Recommendations to the Pennsylvania State Board of Education from the *Science Standards Content Committee and Steering Committee*

Pennsylvania Integrated Standards for Science, Environment, Ecology and Technology (Grades K–5)

Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)

Pennsylvania Technology and Engineering Standards (Grades 6–12)

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Contents

Introduction

The Science Standards Content Committee and Steering Committee reviewed and formulated recommendations on the stakeholder concerns identified by the State Board of Education memo titled: Next Steps on Proposed Amendments to 22 Pa. Code Chapter 4 (Regulation #6-347). The Science Standards Content Committee and Steering Committee either developed additional language to supplement or amend the proposed new standards adopted by the Board in Regulation #6-347 or determined that further amendments to the proposed rulemaking were not warranted, provide a rationale as to why other amendments are unnecessary. This report outlines the Recommendations developed by the Science Standards Content Committee and Steering Committee and the process for developing recommendations. The report also includes a redlined version

Throughout October and November 2021, the Science Standards Content Committee working groups met over 20 times to collaboratively craft recommendations for the Steering Committee to review and provide feedback. The Science Standards Content Committee and Steering Committee met, jointly, five times to review and approve the Content Committee's draft recommendations to the State Board of Education's charges. The committees used over 65 separate resources and research documents to guide the development of the recommendations and proposed revisions to the standards.

Process for Developing Responses to SBE Charge to the Committees

American Institutes for Research has a decade-strong foundation in facilitating standards review, revision, and implementation. AIR's extensive knowledge and work in these three areas incorporate research and evidence-based practices throughout the process to facilitate and guide the standards review, revision, and implementation from an unbiased approach. AIR's work in updating academic standards in science, engineering, technology, environment, and ecology is conducted in collaboration with state leaders and through stakeholder engagement, grounded in research and evidence, and focused on equity.

Before any recommendation could appear in this report, it underwent a rigorous process for development and approval by the Science Standards Content Committee and Steering Committee. The Content Committee first discussed and drafted recommendations, then voted on whether to approve or refine each draft recommendation. This process was iterative and centered on collaborative dialogue, building understanding, and consensus. Once there was consensus, the Content Committee shared their recommendations with the Steering

Committee. The Steering Committee either approved each recommendation or provided feedback to refine it. Then, the Content Committee reviewed the steering committee's feedback and voted to Approve, Refine, or Reject.

Since there were members of the Science Standards Content Committee and Steering Committee who were not able to attend the meetings or contribute this fall, the following recommendations were sent out to all committee members through a Google form for feedback and/or approval at two different time points (November 5 – 8, 2021 and November 22 – 24, 2021). To build consensus, all committee members received the Google form to review the proposed recommendations and share feedback on each one. For questions that did not receive consensus, both committees reconvened to address outstanding concerns and create new responses through the same consensus-building process.

The following recommendations represent consensus from the Science Standards Content Committee and Steering Committee.

Steering and Content Committee Recommendations

The Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering Content and Steering Committees present the following recommendations, collaboratively written to the State Board of Education.

1. ***Charge: Ensure that the proposed new standards incorporate the following essential principles of environmental education:***
    a. Systems Thinking recognizes the complexity of our natural world and reinforces the interconnectivity between nature and our physical, chemical, and biological processes.
    b. Human Health reinforces the inextricable connection between a healthy earth and the sustainability of people-made systems (including social, economic, political, cultural) and technology.
    c. Diversity, Equity, and Inclusion underscores the need for an inclusive, respectful and equitable approach to environmental education that embraces different cultural backgrounds and experiences.
    d. Direct Experience ensures that students have direct connections with nature. These experiences, which foster critical cognitive skills and an appreciation of natural systems, are particularly meaningful when they relate to their communities and surroundings.

e. Expand environmental science and ecology principles across disciplines to enrich cross-curricular connections and reinforces the strong links between environmental education and the sciences and humanities.
f. Critical and Creative Thinking are imperative for active and meaningful learning, instilling lifelong skills that rely on observation, analysis, inference, and communication.
g. Sustainability reinforces the interrelationship between the needs of society and the natural resources and services that support society. It is essential that students understand environmental, social, and economic responsibility and the role each of us play in shaping the future of our planet.

Recommendation: The committee proposes a fifth domain, "Environmental Literacy and Sustainability" (ELS), that incorporates the essential principles of environmental education (labelled a–g per charge #1) into three core ideas: ELS.1 Agricultural and Environmental Systems and Resources; ELS.2 Environmental Literacy Skills; and ELS.3 Sustainability and Stewardship. The decision to create a fifth domain is also supported by the Pennsylvania Environmental Education Act of 1993, which states to fully integrate environmental education into K–12 education and address the committees' charge. Furthermore, the new Environmental Literacy and Sustainability standards domain will be three-dimensional, as described in A Framework for K–12 Science Education (NRC, 2012), and aligned with K–12 and the other proposed PDE standards. In drafting the ELS Domain, the committee utilized standards and guidelines from relevant professional organizations, including the National Council for Agriculture, Food, & Natural Resources (AFNR) and the North American Association of Environmental Educators (NAAEE). We also referenced existing PA Environment and Ecology standards, environmental education research, and examples from other states that addressed similar gaps in environmental literacy and sustainability, including California, Louisiana, Maryland, Virginia, Washington, and Wisconsin.

