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems. (MS-PS2-4), (MS-ESS1-2)

**CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE**

**Interdependence of Science, Engineering, and Technology**

- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-ESS1-3)

**CONNECTIONS TO NATURE OF SCIENCE**

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1), (MS-ESS1-2)

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| **Connections to DCIs in this grade-band: MS.PS2.A** (MS-ESS1-1), (MS-ESS1-2); **MS.PS2.B** (MS-ESS1-1), (MS-ESS1-2); **MS.ESS2.A** (MS-ESS1-3); **MS.ESS1.A** (MS-PS2-4); **MS.ESS1.B** (MS-PS2-4) |
| **Articulation of DCIs across grade-levels: Elementary: 3.PS2.A** (MS-PS2-1), (MS-PS2-2); **3.PS2.B** (MS-PS2-3), (MS-PS2-5)<br>**High School: HS.ESS1.B** (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3); **HS.PS2.B** (MS-ESS1-1), (MS-ESS1-2), (MS-PS2-4) |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.F** (MS-ESS1-1); **2.1.A** (MS-ESS1-1) |

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# Grade 8 | Unit 3 Growth, Development, and Reproduction of Organisms

**RECOMMENDED TIME: 6 WEEKS (ASSUMING 5 PERIODS/WEEK)**

## Unit Overview:

Students explore the genetic basis for the growth and development of organisms. Students revisit the concept of structure and function from grade 7 by reviewing cell structures with a specific focus on those that contribute to reproduction and inheritance. Students develop models to show how genetic mutations affect organisms as well as how genetic information is passed to offspring in both asexual and sexual reproduction. Knowledge of heredity leads students to construct explanations of how both genetic and environmental factors influence the growth of organisms. Empirical evidence allows students to develop arguments to support how specific behaviors and characteristics in both plants and animals affect reproduction. This unit presents an opportunity to use mathematical models and statistics to describe and analyze data.

**Essential Question:**

**Is it possible for an organism to be identical to its parent?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**MS-LS1-4.** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.
[**Clarification Statement:** Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

**MS-LS1-5.** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
[**Clarification Statement:** Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include the genes responsible for size differences in different breeds of dogs. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.]
[**Assessment Boundary:** Assessment does not include genetic mechanisms, gene regulation, biochemical processes, or natural selection.]

**MS-LS3-1.** Develop and use a model to explain why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
[**Clarification Statement:** Mutations in body cells are not inherited. Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [**Assessment Boundary:** Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

**MS-LS3-2.** Develop and use a model to describe how asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
[**Clarification Statement:** Emphasis is on using models such as diagrams and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>▪ Develop and use a model to describe phenomena. (MS-LS3-1), (MS-LS3-2)<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.<br>▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5)<br><br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).<br>▪ Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4) | **LS1.B: Growth and Development of Organisms**<br>▪ Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)<br>▪ Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)<br>▪ Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)<br>▪ Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)<br><br>**LS3.A: Inheritance of Traits**<br>▪ Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)<br>▪ Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2) | **Cause and Effect**<br>▪ Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)<br>▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4), (MS-LS1-5)<br><br>**Structure and Function**<br>▪ Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1) |

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|---|---|---|
| | **LS3.B: Variation of Traits**<br>▪ In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)<br>▪ In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)<br>▪ (NYSED) Mutations may result in changes to the structure and function of proteins. (MS-LS3-1) | |

**Connections to DCIs in this grade-band: 6th Grade: MS.LS2.A** (MS-LS 1-5), (MS-LS 1-4)

**Articulation of DCIs across grade-bands: Elementary: 3.LS3.A** (MS-LS1-5), (MS-LS3-2); **3.LS3.B** (MS-LS3-2); **High School: HS.LS1.B** (MS-LS3-2); **HS.LS3.A** (MS-LS3-2); **HS.LS2.A** (MS-LS1-4), (MS-LS1-5); **HS.LS3.B** (MS-LS3-2)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.D** (MS-LS1-4), (MS-LS1-5); **1.F** (MS-LS3-2); **1.G** (MS-LS1-4), (MS-LS1-5); **2.2.A** (MS-LS1-4), (MS-LS1-5); **2.2.B** (MS-LS3-2)

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**Grade** 8 | **Unit** 4

# Evolution, Natural Selection, and Adaptations

**RECOMMENDED TIME: 8 WEEKS (ASSUMING 5 PERIODS/WEEK)**

### Unit Overview:

After developing a foundation in the processes leading to the changes in DNA and genes, students continue to delve into the theme of change over time by analyzing and interpreting fossil record data to find patterns that document the existence, diversity, and extinction of species throughout Earth's history. Students act as scientists by using empirical evidence to construct explanations describing evolutionary relationships among modern organisms and between modern and fossil organisms. They analyze images of embryos to compare patterns in embryological development across multiple species to develop their understanding of similarities between species. Students further develop their understanding of evolutionary relationships in the second part of the unit by examining the underlying mechanism for the evolution of species, the process of natural selection. In this section, students construct mathematical representations that support explanations of how natural selection may lead to changes in the proportions of specific traits in populations over time. By examining the manner in which genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a given environment, students can construct arguments that explain how species change over time.

### Essential Question:

**How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms?**

### Performance Expectations:

*Students who demonstrate understanding can:*

**MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.**
[**Clarification Statement:** Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [**Assessment Boundary:** Assessment does not include the names of individual species or geological eras in the fossil record.]

**MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.**
[**Clarification Statement:** Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures as evidence of common ancestry.]

**MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.**
[**Clarification Statement:** Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [**Assessment Boundary:** Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]

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**MS-LS4-4.** **Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.**
[**Clarification Statement:** Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]

**MS-LS4-6.** **Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.**
[**Clarification Statement:** Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [**Assessment Boundary:** Assessment does not include Hardy Weinberg calculations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

| SCIENCE AND ENGINEERING PRACTICES | DISCIPLINARY CORE IDEAS | CROSSCUTTING CONCEPTS |
|---|---|---|
| **Analyzing and Interpreting Data**<br>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>■ Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3)<br>■ Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)<br>**Using Mathematics and Computational Thinking**<br>Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.<br>■ Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6) | **LS4.A: Evidence of Common Ancestry and Diversity**<br>■ The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)<br>■ Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)<br>■ Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)<br>**LS4.B: Natural Selection**<br>■ (NYSED) Natural selection can lead to an increase in the frequency of some traits and the decrease in the frequency of other traits. (MS-LS4-4) | **Patterns**<br>■ Patterns can be used to identify cause and effect relationships. (MS-LS4-2)<br>■ Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1), (MS-LS4-3)<br>■ Similarities and differences in patterns can be used to sort and classify organisms. (MS-LS4-2)<br>**Cause and Effect**<br>■ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-6)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**<br>■ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1), (MS-LS4-2) |

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| **Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.<br>▪ Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)<br>▪ Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)<br>**CONNECTIONS TO NATURE OF SCIENCE**<br>**Scientific Knowledge Is Based on Empirical Evidence**<br>▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1) | **LS4.C: Adaptation**<br>▪ Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6) | |
| **Connections to DCIs in this grade-band: 6th Grade: MS.LS2.A** (MS-LS4-4), (MS-LS4-6); **MS.LS2.C** (MS-LS4-6); **8th Grade: MS.LS3.A** (MS-LS4-2)(MS-LS4-4); **MS.LS3.B** (MS-LS4-2), (MS-LS4-4), (MS-LS4-6); **MS.ESS1.C** (MS-LS4-4), (MS-LS4-6); **MS.ESS1.C** (MS-LS4-1), (MS-LS4-2); **MS.ESS2.B** (MS-LS4-1) | | |
| **Articulation of DCIs across grade-bands: Elementary: 3.LS4.A** (MS-LS4-1), (MS-LS4-2); **3.LS3.B** (MS-LS4-4); **3.LS4.B** (MS-LS4-4); **3.LS4.C** (MS-LS4-4), (MS-LS4-6)<br>**High School: HS.LS4.A** (MS-LS4-1), (MS-LS4-2), (MS-LS4-3); **HS.LS3.B** (MS-LS4-4); **HS.LS4.B** (MS-LS4-4), (MS-LS4-6); **HS.LS4.C** (MS-LS4-4), (MS-LS4-6) | | |
| **Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.D** (MS-LS4-2), (MS-LS4-4); **1.E** (MS-LS4-1), (MS-LS4-3); **1.F** (MS-LS4-6); **1.G** (MS-LS4-1), (MS-LS4-2), (MS-LS4-4); **2.2.A** (MS-LS4-1), (MS-LS4-2), (MS-LS4-4); **2.2.B** (MS-LS4-1), (MS-LS4-2), (MS-LS4-3), (MS-LS4-4), (MS-LS4-6); **2.2.C** (MS-LS4-1), (MS-LS4-2), (MS-LS4-4) | | |

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# Grade 8 | Unit 5 Evolution of Technology in Science

**RECOMMENDED TIME: 8 WEEKS**

## Unit Overview:

The overarching theme of stability and change continues to be explored in Unit 5 through the lens of technology. Students build on their knowledge of genes in Unit 1 by first looking at innovations in genetic technology. Students gather and synthesize information about the new ways humans are able to influence the inheritance of desired traits. Students then explore advancements in information technology through a study of waves and electromagnetic radiation. By analyzing the qualitative and quantitative patterns in waves, students develop models to reflect the characteristics and behavior of waves alone and through various materials. A study of waves leads students to develop a scientific understanding of communication and integrate this into an explanation of how modern advancements in technology allow for more reliable information transfer. This unit presents an opportunity to use mathematical reasoning and modeling.

**Essential Question:**

**How has technology changed the way we communicate?**

## Performance Expectations:

*Students who demonstrate understanding can:*

**MS-PS4-1. Develop a model and use mathematical representations to describe waves that includes frequency, wavelength, and how the amplitude of a wave is related to the energy in a wave.**
[**Clarification Statement:** Emphasis is on describing waves with both qualitative and quantitative thinking.] [**Assessment Boundary:** Assessment is limited to comparing standard repeating waves of only one type (transverse or longitudinal).]

**MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.**
[**Clarification Statement:** Emphasis is on both light and mechanical waves. Examples of models could include drawings, ray diagrams, simulations, and written descriptions. Materials could include plane, convex, and concave mirrors and biconvex and biconcave lenses.] [**Assessment Boundary:** Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

**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.**
[**Clarification Statement:** Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.]
[**Assessment Boundary:** Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

**MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.**
[**Clarification Statement:** Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, selective breeding, gene therapy); and, on the impacts these technologies have on society.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

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## SCIENCE AND ENGINEERING PRACTICES

### Developing and Using Models

Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-PS4-2)

### Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)

### Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6-8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.

- Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)
- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)

### CONNECTIONS TO NATURE OF SCIENCE

#### Scientific Knowledge Is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)

## DISCIPLINARY CORE IDEAS

### PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

### PS4.B: Electromagnetic Radiation

- 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-PS4-2)
- (NYSED) The path that light travels can be traced as straight lines, except when it hits a surface between different transparent materials (e.g., air and water, air and glass) obliquely 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-PS4-2)
- (NYSED) However, because light can travel through space, it cannot be a mechanical wave, like sound or water waves. (MS-PS4-2)

### PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)

### LS4.B: Natural Selection

- In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)

## CROSSCUTTING CONCEPTS

### Patterns

- Graphs and charts can be used to identify patterns in data. (MS-PS4-1)

### Cause and Effect

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-5)

### Structure and Function

- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2)
- Structures can be designed to serve particular functions. (MS-PS4-3)

### CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE

#### Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5)

#### Influence of Science, Engineering, and Technology on Society and the Natural World

- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)

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| | | **CONNECTIONS TO NATURE OF SCIENCE**<br>**Science Is a Human Endeavor**<br>▪ Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)<br>**Science Addresses Questions About the Natural and Material World**<br>▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5) |

**Connections to DCIs in this grade-band: 7th Grade: MS.LS1.D** (MS-LS 4-2)

**Articulation of DCIs across grade-bands: Elementary: 4.PS4.A** (MS-PS4-1); **4.PS4.B** (MS-PS4-2); **4.PS4.C** (MS-PS4-3);
**High School: HS.PS4.A** (MS-PS4-1), (MS-PS4-2), (MS-PS4-3); **HS.PS4.B** (MS-PS4-1), (MS-PS4-2); **HS.PS4.C** (MS-PS4-3)

**Connections to Excellence in Environmental Education-Guidelines for Learning (K–12): 1.C** (MS-LS4-5); **1.E** (MS-LS4-5); **1.G** (MS-LS4-5); **2.2.A** (MS-LS4-5); **2.2.B** (MS-LS4-5); **2.4.A** (MS-LS4-5); **2.4.D** (MS-LS4-5)

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# Appendices

# Appendix A:
## NYSED Mandated Instruction in Science
## New York State Education Law: Article 17, Sections 809–810

### 809. Instruction in the humane treatment of animals.

**1.** The officer, board or commission authorized or required to prescribe courses of instruction shall cause instruction to be given in every elementary school under state control or supported wholly or partly by public money of the state, in the humane treatment and protection of animals and the importance of the part they play in the economy of nature as well as the necessity of controlling the proliferation of animals which are subsequently abandoned and caused to suffer extreme cruelty. Such instruction shall be for such period of time during each school year as the board of regents may prescribe and may be joined with work in literature, reading, language, nature study or ethnology. Such weekly instruction may be divided into two or more periods. A school district shall not be entitled to participate in the public school money on account of any school or the attendance at any school subject to the provisions of this section, if the instruction required hereby is not given therein.

**2. Study and care of live animals.** Any school which cares for or uses animals for study shall ensure that each animal in such school be afforded the following: appropriate quarters; sufficient space for the normal behavior and postural requirements of the species; proper ventilation, lighting, and temperature control; adequate food and clean drinking water; and quarters which shall be cleaned on a regular basis and located in an area where undue stress and disturbance are minimized.

**3. Application.** The provisions of this section shall not be construed to prohibit or constrain vocational instruction in the normal practice of animal husbandry, or prohibit or constrain instruction in environmental education activities as established by the department of environmental conservation.

**4. Dissection of animals.** Any student expressing a moral or religious objection to the performance or witnessing of the dissection of an animal, either wholly or in part, shall be provided the opportunity to undertake and complete an alternative project that shall be approved by such student's teacher; provided, however, that such objection is substantiated in writing by the student's parent or legal guardian. Students who perform alternative projects who do not perform or witness the dissection of animals shall not be penalized. The board of education or trustees of a school district shall develop a policy to give reasonable notice to all students enrolled in a course that includes the dissection of an animal and students' parents or legal guardians about their rights under this subdivision. Such notice shall be made available upon request at the school and distributed to parents and students enrolled in a course that includes dissection at least once at the beginning of the school year.

**5. Treatment of live vertebrate animals.** a. Except as provided for in this subdivision, no school district, school principal, administrator, or teacher shall require or permit the performance of a lesson or experimental study on a live vertebrate animal in any such school or during any activity conducted under the auspices of such school whether or not the activity takes place on the premises of such school where such lesson or experimental study employs: (i) micro-organisms which cause disease in humans or animals, (ii) ionizing radiation, (iii) known cancer producing agents, (iv) chemicals at toxic levels, (v) drugs producing pain or deformity, (vi) severe extremes of temperature, (vii) electric or other shock, (viii) excessive noise, (ix) noxious fumes, (x) exercise to exhaustion, (xi) overcrowding, (xii) paralysis by muscle relaxants or other means, (xiii) deprivation or excess of food, water or other essential nutrients, (xiv) surgery or other invasive procedures, (xv) other extreme stimuli, or (xvi) termination of life.

b. Notwithstanding any inconsistent provision of this section, the commissioner may, upon the submission of a written program plan, issue to such school a written waiver of such restrictions for students subject to the following provisions: (i) the student shall be in grade ten, eleven, or twelve; and (ii) the student shall be under the supervision of one or more teachers certified in science; and (iii) the student shall be pursuing an accelerated course of study in the sciences as defined by the commissioner in preparation for taking a state or national advanced placement examination. The commissioner shall issue a waiver of such restrictions for any teacher certified in science instructing such student. The written program plan shall include, but not be limited to: (i) the educational basis for requesting a waiver; (ii) the objective of the lesson or experiment; (iii) the methods and techniques to be used; and (iv) any other information required by the commissioner.

**6. Report.** On or before the first day of January next succeeding the effective date of this amended section, the commissioner shall annually submit a report to the governor and the legislature which shall include, but not be limited to, the number of written program plan proposals submitted by schools and the number of such proposals subsequently approved by the commissioner. In those cases where a program plan proposal has been approved by the commissioner, such plan shall be appended to and become a part of the commissioner's annual report.

## 810. Conservation day.

**1.** The last Friday in April each year is hereby made and declared to be known as Conservation day, and observed in accordance with the provisions of this chapter, except that for the year nineteen hundred seventy-eight, Conservation day shall be May third.

**2.** It shall be the duty of the authorities of every public school in this state to assemble the pupils in their charge on that day in the school building, or elsewhere, as they may deem proper, and to provide for and conduct (1) such exercises as shall tend to encourage the planting, protection and preservation of trees and shrubs, and an acquaintance with the best methods to be adopted to accomplish such results, and (2) such lectures, pictures or tours, as shall tend to increase the interest and knowledge of such pupils in the fish and wild life, soil and water of the state.

