DoDEA College and Career Ready Standards for Science

CCRSS Grade Four

COLLEGE AND CAREER READY

A WORLD-CLASS EDUCATION FOR MILITARY-CONNECTED STUDENTS

dodea

DEPARTMENT OF DEFENSE EDUCATION ACTIVITY

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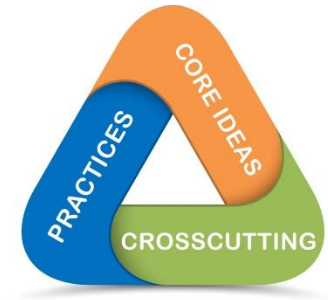
Introduction

The goals for science education in DoDEA are that all students will become critical consumers of scientific information related to their everyday lives and they will be prepared to pursue careers in science and engineering. Students' science education experience will be the foundation for continuing to learn about science throughout their lives as science helps to advance our understanding of the world.



The vision for science education is that students will be actively engaged in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of core ideas in science and engineering. This creates a three dimensional learning experience of Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts. Through their science educational experiences, students will actively engage in the scientific and engineering practices and apply the crosscutting concepts to deepen their understanding of the core ideas. The learning experience will engage students in investigating phenomena and solving problems through the use of the engineering design process (NGSS Executive Summary, 2013).

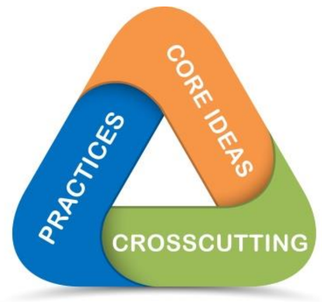
Students in kindergarten through fifth grade begin to develop an understanding of the four disciplinary core areas:

- Physical sciences;
- Life sciences;
- Earth and space sciences; and
- Engineering, technology, and applications of science.

In the earlier grades, students begin by recognizing patterns and formulating answers to questions about the world around them. By the end of fifth grade, students are able to demonstrate grade-appropriate proficiency in gathering, describing, and using information about the natural and designed world(s).

The performance expectations in elementary school grade bands develop ideas and skills that will allow students to explain more complex phenomena in the four disciplines as they progress to middle school and high school. While the performance expectations shown in kindergarten through fifth grade couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations (NGSS Executive Summary, 2013).

Three Dimensional Learning



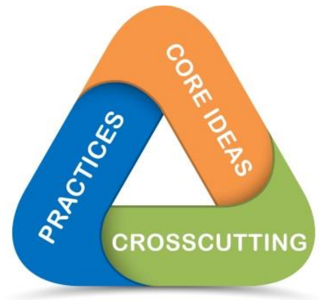
The National Research Council's (NRC) *A Framework for K-12 Science Education* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents the following three dimensions: practices, crosscutting concepts, and disciplinary core ideas (DCIs) that will be combined to form each standard:

DIMENSION 1: PRACTICES	The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires. Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.
DIMENSION 2: CROSSCUTTING CONCEPTS	Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change. The NRC Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.
DIMENSION 3: DISCIPLINARY CORE IDEAS (DCIs)	Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four: ▪ Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline; ▪ Provide a key tool for understanding or investigating more complex ideas and solving problems; ▪ Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge; ▪ Be teachable and learnable over multiple grades at increasing levels of depth and sophistication. Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

How To Read The Standards

Performance Expectation

The DoDEA College and Career Ready Standards for Science (CCRSS) are written as a set of performance expectations that are assessable statements of what students should know and be able to do. An underlying assumption of these standards is that all students should be held accountable for demonstrating their achievement of all performance expectations. A coherent and complete view of what students should be able to do comes when the performance expectations are viewed in tandem with the contents of the foundation boxes that lie just below the performance expectations. These three boxes include the practices, disciplinary core ideas, and crosscutting concepts, derived from the National Research Council's Framework for K12 Science Education that were used to construct this set of performance expectations.