2. Charge: As it pertains to the proposed Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12), include content related to the following either through the addition of a fifth domain within the proposed standards or through an alternative construct:

a. Watersheds and Wetlands – Cycles, Roles of Watersheds, Physical Factors, Characteristics and Functions of Wetlands, Impacts of Watersheds and Wetlands
b. Renewable and Nonrenewable Resources – Uses, Influential Factors
c. Environmental Health – Biological Diversity
d. Agriculture and Society – Society Needs, Agriculture Science, Agriculture Systems, Technology

e. Integrated Pest Management – Effects Benefits an Impacts, Health Risks, Management Practices
f. Ecosystems and their Interactions – Change Over Time
g. Threatened, Endangered, and Extinct Species – Management Strategies
h. Humans and the Environment – Society Needs, Sustainability, Supply and Demand
i. Environmental Laws and Regulations – Environmental Laws and their Impacts

The North American Association for Environmental Education Guidelines for Excellence in the following areas:

a. Human Systems – Individuals Groups and Societies, Culture, Political Systems, Economic Systems
b. Decision-Making and Action Skills – Forming and Evaluating Personal Views, Evaluating Need for Action, Planning and Taking Action, Evaluating Results of Action
c. Personal and Civic Responsibility – Recognizing Rights and Responsibilities, Recognizing Efficacy and Developing Agency, Accepting Personal Responsibility

Recommendation: The committee proposes a fifth domain of standards, "Environmental Literacy and Sustainability" (ELS), that incorporates the essential principles of environmental education (labelled a–g as per charge #1) into three core ideas: ELS.1 Agricultural and Environmental Systems and Resources; ELS.2 Environmental Literacy Skills; and ELS.3 Sustainability and Stewardship. The committees conclude that this is the best way to comply with the Pennsylvania Environmental Education Act of 1993 to fully integrate environmental education into K–12 education and address the committee's charge. Furthermore, the new Environmental Literacy and Sustainability standards domain will be three-dimensional, as described in A Framework for K–12 Science Education (NRC, 2012), and aligned with K–12 and with the other previously proposed standards from September 2020. A gap analysis was performed (comparing the initially proposed Integrated Standards for Science, Environment, and Ecology 6–12 with the PA 2002 Environment & Ecology Standards and the 2019 NAAEE K–12 Environmental Education Guidelines for Excellence) to create the 5th domain, which addresses the concerns of charge #2. The content items of concern in the charge are included in the proposed standards (performance expectations) and will be included in the clarification statements, as well as the additional foundation boxes.

3. Charge: Consider whether the proposed new standards should include Pennsylvania's Environmental Rights Amendment set forth in Article 1, Section 27 of the state constitution.

Recommendation: The committee asserts that the intention of the standards is not to prescribe curriculum and that including the Pennsylvania's Environment Rights Amendment would fall under the scope of curriculum and could potentially impact the relevance of the standards over time. The committee recognizes the importance of Pennsylvania's Environmental Rights Amendment as well as other state-level statutes; therefore, the references to the statutes will be included in the Pennsylvania Context of the standards' Foundation Boxes. The Foundation Boxes provide clarification for how to interpret, teach, and assess the performance expectations in a way that reinforces the intent of the standards within the context of Pennsylvania.

4. Charge: Whether the proposed new standards should emphasize the major role that human activities play in causing the rise in global temperature, similar to how the Next Generation Science Standards add a clarifying statement in its related middle school standard on factors that have caused the rise in global temperatures over the past century to recognize that these factors include human activities.

Recommendation: The committee asserts that the intention of the standards is not to prescribe conclusions but to build students' capacity to engage in investigating issues, analyzing various scientific research and data, and developing informed conclusions. Focusing on the process will allow students to have multiple opportunities to investigate all major factors including natural processes, human and other activities, and potential solutions to those factors. However, the committee recognizes that when the proposed standards are adopted, the Department will make support available during this transition period to assist public school entities with the implementation of standards. Specifically, the Department will provide clarification for how to interpret, teach, and assess the performance expectations in a way that reinforces the intent of the standards. This information is communicated on the PDE FAQ (https://www.education.pa.gov/Teachers%20-%20Administrators/Curriculum/Science/Pages/Answers-to-FAQs.aspx) about the new standards.

5. Charge: Whether climate change should be more explicitly addressed in content at all grade levels and all scientific disciplines.

Recommendation: The committee acknowledges that standards include important foundational ideas in science, environment, and ecology, requiring students to learn deeply about several core ideas, including the disciplinary core ideas underlying climate change as laid out in the Framework for K–12 Science Education. The proposed performance expectations explicitly and implicitly address climate science at all grade levels. Because these core ideas

about climate science are critical, students revisit them throughout the years to build a deeper understanding.

6. Charge: Whether more detailed content related to agriculture should be required for students in kindergarten through grade 5.

Recommendation: The committee acknowledges that agriculture is an important aspect of Pennsylvania's economy. However, the committee asserts that there is existing evidence of agricultural concepts in the Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5) across the K–2 and 3–5 grade bands. Some examples include the following: Grade 1: Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. Grade 2: Plan and conduct an investigation to determine if plants need sunlight and water to grow. Grade 2: Make observations of plants and animals to compare the diversity of life in different habitats. Grade 3: 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. Grade 3: Make a claim supported by evidence 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. Grade 4: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. Grade 5: Support an argument that plants get the materials they need for growth chiefly from air and water. K–2: Categorize ways people harvest, re-distribute, and use natural resources.

7. Charge: Whether the proposed *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)* for Grades 6–8, Weather and Climate, that expects students to, "Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century" should be limited to looking at rising temperatures only of the last century and whether framing the standard to consider this time frame reflects confirmation bias.

Recommendation: The committee recommends the proposed standard text remain unchanged. The committee expects students to rely on all available scientific research to investigate the rise in global temperatures over the past century. Research includes that from the United States Global Change Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC) report, the American Geophysical Union (AGU), the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS).