**3.** The commissioner of education may prescribe from time to time a course of exercises and instruction in the subjects hereinbefore mentioned, which shall be adopted and observed by the public school authorities on Conservation day. Upon receipt of copies of such course sufficient in number to supply all the schools under their supervision, the school authorities aforesaid shall promptly provide each of the schools under their charge with a copy, and cause it to be observed.

Grade **PK** | 

# Appendix B:
## Pre-Kindergarten Evidence Statements

**P-PS1-1. Ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students describe how the observations they make connect to the purpose of the investigation. |
| **3.** | **Planning the investigation** |
| | **a.** Based on the given investigation plan, students describe (with guidance):<br>1. The physical differences between solids and liquids.<br>2. How solids and liquids interact with different materials and each other. |
| **4.** | **Collecting the data** |
| | **a.** With guidance, students collaboratively make observations that would allow them to compare solids and liquids. |
| | **b.** Students will collect observational data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize data from given observations (firsthand or through media) about properties of solids and liquids. |
| **6.** | **Identifying relationships** |
| | **a.** Students identify and describe (with guidance) patterns in the organized data, including:<br>Properties of solids and liquids and the interactions of materials. |
| **7.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) examples of solids and liquids in their world. |
| **8.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade **PK**

# Appendix B:
## Pre-Kindergarten Evidence Statements

**P-PS2-1. Use tools and materials to design and build a device that causes an object to move faster with a push or a pull.***

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students collaboratively identify the phenomenon under investigation, which includes the following idea:<br>The effect caused by different strengths and directions of pushes and pulls on the motion of an object. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively identify the purpose of their investigation, which includes gathering evidence to support student ideas about causes of the phenomenon by comparing the effects of different strengths of pushes and pulls on the motion of an object. |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, students describe with guidance: The object whose motion will be investigated and what will be in contact with the object to cause the push or pull.<br>1. The relative strengths of the push or pull that will be applied to the object to start or stop its motion or change its speed.<br>2. The relative directions of the push or pull that will be applied to the object.<br>3. How the motion of the object will be observed and recorded.<br>4. How the push or pull will be applied to vary strength or direction. |
| **4.** | **Collecting the data** |
| | **a.** According to the investigation plan they developed, and with guidance, students collaboratively make observations that would allow them to compare the effect on the motion of the object caused by changes in the strength or direction of the pushes and pulls. |
| | **b.** Students will collect observational data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize data from given observations (firsthand or through media) about the strength or direction of the pushes and pulls on the motion of an object. |
| **6.** | **Identifying relationships** |
| | **a.** Students identify and describe (with guidance) patterns in the organized data, including:<br>The strength and direction of the pushes and pulls on the motion of an object. |
| **7.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) examples of the effects of pushes and pulls in their world. |
| **8.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade **PK** | # Appendix B: Pre-Kindergarten Evidence Statements

**P-PS4-1. Plan and conduct investigations to provide evidence that sound is produced by vibrating materials.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students collaboratively identify the phenomenon under investigation, which includes the following idea:<br>Sound is caused by vibrating materials. |
| | **b.** With guidance, students collaboratively identify the purpose of their investigation, which includes gathering evidence to support student ideas about what causes a sound to be produced. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively develop an investigation plan to investigate that sound is caused by vibrating materials (i.e., vibrating materials could include percussion instruments (e.g., drum, triangle), string instruments (e.g., guitar, piano), wind instruments (e.g., recorder, whistle) and audio speakers.) |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, students describe, with guidance: The material whose vibration will be investigated.<br>1. What will cause the object to vibrate.<br>2. Relative description of sound and volume.<br>3. Relative comparison of different materials. |
| **4.** | **Collecting the data** |
| | **a.** According to the investigation plan they developed, and with guidance, students collaboratively make observations that would allow them to observe that sound is caused by vibrating materials |
| | **b.** Students will collect observational data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize data from given observations (firsthand or through media) about sound caused by vibrating materials. |
| **6.** | **Identifying relationships** |
| | **a.** Students identify and describe (with guidance) patterns in the organized data, including that sound is caused by vibrating materials. |
| **7.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) examples that sound is caused by vibrating materials in their world. |
| **8.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade **PK**

# Appendix B:
## Pre-Kindergarten Evidence Statements

**P-ESS1-1. Observe and describe the apparent motions of the Sun, moon, and stars to recognize predictable patterns.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students collaboratively identify the phenomenon under investigation, which includes the following idea:<br>To find and identify predictable patterns of the motion of the Sun, moon, and stars. |
| | **b.** With guidance, students collaboratively identify the purpose of their investigation, which includes gathering evidence to support student ideas about causes of the phenomenon under investigation and that enables them to find and identify predictable patterns of the motion of the Sun, moon, and stars. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively develop an investigation plan to investigate identifiable patterns of motion of the Sun, moon, and stars. This includes but is not limited to: Day/Night and Seasons |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, students find and identify, with guidance, predictable patterns of the motion of the Sun, moon, and stars.<br>How do the Sun, moon, and stars move:<br>1. Day and Night follow predictable patterns.<br>2. Seasons change in a cyclical pattern. |
| **4.** | **Collecting the data** |
| | **a.** According to the investigation plan they developed, and with guidance, students collaboratively make observations that would allow them to find and identify predictable patterns of the motion of the Sun, moon, and stars. |
| | **b.** Students will collect observational data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize data from given observations (firsthand or through media) about identifiable patterns of motion of the Sun, moon, and stars and the pattern of the seasons. |
| **6.** | **Identifying relationships** |
| | **a.** Students identify and describe (with guidance) patterns in the organized data, including that of Day/Night and Seasons. |
| **7.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) daily and seasonal patterns in their world. |
| **8.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