Science and Engineering Practices (SEPs)	Disciplinary Core Ideas (DCIs)	Crosscutting Concepts (CCCs)
The blue box on the left includes the science and engineering practices used to construct the performance expectations in the box above. These statements are derived from and grouped by the eight categories detailed in the NRC Framework to further explain the science and engineering practices important to emphasize in each grade band. Most sets of performance expectations emphasize only a few of the practice categories; however, all practices are emphasized within a grade band.	The orange box in the middle includes statements that are taken from the NRC Framework about the most essential ideas in the major science disciplines that all students should understand during 13 years of school. Including these detailed statements was very helpful to the writing team as they analyzed and "unpacked" the disciplinary core ideas and sub-ideas to reach a level that is helpful in describing what each student should understand about each sub-idea at the end of grades 2, 5, 8, and 12. Although they appear in paragraph form in the NRC Framework, here they are bulleted to be certain that each statement is distinct.	The green box on the right includes statements derived from the NRC Framework's list of crosscutting concepts, which apply to one or more of the performance expectations in the box above. Most sets of performance expectations limit the number of crosscutting concepts so as focus on those that are readily apparent when considering the DCIs; however, all are emphasized within a grade band. Aspects of the Nature of Science relevant to the standard are also listed in this box, as are the interdependence of science and engineering, and the influence of engineering, technology, and science on society and the natural world.

CONNECTION BOXES

Three Connection Boxes are designed to support a coherent vision of the standards by showing how the performance expectations in each standard connect to other performance expectations in science, as well as to the DoDEA College and Career Ready Standards for English/Language Arts (CCRSL) and Mathematics (CCRSM).

The three boxes include:

Connections to other DCIs in this grade level or band. This box contains the names of science topics in other disciplines that have related disciplinary core ideas at the same grade level. For example, both Physical Science and Life Science performance expectations contain core ideas related to photosynthesis, and could be taught in relation to one another

Articulation of DCIs across grade levels. This box contains the names of other science topics that either:
1) provide a foundation for student understanding of the core ideas in this set of performance expectations (usually at prior grade levels) or
2) build on the foundation provided by the core ideas in this set of performance expectations (usually at subsequent grade levels).

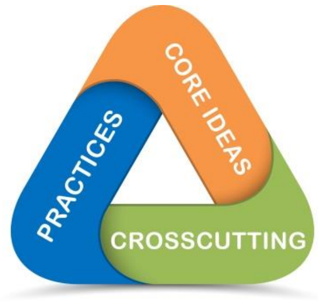
DoDEA College and Career Ready Standards
This box contains the connections to ELA/Literacy (CCRSL) and Mathematics (CCRSM) as shown below.

ELA/Literacy (CCRSL) Connections	
SCIENCE	ELA/LITERACY
Performance Expectation	Standard Connection

Mathematics (CCRSM) Connections	
SCIENCE	MATHEMATICS
Performance Expectation	Standard Connection

Elementary Introduction

Students in kindergarten through fifth grade begin to develop an understanding of the four disciplinary core ideas: physical sciences; life sciences; earth and space sciences; and engineering, technology, and applications of science. In the earlier grades, students begin by recognizing patterns and formulating answers to questions about the world around them. By the end of fifth grade, students are able to demonstrate grade-appropriate proficiency in gathering, describing, and using information about the natural and designed world(s). The performance expectations in elementary school grade bands develop ideas and skills that will allow students to explain more complex phenomena in the four disciplines as they progress to middle school and high school. While the performance expectations shown in kindergarten through fifth grade couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.



Physical Sciences	Earth & Space Sciences	Life Sciences	Engineering, Technology, & Applications of Sciences

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Fourth Grade Storyline

The performance expectations in fourth grade help students formulate answers to questions such as: "What are waves and what are some things they can do? How can water, ice, wind and vegetation change the land? What patterns of Earth's features can be determined with the use of maps? How do internal and external structures support the survival, growth, behavior, and reproduction of plants and animals? What is energy and how is it related to motion? How is energy transferred? How can energy be used to solve a problem?" Fourth grade performance expectations include PS3, PS4, LS1, ESS1, ESS2, ESS3, and ETS1 Disciplinary Core Ideas from the *NRC Framework*. Students are able to use a model of waves to describe patterns of waves in terms of amplitude and wavelength, and that waves can cause objects to move. Students are expected to develop understanding of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans. In order to describe patterns of Earth's features, students analyze and interpret data from maps. Fourth graders are expected to develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, they describe that an object can be seen when light reflected from its surface enters the eye. Students are able to use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object. Students are expected to develop an understanding that energy can be transferred from place to place by sound, light, heat, and electric currents or from object to object through collisions. They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another. The crosscutting concepts of patterns; cause and effect; energy and matter; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the fourth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.