***8. Charge:* Whether the *proposed Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)* for Grades 6–8, Human Impacts, that expects students to, "Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects" reflects an assumption that man is causing temperature increase and that man can somehow create a system to mitigate our current climate and whether there are other causes of which students should be made aware.**

Recommendation: The committee asserts that the proposed standard should expect students to rely on current scientific research to analyze and interpret data on natural hazards (such as hurricanes, earthquakes, floods, and severe weather). This standard is consistent with the United States Global Change Research Program (USGCRP), the American Geophysical Union (AGU), and the Intergovernmental Panel on Climate Change (IPCC) report (https://www.ipcc.ch/report/ar6/wg1/). An example from the IPCC report text that pertains to this concern includes findings such as, "Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events."

***9. Charge:* Whether the proposed *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)* for Grades 6–8, Human Impacts, that expects students to, "Apply scientific principles to design a method for monitoring and minimizing human impact on the environment" ignores improvements over recent years in air and water cleanliness and that the Earth heals itself.**

Recommendation: The committee disagrees with the assumption that current advances will be ignored. The standard is written for students to "apply scientific principles to design a method" as the Science and Engineering Practice.

***10. Charge:* Whether the proposed *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)* for Grades 6–8, Human Impacts, that expects students to, "Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems" is more pertinent to politics and the unfair distribution of natural resources.**

Recommendation: The committee will add clarity to the standard through supporting documents that elaborate on the standards. The proposed standard includes a clarification statement in the foundation boxes.

Supporting documents will include language such as the following: Examples of evidence 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 can 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.

11. Charge: Whether the proposed *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)* for Grades 9–12, Weather and Climate, that expects students to, "Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate" is an attack on fossil fuels.

Recommendation: The committee disagrees with the assumption that this standard is an attack on the fossil fuel industry. The committee asserts that this standard encompasses all interactions and all energy flows into, out of, and among Earth's systems, including dynamic systems modeling, energy flow, thermodynamics, and system feedback loops.

12. Charge: Whether the proposed *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12)* for Grades 9–12, Earths Systems, that expects students to, "Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems" more appropriately belongs in social students [sic] due to a lack of scientific evidence that support the theory that man's activity is significantly changing temperatures or climate on Earth.

Recommendation: The committee asserts that this standard encompasses all interactions among Earth's systems, including dynamic systems modeling, thermodynamics, and system feedback loops.

13. Charge: Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Kindergarten, Earth's Systems, that expects students to, "Use observations of local weather conditions to describe patterns over time" should include students sharing with each other as a critical part of three-dimensional learning/communication.

Recommendation: The committee proposes that communication is part of three-dimensional learning and should be included in the standard. The committee proposes to change the

standard to read, “Use and share observations of local weather conditions to describe patterns over time.”

14. Charge: **Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Grade 3, Life Science – Ecosystems: Interactions, Energy and Dynamics that expects students to, “Construct an argument that some animals have physical and behavioral adaptations that help members survive” does not match the title of the section in which it is included, and whether the proposed standard already appears appropriately under the Grade 3 standard for Life Sciences – Biological Evolution: Unity and Diversity #2 that addresses evolutionary adaptations.**

Recommendation: The committee proposes to reword this standard to read, “Construct an argument that some animals form groups that help members survive.”

15. Charge: **Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Grade 3, Physical Science – Motion and Stability that expects students to, “Make and communicate observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion” asks students to complete two practices in one standard and, to reconcile this, communication should be removed from the proposed standard.**

Recommendation: The committee acknowledges that the science and engineering practices (SEPs) work together and agrees that the practices should not be treated as standalone, so while there may be foci practices, there can be multiple that are occurring. According to Bell et al. (2012), “the eight practices do not operate in isolation. Rather, they tend to unfold sequentially, and even overlap. For example, the practice of “asking questions” may lead to the practice of “modeling” or “planning and carrying out an investigation,” which in turn may lead to “analyzing and interpreting data.” The practice of “mathematical and computational thinking” may include some aspects of “analyzing and interpreting data.” Just as it is important for students to carry out each of the individual practices, it is important for them to see the connections among the eight practices” (Achieve, p. 3, Appendix F: Science and Engineering Practices NGSS) (See also, Bell, P., Bricker, L., Tzou, Carrie, Lee., T., and Van Horne, K. (2012) http://fspsscience.pbworks.com/w/file/fetch/67877369/Obtaining%20and%20Communicating%20Information.pdf. Exploring the science framework; Engaging learners in science practices related to obtaining, evaluating, and communicating information. Science Scope, 36(3), 18–22). [Available at: http://fspsscience.pbworks.com/w/file/fetch/67877369/Obtaining%20and%20Communicating%20Information.pdf]

16. Charge: **Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Grade 4, Physical Science – Energy that expects students to, "Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents" asks students to complete two practices in one standard and, to reconcile this, communication should be removed from the proposed standard.**

Recommendation: The committee acknowledges that the science and engineering practices (SEPs) work together and agrees that the practices should not be treated as standalone, so while there may be foci practices, there can be multiple that are occurring. According to Bell et al. (2012), "the eight practices do not operate in isolation. Rather, they tend to unfold sequentially, and even overlap. For example, the practice of "asking questions" may lead to the practice of "modeling" or "planning and carrying out an investigation," which in turn may lead to "analyzing and interpreting data." The practice of "mathematical and computational thinking" may include some aspects of "analyzing and interpreting data." Just as it is important for students to carry out each of the individual practices, it is important for them to see the connections among the eight practices" (Achieve, p. 3, Appendix F: Science and Engineering Practices NGSS) (See also, Bell, P., Bricker, L., Tzou, Carrie, Lee., T., and Van Horne, K. (2012) http://fspsscience.pbworks.com/w/file/fetch/67877369/Obtaining%20and%20Communicating%20Information.pdf. Exploring the science framework; Engaging learners in science practices related to obtaining, evaluating, and communicating information. Science Scope, 36(3), 18–22). [Available at: http://fspsscience.pbworks.com/w/file/fetch/67877369/Obtaining%20and%20Communicating%20Information.pdf]

17. Charge: **Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Grade 5, Earth and Space Sciences – Earth's Place in the Universe that expects students to, "Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth" should be rephrased to replace "compared to" with "and" to reflect the intention of the standard to focus on patterns more than just our star.**

Recommendation: The committee proposes keeping the standard as currently written because comparisons to the sun are appropriate in fifth grade according to the performance

expectations that were developed using elements from the NRC document A Framework for K-12 Science Education.