# Appendix B: Pre-Kindergarten Evidence Statements

**P-ESS2-1. Ask questions, make observations, and collect and record data using instruments to recognize patterns about how local weather conditions change daily and seasonally.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students are able to describe daily weather conditions and changes. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively develop an investigation plan to investigate identifiable weather conditions. |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, students to describe daily weather conditions and changes.<br>What changes:<br>1. The number of sunny, cloudy, rainy, windy, cool, or warm days.<br>2. The relative temperature. |
| **4.** | **Collecting the data** |
| | **a.** According to the investigation plan they developed, and with guidance, students collaboratively make observations that would allow them to identify and record daily weather conditions and changes. |
| | **b.** Students will collect observational data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize data from given observations (firsthand or through media) about local weather conditions using graphical displays (e.g., pictures, charts).<br>1. The number of sunny, cloudy, rainy, windy, cool, or warm days.<br>2. The relative temperature. |
| **6.** | **Identifying relationships** |
| | **a.** Students identify and describe (with guidance) patterns in the organized data, including:<br>Daily weather conditions and changes:<br>1. The relative number of days of different types of weather conditions in a month.<br>2. The change in the relative temperature (e.g., hotter/colder). |
| **7.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) examples of solids and liquids in their world. |
| **8.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade **PK**

# Appendix B:
## Pre-Kindergarten Evidence Statements

**P-PS3-1. Ask questions, make observations, and collect and record data using a simple plan and conduct an investigation to determine the effect of sunlight on Earth's surface.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** From the given investigation plan, students describe (with guidance) the phenomenon under investigation, which includes the following idea:<br>Sunlight warms the Earth's surface. |
| | **b.** Students describe (with guidance) the purpose of the investigation, which includes determining the effect of sunlight on Earth materials by identifying patterns of relative warmth of materials in sunlight and shade (e.g., sand, soil, rocks, water). |
| | **c.** Students describe (with guidance) the purpose of the investigation, which includes determining the warming effect of sunlight on living and nonliving things. |
| | **d.** Students describe (with guidance) the purpose of the investigation, which includes illumination and casting shadows. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** Based on the given investigation plan, students describe (with guidance) the evidence that will result from the investigation, including observations of the relative warmth of materials in the presence and absence of sunlight (i.e., effects on living and nonliving things and the qualitative measures of temperature; e.g., hotter, warmer, colder). |
| | **b.** Students describe (with guidance) how the observations they make connect to the purpose of the investigation. |
| **3.** | **Planning the investigation** |
| | **a.** Based on the given investigation plan, students describe (with guidance):<br>1. The materials on the Earth's surface to be investigated (e.g., dirt, sand, rocks, water, grass).<br>2. How the relative warmth of the materials will be observed and recorded.<br>3. How the sun illuminates and how shadows are cast.<br>4. How the Sun's warmth effects living and nonliving things. |

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| | |
|---|---|
| **4.** | **Collecting the data** |
| | **a.** According to the given investigation plan and with guidance, students collect and record data that will allow them to:<br>1. Compare the warmth of Earth materials placed in sunlight and the same Earth materials placed in shade.<br>2. Identify patterns of relative warmth of materials in sunlight and in shade (i.e., qualitative measures of temperature; e.g., hotter, warmer, colder).<br>3. Describe (with guidance) that sunlight warms the Earth's surface and its effect on living and nonliving things.<br>4. Describe the relationship between the Sun's illumination and the shadows that are cast by objects. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize data from given observations (firsthand or from media) about the effects of the Sun on the Earth's surface using graphical displays (e.g., pictures, charts). The effects include:<br>1. The materials on the Earth's surface to be investigated (e.g., dirt, sand, rocks, water, grass).<br>2. The relative warmth of the materials that were observed and recorded.<br>3. The effect of the Sun's warmth on living and nonliving things.<br>4. Illumination and shadows. |
| **6.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) the effects of the Sun's warmth on the world around them. |
| **7.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade **PK**

# Appendix B:
## Pre-Kindergarten Evidence Statements

**P-LS1-1. Observe familiar plants and animals (including humans) and describe what they need to survive.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students are able to observe familiar plants and animals and describe what they need to survive. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively develop an investigation to determine what living organisms need to grow and survive. |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, with guidance, students will describe the survival needs of plants and animals. What needs:<br>1. The needs of plants.<br>2. The needs of animals (including humans). |
| **4.** | **Collecting the data** |
| | **a.** According to the given investigation plan and with guidance, students observe and record data about the survival needs of living things:<br>What needs:<br>1. Needs of different types of animals (including humans).<br>2. Data about the foods different animals eat.<br>3. Data about animals' drinking water.<br>4. Data about plants' need for water (e.g., observations of the effects on plants in a classroom or school when they are not watered, observations of natural areas that are very dry).<br>5. Data about plants' need for light (e.g., observations of the effect on plants in a classroom when they are kept in the dark for a long time; observations about the presence or absence of plants in very dark places, such as under rocks or porches). |

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| | |
|---|---|
| **5.** | **Organizing the data** |
| | **a** According to the given investigation plan and with guidance, students observe and record data about the survival needs of living things:<br>What needs:<br>1. Needs of different types of animals (including humans).<br>2. Data about the foods different animals eat.<br>3. Data about animals' drinking water.<br>4. Data about plants' need for water (e.g., observations of the effects on plants in a classroom or school when they are not watered, observations of natural areas that are very dry).<br>5. Data about plants' need for light (e.g., observations of the effect on plants in a classroom when they are kept in the dark for a long time; observations about the presence or absence of plants in very dark places, such as under rocks or porches). |
| **6.** | **Identifying relationships** |
| | **a.** Students identify patterns in the organized data, including that:<br>1. All animals eat food.<br>2. Some animals eat plants.<br>3. Some animals eat other animals.<br>4. Some animals eat both plants and animals.<br>5. No animals do not eat food.<br>6. All animals drink water.<br>7. Plants cannot live or grow if there is no water.<br>8. Plants cannot live or grow if there is no light. |
| **7.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) their own survival needs based on the world around them. |
| **8.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade PK