4. Energy

4. Energy

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-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
[Assessment Boundary: Assessment does not include quantitative measurements 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.]

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 motion energy of a vehicle, light, or sound; 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-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 energy, 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.]

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 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 and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) **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. ▪ Make observations to produce data to serve as the basis for evidence for an explanation of a	**PS3.A: Definitions of Energy** ▪ The faster a given object is moving, the more energy it possesses. (4- PS3-1) ▪ Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2), (4-PS3-3) **PS3.B: Conservation of Energy and Energy Transfer** ▪ 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), (4-PS3-3)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1) **Energy and Matter** ▪ Energy can be transferred in various ways and between objects. (4-PS3-1), (4- PS3-2), (4-PS3-3), (4-PS3-4)

phenomenon or test a design solution. (4-PS3-2) **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. ▪ Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) ▪ Apply scientific ideas to solve design problems. (4-PS3-4) **Obtaining, Evaluating, & 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)	▪ Light also transfers energy from place to place. (4-PS3-2) ▪ Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4- PS3-4) **PS3.C: Relationship Between Energy and Forces** ▪ When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) **PS3.D: Energy in Chemical Processes & Everyday Life** ▪ The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) **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) **ETS1.A: Defining 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. (secondary to 4-PS3-4)	-- **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. (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. (4-PS3-4) -- **Connections to Nature of Science** **Science is a Human Endeavor** ▪ Most scientists and engineers work in teams. (4-PS3-4) ▪ Science affects everyday life. (4-PS3-4)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.

Connections

CONNECTIONS
Connections to other DCIs in fourth grade: N/A
Articulation of DCIs across grade-levels: K.PS2.B (4-PS3-3); K.ETS1.A (4-PS3-4); 2.ETS1.B (4-PS3-4); 3.PS2.A (4-PS3-3); 5.PS3.D (4-PS3-4); 5.LS1.C (4-PS3-4); 5.ESS3.C (4-ESS3-1); MS.PS2.A (4-PS3-3); MS.PS2.B (4-PS3-2); MS.PS3.A (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4); MS.PS3.B (4-PS3-2), (4-PS3-3), (4-PS3-4); MS.PS3.C (4-PS3-3); MS.PS3.D (4- ESS3-1); MS.PS4.B (4-PS3-2); MS.ESS2.A (4-ESS3-1); MS.ESS3.A (4-ESS3-1); MS.ESS3.C (4-ESS3-1); MS.ESS3.D (4-ESS3-1); MS.ETS1.B (4-PS3-4); MS.ETS1.C (4-PS3-4)

DODEA COLLEGE AND CAREER READY STANDARDS

ELA/Literacy (CCRSL) Connections

SCIENCE	ELA/LITERACY
(4-PS3-1)	**RI.4.1:** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
(4-PS3-1)	**RI.4.3:** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
(4-PS3-1)	**RI.4.9:** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.
(4-PS3-1)	**W.4.2:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
(4-PS3-2) (4-PS3-3) (4-PS3-4) (4-ESS3-1)	**W.4.7:** Conduct short research projects that build knowledge through investigation of different aspects of a topic.
(4-PS3-1) (4-PS3-2) (4-PS3-3) (4-PS3-4) (4-ESS3-1)	**W.4.8:** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
(4-PS3-1) (4-ESS3-1)	W.**4.9:** Draw evidence from literary or informational texts to support analysis, reflection, and research.

Mathematics (CCRSM) Connections	
SCIENCE	MATHEMATICS
(4-ESS3-1)	**MP.2:** Reason abstractly and quantitatively.
(4-ESS3-1)	**MP.4:** Model with mathematics.
(4-ESS3-1)	**4.OA.1:** Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.
(4-PS3-4)	**4.OA.3:** Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

4. Waves: Waves and Information

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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-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:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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) **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-PS4-3) -- **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science findings are based on recognizing patterns. (4- PS4-1)	**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) **PS4.C: Information Technologies & Instrumentation** ▪ 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) **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. (secondary to 4-PS4-3)	**Patterns** ▪ Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1) ▪ Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3) -- **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-PS4-3)