18. Charge: **Whether the proposed Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5) for Grade 5, Earth and Space Sciences – Earth and Human Activity that expects students to, "Generate and design possible solutions to a current environmental issue, threat, or concern" reflects an added proposed standard that is not written three-dimensionally, does not connect with the rest of the K–5 standards, and should be removed due to a lack of 3D, lack of clarity, addition of a standard without removing another, and lack of vertical coherence.**

Recommendation: The committee believes this standard is needed because it helps strengthen vertical coherence of existing proposed standards and the addition of the 5th domain in 6-12. The standard demonstrates 3-Dimensionality through the following: Cross Cutting Concepts (Stability and Change, Cause and Effect); Disciplinary Core Ideas (Human Impacts, Technology and Engineering); Science and Engineering Practices (Designing Solutions, Obtaining, Evaluating, and Communicating Information In terms of vertical coherence).

Furthermore, the committee recognizes that the terms "generate and design" can be encompassed within the engineering design process with appropriate clarification in the foundation box and PA context.

19. Charge: **Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Grade 5, Physical Science – Matter and Its Interactions that expects students to, "Make and communicate observations and measurements to identify materials based on their properties" asks students to complete two practices in one standard and, to reconcile this, communication should be removed from the proposed standard.**

Recommendation: The committee acknowledges that the science and engineering practices (SEPs) work together and agrees that the practices should not be treated as standalone, so while there may be foci practices, there can be multiple that are occurring. According to Bell et al. (2012), "the eight practices do not operate in isolation. Rather, they tend to unfold sequentially, and even overlap. For example, the practice of "asking questions" may lead to the practice of "modeling" or "planning and carrying out an investigation," which in turn may lead to "analyzing and interpreting data." The practice of "mathematical and computational thinking" may include some aspects of "analyzing and interpreting data." Just as it is important

for students to carry out each of the individual practices, it is important for them to see the connections among the eight practices" (Achieve, p. 3, Appendix F: Science and Engineering Practices NGSS) (See also, Bell, P., Bricker, L., Tzou, Carrie, Lee., T., and Van Horne, K. (2012) http://fspsscience.pbworks.com/w/file/fetch/67877369/Obtaining%20and%20Communicating%20Information.pdf. Exploring the science framework; Engaging learners in science practices related to obtaining, evaluating, and communicating information. Science Scope, 36(3), 18–22). [Available at: http://fspsscience.pbworks.com/w/file/fetch/67877369/Obtaining%20and%20Communicating%20Information.pdf]

20. Charge: Whether the proposed *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5)* for Grade 5, Physical Science – Matter and Its Interactions that expects students to, "Interpret and analyze data and observations to make decisions about how to utilize materials based on their properties" is not 3D, is similar to standard #3 within the same section, and should be removed due to a lack of 3D/clarity, the addition of a standard without removing another, a lack of coherence, and similarity to another standard.

Recommendation: The committee states that the additional standard is not redundant, but rather intended to build upon other standards. Standard PS1-3 focuses on identifying materials based on their properties, while PS1-5 focuses on the synthesizing skills, interpreting, and analyzing. Additionally, the committee proposes clarifying the standard by removing "and observations" so that the standard will read, "Interpret and analyze data to make decisions about how to utilize materials based on their properties."

21. Charge: Whether the proposed Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5) for Grades K–2 Environment and Ecology are too vague for teachers, not grade appropriate, not 3D, and more appropriately belong in social science standards.

Recommendation: The Environment and Ecology standards have been regrouped as the Environmental Literacy and Sustainability standards to vertically align K–12. Within these standards, the committee recognizes the need for 3D language and has addressed this through rewording Performance Expectations and ensuring that Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas were the foundation. Through this process, we have clarified any vague language for teachers. We addressed the grade-level appropriateness by assigning the Environmental Literacy and Sustainability standards to the K–2 or 3–5 grade band. The banding is informed by the bands in the NAAEE's K-12 Guidelines

for Excellence Standards. The foundation boxes will highlight relevant connections to the social sciences while ensuring that content is most relevant to Environmental Literacy and Sustainability.

22. Charge: Whether the proposed new standards include sufficient content on simple machines, compound machines, or mechanical advantage.

Recommendation: The committee asserts that the intention of the standards is not to prescribe curriculum, including simple machines, compound machines, or mechanical advantage, which fall under the scope of the curriculum.

23. Charge: Whether "Applied Science" should be added as a ninth crosscutting concept reflecting how applied, multidisciplinary, real-world projects can be used to show how core sciences work together.

Recommendation: The committee notes that "Applied Science" is included in the proposed standards as a separate set of standards for technology and engineering for grades 6–12 (The Pennsylvania Technology and Engineering Standards). In grades K–5, technology and engineering standards are incorporated in the proposed standards.

A. Charge: Why didn't PA just adopt NGSS wholesale?

Recommendation: The committee asserts that the Next Generation Science Standards (NGSS) were missing content, such as agriculture, watersheds, and wetlands, that was critical for Pennsylvanian students. The committee used the NRC Framework to inform the standard structure. The committee acknowledges that the NGSS are a great reference but asserts that they are not exactly what Pennsylvania wanted, as they do not reflect the uniqueness of the Pennsylvanian context.