# Appendix B:
## Pre-Kindergarten Evidence Statements

**P-LS1-2. Plan and conduct an investigation to determine how familiar plants and/or animals use their external parts to help them survive in the environment.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students are able to observe familiar plants and animals and describe how familiar plants and/or animals use their external parts to help them survive in the environment. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively develop an investigation plan to investigate how familiar plants and/or animals use their external parts to help them survive in the environment. |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, students describe: The plants and/or animals that will be investigated. .<br>1. The identification of the survival need.<br>2. The identification of the external part of the plant and/or animal.<br>3. How the external part will be applied to meet the survival need. |
| **4.** | **Collecting the data** |
| | **a.** According to the investigation plan they developed, and with guidance, students collaboratively make observations. This would allow them to identify the external part of the plant/animal and how it helps them survive. |
| | **b.** Student will collect and record qualitative data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize the given data from observations (firsthand or from media) using graphical displays (e.g., pictures, charts), including:<br>1. The external part of the plant/animal and how it helps them survive.<br>2. Relationship between physical and living environment (e.g., roots/stems, eyes/ears). |
| **6.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) how their own external parts allow them to survive in their environment. |
| **7.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade **PK** | # Appendix B: Pre-Kindergarten Evidence Statements

**P-LS3-1. Develop a model to describe that some young plants and animals are similar to, but not exactly like, their parents.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** With guidance, students are able to observe that some young plants and animals are similar to, but not exactly like, their parents. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** With guidance, students collaboratively develop an investigation to model and observe that some young plants and animals are similar to, but not exactly like, their parents. |
| **3.** | **Planning the investigation** |
| | **a.** In the collaboratively developed investigation plan, students describe that some young plants and animals are similar to, but not exactly like, their parents. |
| **4.** | **Collecting the data** |
| | **a.** According to the investigation plan they developed, and with guidance, students collaboratively make observations. This would allow them to describe that some young plants and animals are similar to, but not exactly like, their parents. |
| | **b.** Student will collect and record qualitative data. |
| **5.** | **Organizing the data** |
| | **a** With guidance, students organize the given data from observations (firsthand or from media) using graphical displays (e.g., pictures, charts), including descriptions that some young plants and animals are similar to, but not exactly like, their parents. |
| **6.** | **Addressing the natural world** |
| | **a.** Students identify and describe (with guidance) how they are similar to their parents. |
| **7.** | **Communicating information** |
| | **a.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade K

# Appendix B:
## Kindergarten Evidence Statements

**K-PS1-1. Plan and conduct an investigation to test the claim that different kinds of matter exist as either solid or liquid depending on temperature.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** Students identify and describe the phenomenon under investigation, which includes the following idea: Different kinds of matter have different properties, and sometimes the same kind of matter has different properties depending on temperature. |
| | **b.** Students identify and describe the purpose of the investigation, which includes answering a question about the phenomenon under investigation by describing* and classifying different kinds of materials by their observable properties. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** Students collaboratively develop an investigation plan and describe the evidence that will be collected, including the properties of matter of the materials that would allow for classification, and the temperature at which those properties are observed (i.e., hot, warm, cool, cold, as per the assessment boundaries). |
| | **b.** Students individually describe that the observations of the materials provide evidence about the properties of different kinds of materials. |
| **3.** | **Planning the investigation** |
| | **a.** Students individually describe that the observations of the materials provide evidence about the properties of different kinds of materials. |
| | **b.** Students describe how to determine the temperature (qualitative) of matter (within the assessment boundaries). |
| **4.** | **Collecting the data** |
| | **a.** According to the developed investigation plan, students collaboratively collect and record data on the temperature of the materials. |
| | **b.** Students will communicate their understandings through show and tells, drawings, paintings, and group discussions. |

Grade 3

# Appendix B:
## Third Grade Evidence Statements

**3-ESS2-3 Plan and conduct an investigation to determine the connections between weather and water processes in Earth systems.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon to be investigated** |
| | **a.** Students identify weather and weather patterns and the connection between water processes on Earth, such as the water cycle. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** Students use books and other reliable media as sources for scientific information to answer scientific questions about:<br>1. Where water is found on Earth, including in oceans, rivers, lakes, and ponds.<br>2. The idea that water can be found on Earth as liquid water or solid ice (e.g., a frozen pond, liquid pond, frozen lake).<br>3. Patterns of where water is found, and what form it is in.<br>4. The processes that continuously cycle water and contribute to weather and climate. |
| **3.** | **Planning the investigation** |
| | **a.** Students plan an investigation that produces data to serve as the basis for evidence, using a fair test for an explanation of a phenomenon. |
| **4.** | **Collecting the data** |
| | **a.** Students collect data using appropriate tools (rain gauge, thermometer, and anemometer). |
| **5.** | **Organizing the data** |
| | **a.** Students use graphical displays (e.g., table, chart, graph) to organize the given data by season using tables, pictographs, and/or bar charts, including:<br>1. Weather data from the same area across multiple seasons (e.g., average temperature, precipitation, and wind direction).<br>2. Weather data from different areas (e.g., hometown and nonlocal areas, such as a town in another state). |
| **6.** | **Identifying relationships** |
| | **a.** Students identify and describe patterns of weather conditions across:<br>1. Different seasons (e.g., cold and dry in the winter, hot and wet in the summer, more or less wind in a particular season).<br>2. Different areas (e.g., certain areas (defined by location, such as a town in the Northeast) have high precipitation, while a different area (based on location or type, such as a town in the Southeast) have very little precipitation. |
| **7.** | **Interpreting data** |
| | **a.** Students use patterns of weather conditions in different seasons and different areas to predict:<br>1. The typical weather conditions expected during a particular season (e.g., In New York City in the summer it is typically hot, as indicated on a bar graph, while in the winter it is typically cold; therefore, the prediction is that next summer it will be hot and next winter it will be cold.).<br>2. The typical weather conditions expected during a particular season in different areas. |
| **8.** | **Evaluating information** |
| | **a.** Students combine obtained information to provide evidence about the weather pattern in a region that can be used to make predictions about typical weather conditions in that region. |