Connections

CONNECTIONS
Connections to other DCIs in fourth grade: 4.PS3.A (4-PS4-1); 4.PS3.B (4-PS4-1); 4.ETS1.A (4-PS4-3)
Articulation of DCIs across grade-levels: K.ETS1.A (4-PS4-3); 1.PS4.C (4-PS4-3); 2.ETS1.B (4-PS4-3); 2.ETS1.C (4-PS4-3); 3.PS2.A (4-PS4-3); MS.PS4.A (4-PS4-1); MS.PS4.C (4-PS4-3); MS.ETS1.B (4-PS4-3)

DODEA COLLEGE AND CAREER READY STANDARDS

ELA/Literacy (CCRSL) Connections	
SCIENCE	ELA/LITERACY
(4-PS4-3)	**RI.4.1:** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
(4-PS4-3)	**RI.4.9:** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.
(4-PS4-1)	**SL.4.5:** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.

Mathematics (CCRSM) Connections	
SCIENCE	MATHEMATICS
(4-PS4-1)	**MP.4:** Model with mathematics.
(4-PS4-1)	**4.G.1:** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.

4. Earth's Systems: Processes that Shape the Earth

4. Earth's Systems: Processes that Shape the Earth

Students who demonstrate understanding can:

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; 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, 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.]

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-ESS3-2. 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.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

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 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. ▪ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1) **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)	**ESS1.C: The History of Planet Earth** ▪ 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) **ESS2.A: Earth Materials and Systems** ▪ 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) **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	**Patterns** ▪ Patterns can be used as evidence to support an explanation. (4-ESS1-1), (4- ESS2-2) Cause and Effect ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1), (4-ESS3-2)

Constructing Explanations & 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. ▪ Identify the evidence that supports particular points in an explanation. (4-ESS1-1) ▪ 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)	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) **ESS2.E: Biogeology** ▪ Living things affect the physical characteristics of their regions. (4- ESS2-1) **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.) **ETS1.B: Designing Solutions to Engineering Problems** ▪ Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)	-- **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2) -- **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes consistent patterns in natural systems. (4-ESS1-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.

Connections

CONNECTIONS
Connections to other DCIs in fourth grade: 4.ETS1.C (4-ESS3-2)
Articulation of DCIs across grade-levels: K.ETS1.A (4-ESS3-2); 2.ESS1.C (4-ESS1-1), (4-ESS2-1); 2.ESS2.A (4-ESS2-1); 2.ESS2.B (4-ESS2-2); 2.ESS2.C (4-ESS2-2); 2.ETS1.B (4- ESS3-2); 2.ETS1.C (4-ESS3-2); 3.LS4.A (4-ESS1-1); 5.ESS2.A (4-ESS2-1); 5.ESS2.C (4-ESS2-2); MS.LS4.A (4-ESS1-1); MS.ESS1.C (4-ESS1-1), (4-ESS2-2); MS.ESS2.A (4-ESS1-1), (4-ESS2-2), (4-ESS3-2); MS.ESS2.B (4-ESS1-1), (4-ESS2-2); MS.ESS3.B (4-ESS3-2); MS.ETS1.B (4-ESS3-2)

DODEA COLLEGE AND CAREER READY STANDARDS

ELA/Literacy (CCRSL) Connections	
SCIENCE	ELA/LITERACY
(4-ESS3-2)	**RI.4.1:** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
(4-ESS2-2)	**RI.4.7:** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
(4-ESS3-2)	**RI.4.9:** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.
(4-ESS1-1) (4-ESS2-1)	**W.4.7:** Conduct short research projects that build knowledge through investigation of different aspects of a topic.
(4-ESS1-1) (4-ESS2-1)	**W.4.8:** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
(4-ESS1-1)	**W.4.9:** Draw evidence from literary or informational texts to support analysis, reflection, and research.

Mathematics (CCRSM) Connections	
SCIENCE	MATHEMATICS
(4-ESS1-1) (4-ESS2-1) (4-ESS3-2)	**MP.2:** Reason abstractly and quantitatively.
(4-ESS1-1) (4-ESS2-1) (4-ESS3-2)	**MP.4:** Model with mathematics.
(4-ESS2-1)	**MP.5:** Use appropriate tools strategically.
(4-ESS1-1) (4-ESS2-1)	**4.MD.1:** Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.
(4-ESS2-1) (4-ESS2-2)	**4.MD.2:** Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
(4-ESS3-2)	**4.OA.1:** Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.