B. Charge: Why integrated Technology and Engineering and Environment and Ecology in K–5?

Recommendation: The committee maintains that integrating all science, environment, ecology, technology, and engineering content into a single document makes the standards more accessible for elementary teachers when developing curricula that integrate related content. In addition, integrating science, environment, ecology, technology, and engineering in one of the standards encourages integrated teaching across these disciplines. It promotes equity by ensuring that environment, ecology, technology, and engineering are taught in science courses across grades K–5. The committee notes that Technology and Engineering, particularly at the K–

5 level, does not exist in silos (as it does in the upper levels), and it has historically been integrated.

C. *Charge:* Why grade level bands in K–5? Can curricular assets be created in this space?

Recommendation: The committee presented grade-specific standards in K–5 that allow for a clear learning progression in elementary school. Environmental Literacy and Sustainability along with Technology and Engineering are grade-banded to reflect the National Research Council (NRC) Framework structure for engineering, technology, and applications of science as well as the North American Association for Environmental Education Guidelines for Excellence.

The committee understands the need for a curriculum that supports the standards; however, in Pennsylvania, this alignment is left up to individual district discretion.

Modification to a Middle School Standard

The following context provides the rationale for the committee revising Middle School Life Science proposed standard which states: 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.

Rationale: The emphasis is on inferring general patterns of relatedness among structures of different organisms by comparing the appearance of diagrams or pictures. In addition, The Recapitulation Theory (Biogenetic Principle) is no longer scientifically valid. Furthermore, the standard was written in a way that overlapped with curricular decisions and the developmental appropriateness for younger middle-school students is questionable.

Recommendation: Revise the standard to read, “Analyze displays of pictorial data to compare patterns of similarities in the anatomical structures across multiple species of similar classification levels to identify relationships”.

Revisions to Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)

Standards by Grade Level

Kindergarten

Earth and Space Sciences

Earth and Human Activity

1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.
3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Earth's Systems

1. Use and share observations of local weather conditions to describe patterns over time.
2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

Life Science

From Molecules to Organisms: Structures and Processes

1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

Physical Science

Motion and Stability: Forces and Interactions

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.
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.

Energy

1. Make observations to determine the effect of sunlight on Earth's surface.
2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

Grade 1

Earth and Space Sciences

Earth's Place in the Universe

1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.
2. Make observations at different times of year to relate the amount of daylight to the time of year.

Life Science

From Molecules to Organisms: Structures and Processes

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

Heredity: Inheritance and Variation of Traits

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

Physical Science

Waves and Their Applications in Technologies for Information Transfer

1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.
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.
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.

Grade 2

Earth and Space Sciences

Earth's Place in the Universe

1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

Earth's Systems

1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.
3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

Life Science

Ecosystems: Interactions, Energy, and Dynamics

1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.
2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Biological Evolution: Unity and Diversity

1. Make observations of plants and animals to compare the diversity of life in different habitats.

Matter and its Interactions

1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
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.
4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Grade 3

Earth and Space Sciences

Earth's Systems

1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
2. Obtain and combine information to describe climates in different regions of the world.

Earth and Human Activity

1. Make a claim supported by evidence about the merit of a design solution that reduces the impacts of a weather-related hazard.

Life Science

From Molecules to Organisms: Structures and Processes

1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

Ecosystems: Interactions, Energy, and Dynamics

1. Construct an argument that some animals form groups ~~have physical and behavioral adaptations that~~help members survive.

Heredity: Inheritance and Variation of Traits

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.
2. Use evidence to support the explanation that traits can be influenced by the environment.

Biological Evolution: Unity and Diversity

1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
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.
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.
4. Make a claim supported by evidence 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.

Physical Science

Motion and Stability: Forces and Interactions

1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
2. Make and communicate observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
4. Define a simple design problem that can be solved by applying scientific ideas about magnets.

Grade 4

Earth and Space Sciences

Earth's Place in the Universe

1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Earth's Systems

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

Earth and Human Activity

1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Life Science

From Molecules to Organisms: Structures and Processes

1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
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.

Physical Science

Waves and Their Applications in Technologies for Information Transfer

1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
3. Generate and compare multiple solutions that use patterns to transfer information.

Energy

1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
2. Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grade 5

Earth and Space Sciences

Earth's Place in the Universe

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.
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.

Earth's Systems

1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Earth and Human Activity

1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

2. Generate and design possible solutions to a current environmental issue, threat, or concern.

Life Science

From Molecules to Organisms: Structures and Processes

1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Ecosystems: Interactions, Energy, and Dynamics

1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Physical Science

Matter and Its Interactions

1. Develop a model to describe that matter is made of particles too small to be seen.
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 weight of matter is conserved.
3. Make and communicate observations and measurements to identify materials based on their properties.
4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
5. Interpret and analyze data ~~and observations~~ to make decisions about how to utilize materials based on their properties.

Motion and Stability: Forces and Interactions

1. Support an argument that the gravitational force exerted by Earth on objects is directed down.

Energy

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.

Standards by Grade Band

Grades K-2: ~~Environment and Ecology~~ Environmental Literacy and Sustainability

Agriculture and Environmental Systems and Resources

~~1. Categorize ways people harvest, re-distribute, and use natural resources.~~

~~1. Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.~~

~~2.~~ Examine how people from different cultures and communities, including one's own, interact and express their beliefs about nature.

~~*1. . Examine and express their own views on environmental issues.*~~

1. ~~Determine whether action is needed on~~Construct an argument to support whether action is needed on a selected environmental issues and whether they should be involved. ~~They describe their reasoning.~~

3. ~~Develop an action strategy or design solution for a specific local environmental issue of their choosing.~~

2. ~~Identify~~ Make a claim about the environmental and social consequences of design solutions and civic actions,including their own actions.