Grades **6-8**

# Appendix B:
## Middle School Evidence Statements

**MS-PS1-7 Use evidence to illustrate that density is a property that can be used to identify samples of matter.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Supported claims** |
| | **a.** Students make a claim to be supported about a given phenomenon. In their claim, students include the following idea:<br>Density is a property that can be used to identify samples of matter. |
| **2.** | **Identifying scientific evidence** |
| | **a.** Students identify and describe the given evidence that supports the claim, including:<br>i. The masses and volumes of regular and irregular shaped objects.<br>ii. Using density calculations to identify samples of matter. |
| **3.** | **Evaluating and critiquing the evidence** |
| | **a.** Students evaluate the evidence and identify its strengths and weaknesses, including:<br>i. Types of sources.<br>ii. Sufficiency, including validity and reliability, of the evidence to make and defend the claim.<br>iii. Any alternative interpretations of the evidence, and why the evidence supports the given claim as opposed to counterclaims. |
| **4.** | **Reasoning and synthesis** |
| | **a.** Students use reasoning to connect the appropriate evidence about the density of objects and construct the argument that density can be used to identify samples of matter. Students describe the following chain of reasoning:<br>i. Density of regular and irregular objects can be calculated using the measurements of mass and volume.<br>ii. In every case for which evidence exists, there is a specific density for every type of matter. |
| | **b.** To support the claim, students present their oral or written argument concerning density as an identifying property of matter. |

**MS-PS3-6 Make observations to provide evidence that energy can be transferred by electric currents.**

Observable features of the student performance by the end of the course:

| | |
|---|---|
| **1.** | **Identifying the phenomenon under investigation** |
| | **a.** From the given investigation plan, students describe the phenomenon under investigation, which include the similarities and differences between series and parallel circuits. |
| | **b.** Students identify the purpose of the investigation, which includes providing evidence to answer questions about how energy flows within a series vs. a parallel circuit. [Note: expectations of students regarding energy transfer are limited to the behavior of a mechanism (i.e., light bulb) within a series vs. a parallel circuit. |
| **2.** | **Identifying the evidence to address the purpose of the investigation** |
| | **a.** From a given investigation plan, students describe the qualitative data to be collected and the evidence to be derived from the data that would indicate that energy flows differently within a series and parallel circuit.<br>i. Circuits provide a path through which electrical energy can transfer.<br>ii. Identifying the number of energy paths within a series vs. parallel circuit.<br>iii. The relationship between the number of mechanisms that can function (i.e., light bulb) within a series vs. parallel circuit. |
| | **b.** Students describe how the evidence to be collected will be relevant to determining the relationship between energy transfers within series vs. parallel circuits. |
| **3.** | **Planning the investigation** |
| | **a.** Students describe the methods by which they will collect evidence within the given investigation, including how they are relevant to the purpose of the investigation. |
| **4.** | **Collecting the data** |
| | **a.** According to the provided investigation plan, students make observations and record data, either firsthand and/or from secondary source on the different paths that energy can flow through series vs. parallel circuits. |

Grades **6-8**

# Appendix B: Middle School Evidence Statements

**MS-PS1-8 Matter and its interactions.**

Observable features of the student performance by the end of the course:

**1. Identifying the phenomenon to be investigated**

**a.** Students identify the phenomenon under investigation, which includes the relationship between the properties of the components of a mixture and a method of separation.

**b.** Students identify the purpose of the investigation, which includes designing a method of separation that takes into account the following:

- i. The physical properties of the components of the mixture, such as color, odor, density, boiling point, melting point, and magnetism.
- ii. The ability to separate samples of matter.
- iii. The methods of separating mixtures, such as evaporation, filtration, and magnetism.

**2. Identifying the evidence to address the purpose of the investigation**

**a.** Students develop a plan for the investigation individually or collaboratively. In the plan, students describe the data to be collected and the evidence to be derived from the data, including:

- i. That the following data will be collected:
  1. Qualitative data describing each component in the mixture before or after separation.
  2. The quantity or volume of each component in the mixture before or after separation.
- ii. Which data are needed to provide evidence for each of the following:
  1. Mixtures are combinations of substances that can be separated by physical means.

**3. Planning the investigation**

**a.** In the investigation plan, students describe:

- i. How the following factors will be determined and measured:
  1. The physical properties of the components of the mixture, such as color, odor, density, boiling point, melting point, and magnetism.
  2. The methods of separating each component, such as evaporation, filtration, and magnetism.
- ii. Which factors will serve as independent and dependent variables in the investigation (e.g., method of separation is an independent variable, pure substances can be dependent).
- iii. The controls for each experimental condition.
- iv. The number of trials for each experimental condition.