4. Structure, Function, and Information Processing

4. Structure, Function, and Information Processing

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:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (4-PS4-2) ▪ Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2) **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). ▪ Construct an argument with evidence, data, and/or a model. (4-LS1-1)	**PS4.B: Electromagnetic Radiation** ▪ An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2) **LS1.A: Structure and Function** ▪ Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) **LS1.D: Information Processing** ▪ 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** ▪ Cause and effect relationships are routinely identified. (4-PS4-2) **Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (4- LS1-1), (LS1-2)

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Connections

CONNECTIONS
Connections to other DCIs in fourth grade: N/A
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)

DODEA COLLEGE AND CAREER READY STANDARDS

ELA/Literacy (CCRSL) Connections

SCIENCE	ELA/LITERACY
(4-LS1-1)	**W.4.1:** Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
(4-PS4-2) (4-LS1-2)	**SL.4.5:** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.

Mathematics (CCRSM) Connections

SCIENCE	MATHEMATICS
(4-PS4-2)	**MP.4:** Model with mathematics.
(4-PS4-2)	**4.G.1:** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
(4-LS1-1)	**4.G.3:** Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded across the line into matching parts. Identify line- symmetric figures and draw lines of symmetry.

3-5. Engineering Design

<table>
<tr><th colspan="3">3-5. Engineering Design</th></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</td></tr>
<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th></tr>
<tr><td>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)</td><td>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</td><td>Influence of Engineering, Technology, and Science 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)</td></tr>
</table>

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)	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)	

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Connections

CONNECTIONS
Connections to other DCIs in fifth grade: N/A
Articulation of DCIs across grade-levels: **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)

DODEA COLLEGE AND CAREER READY STANDARDS

ELA/Literacy (CCRSL) Connections

SCIENCE	ELA/LITERACY
(3-5-ETS1-2)	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-ETS1-1) (3-5-ETS1-3)	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.

Mathematics (CCRSM) Connections	
SCIENCE	**MATHEMATICS**
(3-5-ETS1-1) (3-5-ETS1-2) (3-5-ETS1-3)	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.OA Operations and Algebraic Thinking

Acronyms

List of Common Acronyms used by DoDEA College and Career Ready Standards for Science (CCRSS).

AAAS:	American Association for the Advancement of Science
AYP:	Annual Yearly Progress
BF:	Building Functions (CCRSM Connection)
CC:	Counting & Cardinality (CCRSM Connection)
CED:	Creating Equations (CCRSM Connection)
CR:	Chemical Reactions (Topic Name)
CCR:	College and Career Ready
CCRSL:	College and Career Ready Standards for ELA/Literacy (CCRSL Connection)
CCRSM:	College and Career Ready Standards for ELA/Literacy (CCRSM Connection)
CCC:	Crosscutting Concept
DCI:	Disciplinary Core Idea
ELL:	English Language Learner
E:	Energy (Topic Name)
EE:	Expressions & Equations (CCRSM Connection)
ELA:	English Language Arts
ED:	Engineering Design (Topic Name)
ES:	Earth’s Systems (Topic Name)
ESEA:	Elementary and Secondary Education Act
ESS:	Earth and Space Science
ETS:	Engineering, Technology, and Applications of Science
F:	Functions (CCRSM Connection)
FI:	Forces and Interactions (Topic Name)
FB:	Foundation Box
G:	Geometry (CCRSM Connection)
GBE:	Grade Band Endpoint
GDRO:	Growth, Development, and Reproduction of Organisms (Topic Name)
HI:	Human Impacts (Topic Name)
HS:	High School
ID:	Interpret Data (CCRSM Connection)
IDEA:	Individuals with Disabilities Education Act
IEP:	Individualized Education Program
IF:	Interpreting Functions (CCRSM Connection)