~~*Personal and Civic Responsibility*~~ *Environmental Literacy Skills*

~~1. Describe their basic rights and responsibilities as members of a community and the importance of these rights and responsibilities in promoting environmental quality and community well-being.~~

~~2. Describe how they can realistically and meaningfully contribute to their community and environmental quality.~~

~~3. Identify ways in which they are responsible for the environmental and social effects of their actions.~~

1. Explain ways that places differ in their physical characteristics, their meaning, and their value and/or importance.

2. Plan and carry out an investigation to address an issue in their local environment and community.

~~1.~~

~~*Earth's Physical and Living Systems*~~

~~1. Describe characteristics of Earth's physical systems, including air, water, and land. They explain how these systems interact with one another and identify changes in the physical environment over time. They provide examples of how physical systems affect living organisms, including humans.~~

~~2.~~1. Analyze how ~~Identify basic similarities and differences among a wide variety of~~ living

organisms. They explain ways that living organisms, including humans, affect the environment in which they live, and how their environment affects them.

Human Systems

1. Generate examples of how people act, as individuals, as members of a group, and as members of society, toward the environment. They articulate their own beliefs and the beliefs of family and community members about the environment and environmental issues.

2.1. Identify ways thatExamine how from different cultures and communities, including one's own, interact and express beliefs about nature. people express different cultural backgrounds and how these caninfluence environmental perceptions and activities.

Environment and Society Sustainability and Stewardship

3. Identify Critique ways that people depend on and, change, and are affected by the environment.

1. Describe Categorize ways people harvest, re-distribute, and use natural resources.

1.4. Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.

5. Identify Explain ways that places differ in their physical and human characteristics, their meaning, and their value and/or importance.

3.2. Investigate how perspectives over the use of resources and the development of technology have changed over time and resulted in conflict over the development of societies and nations. Recognize that change is a normal part of individual and societal life.

Skills for Analyzing and Investigating Environmental Issues

1. Identify andPlan and carry out an investigation to address ane issues in their local environment and community. [Moved to Environmental Literacy]
2. Use their knowledge of how ecological and human systems are interconnected to describe the environmental and social consequences of local environmental issues. Develop a model to demonstrate how local environmental issues are connected to the larger local environment and human systems.
3. Develop plans, including possible design solutions, for addressing selected local environmental issues.
4. Demonstrate openness and receptivity while listening to and working with others who have perspectives about the environment that are different from their own.

Grades K-2: Technology and Engineering

Applying, Maintaining, and Assessing Technological Products and Systems

1. Analyze how things work.

2. Identify and use everyday symbols.
3. Describe qualities of everyday products.

Core Concepts of Technology and Engineering

1. Illustrate how systems have parts or components that work together to accomplish a goal.
2. Safely use tools to complete tasks.
3. Explain that materials are selected for use because they possess desirable properties and characteristics.
4. Develop a plan in order to complete a task.
5. Collaborate effectively as a member of a team.

Design in Technology and Engineering Education

1. Apply design concepts, principles, and processes through play and exploration.
2. Demonstrate that designs have requirements.
3. Explain that design is a response to wants and needs.
4. Discuss that all designs have different characteristics that can be described.
5. Illustrate that there are different solutions to a design and that none are perfect.
6. Demonstrate essential skills of the engineering design process.
7. Apply skills necessary for making in design**.**

History of Technology

1. Discuss how the way people live and work has changed throughout history because of technology.

Impacts of Technology

1. Explain ways that technology helps with everyday tasks.
2. Illustrate helpful and harmful effects of technology.
3. Compare simple technologies to evaluate their impacts.
4. Select ways to reduce, reuse, and recycle resources in daily life.
5. Design new technologies that could improve their daily lives.

Influence of Society on Technological Development

1. Explain the needs and wants of individuals and societies.
2. Explore how technologies are developed to meet individual and societal needs and wants.
3. Investigate the use of technologies in the home and community.

Integration of Knowledge, Technologies, and Practices

1. Apply concepts and skills from technology and engineering activities that reinforce concepts and skills across multiple content areas.
2. Draw connections between technology and human experiences.

Nature and Characteristics of Technology and Engineering

1. Compare the natural world and human-made world.
2. Explain the tools and techniques that people use to help them do things.
3. Demonstrate that creating can be done by anyone.
4. Discuss the roles of scientists, engineers, technologists and others who work with technology.

Grades 3-5: ~~Environment and Ecology~~ Environmental Literacy and Sustainability

Agriculture and Environmental Systems and Resources

1. Categorize ways people harvest, re-distribute, and use natural resources.

2.Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.

3. Make a claim about the environmental and social impacts of design solutions and civic actions, including their own actions.

~~1. Categorize ways people harvest, re-distribute, and use natural resources.~~

~~2.Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.~~

~~3. Make a claim about the environmental and social impacts of design solutions and civic actions, including their own actions.~~

~~*Decision-Making and Action Skills*~~ *Environmental Literacy*

~~1. Identify, justify, and clarify their views on environmental issues and alternative ways to address them.~~

~~2. Evaluate whether action is needed in specific situations, using environmental, cultural/social, and economic criteria. They decide whether they should be involved in that action.~~

~~3. Use their research results to develop action strategies and design solutions at levels consistent with their maturity and preparation. As appropriate, they implement their plans.~~

~~4. Analyze the effects of design solutions, their own civic actions, and actions taken by other individuals and groups. They describe the short- and long-term effects of these actions and design solutions in terms of environmental, social, and economic consequences.~~

~~*Personal and Civic Responsibility*~~ *Environmental Literacy*

~~1. Explain the rights and responsibilities of community membership and their role in addressing environmental quality and sustainability.~~

~~2. Possess a realistic self-confidence in their effectiveness as community members to make changes in their community that address environmental quality and sustainability.~~

~~1.~~ ~~Describe the broad environmental, social, and economic consequences of their personaland group actions and as appropriate, accept responsibility for their actions.~~

2. Investigate how perspectives over the use of resources and the development of technology has changed over time and resulted in conflict over the development of societies and nations.