# Appendix C:

## New York State P-12 Science Learning Standards

### K-2. Engineering Design

Students who demonstrate understanding can:

**K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

**K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**

**K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

#### Science and Engineering Practices

**Asking Questions and Defining Problems**
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions.
- Ask questions based on observations to find more information about the natural and/or designed world. (K-2-ETS1-1)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

**Developing and Using Models**
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

**Analyzing and Interpreting Data**
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)

#### Disciplinary Core Ideas

**ETS1.A: Defining and Delimiting Engineering Problems**
- A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

**ETS1.B: Developing Possible Solutions**
- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)

**ETS1.C: Optimizing the Design Solution**
- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)

#### Crosscutting Concepts

**Structure and Function**
- The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

*Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:*
**Kindergarten:** K-PS2-2, K-ESS3-2
*Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:*
**Kindergarten:** K-ESS3-3, **First Grade:** 1-PS4-4, **Second Grade:** 2-LS2-2
*Connections to K-2-ETS1.C: Optimizing the Design Solution include:*
**Second Grade:** 2-ESS2-1

*Articulation of DCIs across grade-bands:* **3-5.ETS1.A** (K-2-ETS1-1),(K-2-ETS1-2),(K-2 -ETS1-3); **3-5.ETS1.B** (K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1.C** (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3)

*Common Core State Standards Connections:*
*ELA/Literacy –*

**RI.2.1** Ask and answer such questions as *who*, *what*, *where*, *when*, *why*, and *how* to demonstrate understanding of key details in a text. (K-2-ETS1-1)
**W.2.6** With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1),(K-2-ETS1-3)*
**W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),*(K-2-ETS1-3)*
**SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

*Mathematics –*

**MP.2** Reason abstractly and quantitatively. *(K-2-ETS1-1),(K-2-ETS1-3)*
**MP.4** Model with mathematics. *(K-2-ETS1-1),(K-2-ETS1-3)*
**MP.5** Use appropriate tools strategically. *(K-2-ETS1-1),(K-2-ETS1-3)*
**2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. *(K-2-ETS1-1),(K-2-ETS1-3)*

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# New York State P-12 Science Learning Standards

## 3-5. Engineering Design

Students who demonstrate understanding can:

**3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

**3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

**3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

### Science and Engineering Practices

**Asking Questions and Defining Problems**
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

**Planning and Carrying Out Investigations**
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

**Constructing Explanations and Designing Solutions**
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

### Disciplinary Core Ideas

**ETS1.A: Defining and Delimiting Engineering Problems**

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

**ETS1.B: Developing Possible Solutions**

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

**ETS1.C: Optimizing the Design Solution**

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

### Crosscutting Concepts

**Influence of Science, Engineering, and Technology on Society and the Natural World**

- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

*Connections to 3-5-ETS1.A: Defining and Delimiting Engineering Problems include:*
**Fourth Grade:** 4-PS3-4
*Connections to 3-5-ETS1.B: Designing Solutions to Engineering Problems include:*
**Fourth Grade:** 4-ESS3-2
*Connections to 3-5-ETS1.C: Optimizing the Design Solution include:*
**Fourth Grade:** 4-PS4-3

*Articulation of DCIs across grade-bands:* **K-2.ETS1.A** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **K-2.ETS1.B** (3-5-ETS1-2); **K-2.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.A** (3-5-ETS1-1); **MS.ETS1.B** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3)

*Common Core State Standards Connections:*
*ELA/Literacy –*
**RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(3-5-ETS1-2)*
**RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(3-5-ETS1-2)*
**RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
**W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
**W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-1),(3-5-ETS1-3)*
**W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-1),(3-5-ETS1-3)*
*Mathematics –*
**MP.2** Reason abstractly and quantitatively. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
**MP.4** Model with mathematics. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
**MP.5** Use appropriate tools strategically. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
**3-5.OA** Operations and Algebraic Thinking *(3-5-ETS1-1),(3-5-ETS1-2)*

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# New York State P-12 Science Learning Standards

## MS. Engineering Design

Students who demonstrate understanding can:

**MS-ETS1-1.** **Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**

**MS-ETS1-2.** **Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**

**MS-ETS1-3.** **Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**

**MS-ETS1-4.** **Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

### Science and Engineering Practices

**Asking Questions and Defining Problems**
Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

**Developing and Using Models**
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

**Analyzing and Interpreting Data**
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)

**Engaging in Argument from Evidence**
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

### Disciplinary Core Ideas

**ETS1.A: Defining and Delimiting Engineering Problems**
- 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 are likely to limit possible solutions. (MS-ETS1-1)

**ETS1.B: Developing Possible Solutions**
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)

**ETS1.C: Optimizing the Design Solution**
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

### Crosscutting Concepts

**Influence of Science, Engineering, and Technology on Society and the Natural World**
- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

*Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:*
**Physical Science:** MS-PS3-3
*Connections to MS-ETS1.B: Developing Possible Solutions Problems include:*
**Physical Science:** MS-PS1-6, MS-PS3-3, **Life Science:** MS-LS2-5
*Connections to MS-ETS1.C: Optimizing the Design Solution include:*
**Physical Science**: MS-PS1-6

*Articulation of DCIs across grade-bands:* **3-5.ETS1.A** (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3); **3-5.ETS1.B** (MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); **3-5.ETS1.C** (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); **HS.ETS1.A** (MS-ETS1-1),(MS-ETS1-2); **HS.ETS1.B** (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); **HS.ETS1.C** (MS-ETS1-3),(MS-ETS1-4)

*Common Core State Standards Connections:*
*ELA/Literacy –*

**RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1),*(MS-ETS1-2),(MS-ETS1-3)*

**RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (*MS-ETS1-3)*

**RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2),(MS-ETS1-3)

**WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)

**WHST.6-8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)

**WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. *(MS-ETS1-2)*

**SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ETS1-4)*

*Mathematics –*

**MP.2** Reason abstractly and quantitatively. *(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4)*

**7.EE.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)*

**7.SP** Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. *(MS-ETS1-4)*

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New York City

# PK–8

# Science Scope & Sequence 2018

NYC Department of Education
*Carmen Fariña, Chancellor*

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