IRE:	Interdependent Relationships in Ecosystems (Topic Name)
IVT:	Inheritance and Variation of Traits (Topic Name)
K:	Kindergarten
LEP:	Limited English Proficiency
LS:	Life Science
MD:	Measurement & Data (CCRSM Connection)
MEOE:	Matter and Energy in Organisms and Ecosystems (Topic Name)
MP:	Math Practice-Standard of Mathematical Practice (CCRSM Connection)
MS:	Middle School
NAEP:	National Assessment of Educational Progress
NAGC:	National Association for Gifted Children
NBT:	Number & Operations in Base Ten (CCRSM Connection)
NCLB:	No Child Left Behind Act
NF:	Number & Operations— Fractions (CCRSM Connection)
NGSS:	Next Generation Science Standards
NOS:	Nature of Science
NSTA:	National Science Teachers Association
NRC:	National Research Council
NS:	The Number System (CCRSM Connection)
NSA:	Natural Selection and Adaptations (Topic Name)
NSE:	Natural Selection and Evolution (Topic Name)
NSF:	National Science Foundation
OA:	Operations & Algebraic Thinking (CCRSM Connection)
PE:	Performance Expectation
PISA:	Program for International Student Assessment
PS:	Physical Sciences
Q:	Quantities (CCRSM Connection)
RI:	Reading Informational Text (CCRSL Connection)
RL:	Reading Literature (CCRSL Connection)
RP:	Ratios and Proportional Relationships (CCRSM Connection)
RST:	Reading in Science & Technical Subjects (CCRSL Connection)
SEP:	Science and Engineering Practices
SF:	Structure and Function (Topic Name)
SFIP:	Structure, Function, and Information Processing (Topic Name)
SL:	Speaking & Listening (CCRSL Connection)

SP:	Statistics & Probability (CCRSM Connection)
SPM:	Structures and Properties of Matter (Topic Name)
SS:	Space Systems (Topic Name)
SSE:	Seeing Structure in Expressions (CCRSM Connection)
STEM:	Science, Technology, Engineering, and Mathematics
STS:	Science, Technology, and Society
TELA:	Technology and Engineering Literacy Assessment
TIMSS:	Trends in International Mathematics and Science Study
W:	Waves (Topic Name)
W:	Writing (CCRSL Connection)
WHST:	Writing in History/Social Studies, Science, & Technical Subjects (CCRSL Connection)
WC:	Weather and Climate (Topic Name)
WER:	Waves and Electromagnetic Radiation (Topic Name)

CCRSS Appendices

	Appendices	Description
A.	Conceptual Shifts	Appendix A addresses the seven conceptual shifts that science educators and stakeholders need to make to effectively use the College and Career Ready Standards for Science.
B.	Responses to Public Drafts	Appendix B shows the results of public feedback and the responses to the standards.
C.	College and Career Readiness	Appendix C describes how the vision for K-12 science education and the content of the standards will properly prepare students for their college and careers.
D.	All Standards, All Students: Case Studies	Appendix D emphasizes that these standards require instructional shifts to enable all students to meet the requirements for college and career readiness and highlights implementation strategies.
E.	Disciplinary Core Idea Progressions	Appendix E presents the DCI learning progressions which demonstrate how each disciplinary core idea develops across the grade bands to ensure students achieve the depth of understanding expected before leaving high school.
F.	Science and Engineering Practices	Appendix F presents the eight Science and Engineering Practices. These mirror the practices of professional scientists and engineers. The SEP progressions illustrate how the SEPs are developed throughout students' K-12 science education.
G.	Crosscutting Concepts	Appendix G presents the seven Crosscutting Concepts. These crosscutting concepts give students an organizational structure to understand the world and help students make sense of and connect DCIs across disciplines and grade bands. The CCC progressions illustrate how the CCC are developed throughout students' K-12 science education.
H.	Nature of Science	Appendix H presents the eight basic understandings about the nature of science. This appendix explains the perspectives, rationale, and research supporting the importance of nature of science in the standards.
I.	Engineering Design in the NGSS	Appendix I describes engineering design and the way it allows students to engage in and aspire to solve major societal and environmental challenges they will face in the decades ahead.
J.	Science, Technology, Society, and the Environment	Appendix J describes the importance of students learning about the relationship between science, technology, society, and the environment.
K.	Model Course Mapping in Middle and High School	Appendix K supports school systems in their decision-making about how to organize science courses to address the MS and HS science standards to prepare students for post-secondary success.
L.	Connections to CCSS-Mathematics	Appendix L highlights the relationship between mathematics and science.
M.	Connections to CCSS-Literacy in Science and Technical Subjects	Appendix M highlights the relationship between literacy and science.

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