3. Develop a model to demonstrate how local environmental issues are connected to larger local environment and human systems.

~~*Earth's Physical and Living Systems*~~

~~1. Describe the physical processes that shape Earth, including weather, climate, plate tectonics, and the hydrologic cycle. They explain how matter cycles and energy flows among the abiotic and biotic components of the environment. They describe how humans affect and are affected by Earth's physical systems.~~

~~2. Describe how living things, including humans, are dependent on their environment and are adapted to live in particular ecosystems under particular environmental conditions. They describe major interactions among organisms and populations of organisms and explain the importance of biodiversity to ecosystem health. They describe how humans affect and are affected by the biosphere.~~

~~*Human Systems*~~

~~1. Explain ways that individual traits and group membership or affiliation influence perceptions of and actions toward the environment. They describe how their environmental beliefs and values are shaped by their community and the larger society. They compare their beliefs and values to those held by others in their community.~~

~~2. Describe examples of the interconnection between cultural perspectives and the environment.~~

~~3. Describe how political systems at varying scales account for, manage, and affect natural resources and environmental quality.~~

~~4. Describe how economic systems and economic decision-making influence natural resource use and management as well as environmental and human well-being.~~

~~*Environment and Society*~~ *Sustainability and Stewardship*

1. Critique ways that people depend on and change the environment~~.~~

2. Examine ways you influence your local environment and community by collecting and displaying data.

3. Construct an argument to support whether action is needed on a selected environmental issue and propose possible solutions.

~~1. Describe human-caused changes that affect the immediate environment as well as other places, other people, and future times.~~

~~2. Explain that uneven geographic distribution of natural resources influences their use and perceived value.~~

~~3. Describe the meaning of "place" both close to home and around the world.~~

~~4. Explain that human social systems are dynamic and that conflicts sometimes arise over differing and changing viewpoints about the environment and natural resource use and management.~~

~~*Skills for Analyzing and Investigating Environmental Issues*~~

~~1. Use primary and secondary sources of information and apply research and analytical skills to investigate environmental issues, beginning in their own community and region.~~

~~2. Apply their knowledge of ecological and human processes and systems to describe the short- and long- term consequences of selected environmental issues on sustainability.~~

~~3. Identify and develop action strategies, including design solutions, appropriate for addressing a range of environmental issues at community and regional levels. They describe how their action strategies and design solutions might impact environmental quality and other people now and in the future.~~

~~4.~~1. ~~Demonstrate active listening, tolerance, adaptability, and openness as they work with others~~to gather a range of perspectives and information~~~~.

Grades 3-5: Technology and Engineering

Applying, Maintaining, and Assessing Technological Products and Systems

1. Follow directions to complete a technological task.
2. Use appropriate symbols, numbers and words to communicate key ideas about technological products and systems.
3. Identify why a product or system is not working properly.
4. Examine information to assess the trade-offs of using a product or system.

Core Concepts of Technology and Engineering

1. Describe how a subsystem is a system that operates as a part of another larger system.
2. Illustrate how, when parts of a system are missing, it may not work as planned.
3. Identify the resources needed to get a technical job done, such as people, materials, capital, tools, machines, knowledge, energy, and time.

4. Describe the properties of different materials.
5. Demonstrate how tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.
6. Describe requirements of designing or making a product or system.
7. Create a new product that improves someone's life.

Design in Technology and Engineering Education

1. Illustrate that there are multiple approaches to design.
2. Demonstrate essential skills of the engineering design process.
3. Evaluate designs based on criteria, constraints, and standards.
4. Interpret how good design improves the human condition.
5. Apply universal principles and elements of design.
6. Evaluate the strengths and weaknesses of existing design solutions, including their own solutions.
7. Practice successful design skills.
8. Apply tools, techniques, and materials in a safe manner as part of the design process.

History of Technology

1. Create representations of the tools people made, how they cultivated to provide food, made clothing, and built shelters to protect themselves.

Impacts of Technology

1. Describe the helpful and harmful effects of technology.
2. Judge technologies to determine the best one to use to complete a given task or meet a need.
3. Classify resources used to create technologies as either renewable or nonrenewable.
4. Explain why responsible use of technology requires sustainable management of resources.
5. Predict how certain aspects of their daily lives would be different without given technologies.

Influence of Society on Technological Development

1. Determine factors that influence changes in a society’s technological systems or infrastructure.
2. Explain how technologies are developed or adapted when individual or societal needs and wants change.

Integration of Knowledge, Technologies, and Practices

1. Demonstrate how simple technologies are often combined to form more complex systems.
2. Explain how various relationships can exist between technology and engineering and other content areas.

Nature and Characteristics of Technology and Engineering

1. Compare how things found in nature differ from things that are human-made, noting differences and similarities in how they are produced and used.
2. Describe the unique relationship between science and technology, and how the natural world can contribute to the human-made world to foster innovation.
3. Differentiate between the role of scientists, engineers, technologists, and others in creating and maintaining technological systems.
4. Design solutions by safely using tools, materials, and skills.
5. Explain how solutions to problems are shaped by economic, political, and cultural forces.

Revisions to the Draft 6 – 12 Standards

Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6-12)

Standards for Grades 6-8

Physical Science

Structure and Properties of Matter

1. Develop models to describe the atomic composition of simple molecules and extendedstructures
2. Gather and make sense of information to describe that synthetic materials come fromnatural resources and impact society.
3. Develop a model that predicts and describes changes in particle motion, temperature andstate of a pure substance when thermal energy is added or removed.

Chemical Reactions

1. Analyze and interpret data on the properties of substances before and after the substancesinteract to determine if a chemical reaction has occurred.
2. Develop and use a model to describe how the total number of atoms does not change in achemical reaction and thus mass is conserved.
3. Undertake a design project to construct, test, and modify a device that either releases orabsorbs thermal energy by chemical processes.*

Forces and Interactions

1. Apply Newton's Third Law to design a solution to a problem involving the motion of twocolliding objects.*
2. Plan an investigation to provide evidence that the change in an object's motion depends onthe sum of the forces on the object and the mass of the object.
3. Ask questions about data to determine the factors that affect the strength of electric andmagnetic forces.

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4. Construct and present arguments using evidence to support the claim that gravitationalinteractions are attractive and depend on the masses of interacting objects.
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 incontact.

Energy

1. Construct and interpret graphical displays of data to describe the relationships of kineticenergy to the mass and to the speed of an object.
2. Develop a model to describe that when the arrangement of objects interacting at a distancechanges, different amounts of potential energy are stored in the system.
3. Apply scientific principles to design, construct, and test a device that either minimizes ormaximizes thermal energy transfer.*
4. Plan an investigation to determine the relationships among the energy transferred, the typeof matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
5. Construct, use, and present arguments to support the claim that when the kinetic energy ofan object changes, energy is transferred to or from the object.

Waves and Electromagnetic Radiation

1. Use mathematical representations to describe a simple model for waves that includes howthe amplitude of a wave is related to the energy in a wave.
2. Develop and use a model to describe that waves are reflected, absorbed, or transmittedthrough various materials.
3. Integrate qualitative scientific and technical information to support the claim that digitizedsignals are a more reliable way to encode and transmit information than analog signals.

Life Science

Structure, Function, and Information Processing

1. Conduct an investigation to provide evidence that living things are made of cells; either onecell or many different numbers and types of cells.
2. Develop and use a model to describe the function of a cell as a whole and the ways the parts of cells contribute to the function.
3. Use arguments supported by evidence for how the body is a system of interactingsubsystems composed of groups of cells.
4. Gather and synthesize information that sensory receptors respond to stimuli by sendingmessages to the brain for immediate behavior or storage as memories.

Matter and Energy in Organisms and Ecosystems

1. Construct a scientific explanation based on evidence for the role of photosynthesis in thecycling of matter and flow of energy into and out of organisms.
2. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through anorganism.
3. Analyze and interpret data to provide evidence for the effects of resource availability onorganisms and populations of organisms in an ecosystem.
4. Develop a model to describe the cycling of matter and flow of energy among living andnonliving parts of an ecosystem.
5. Construct an argument supported by empirical evidence that changes to physical orbiological components of an ecosystem affect populations.

Interdependent Relationships in Ecosystems

1. Construct an explanation that predicts patterns of interactions among organisms acrossmultiple ecosystems.
2. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

Growth, Development, and Reproduction of Organisms

1. Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affectthe probability of successful reproduction of animals and plants, respectively.
2. Construct a scientific explanation based on evidence for how environmental and geneticfactors influence the growth of organisms.
3. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effectsto the structure and function of the organism.
4. Develop and use a model to describe why asexual reproduction results in offspring withidentical genetic information and sexual reproduction results in offspring with genetic variation.
5. Gather and synthesize information about the technologies that have changed the wayhumans influence the inheritance of desired traits in organisms.

Natural Selection and Adaptations

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 theassumption that natural laws operate today as in the past.
2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to inferevolutionary relationships.
3. Analyze displays of pictorial data to compare patterns of similarities in the ~~embryological development~~ anatomical structures across multiple species to identify relationships not evident in the fully formedanatomy.
4. Construct an explanation based on evidence that describes how genetic variations of traitsin a population increase some individuals' probability of surviving and reproducing in a specific environment.
5. Use mathematical representations to support explanations of how natural selection maylead to increases and decreases of specific traits in populations over time.

Earth and Space Science

Space Systems

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.
2. Develop and use a model to describe the role of gravity in the motions within galaxies andthe solar system.
3. Analyze and interpret data to determine scale properties of objects in the solar system.

History of Earth

1. Construct a scientific explanation based on evidence from rock strata for how the geologictime scale is used to organize Earth's 4.6-billion-year-old history.
2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, andseafloor structures to provide evidence of the past plate motions.

Earth's Systems

1. Develop a model to describe the cycling of Earth's materials and the flow of energy

thatdrives this process.

2. Develop a model to describe the cycling of water through Earth's systems driven by energyfrom the sun and the force of gravity.
3. Construct a scientific explanation based on evidence for how the uneven distributions ofEarth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Weather and Climate

1. Collect data to provide evidence for how the motion and complex interactions of air massesresult in changes in weather conditions.
2. Develop and use a model to describe how unequal heating and rotation of the Earth causepatterns of atmospheric and oceanic circulation that determine regional climates.
3. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Human Impacts

1. Analyze and interpret data on natural hazards to forecast future catastrophic events andinform the development of technologies to mitigate their effects.
2. Apply scientific principles to design a method for monitoring and minimizing human impacton the environment.*
3. Construct an argument supported by evidence for how increases in human population andper capita consumption of natural resources impact Earth's systems.

Engineering, Technology, and Applications of Science

Engineering Design (Define Problems, Develop Solutions and ImproveDesigns)

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 onpeople and the natural environment that may limit possible solutions.
2. Evaluate competing design solutions using a systematic process to determine how well theymeet the criteria and constraints of the problem.
3. Analyze data from tests to determine similarities and differences among several designsolutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

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 achieve

Environmental Literacy and Sustainability

Agricultural and Environmental Systems and Resources

Agricultural Systems

Develop a model to describe how agricultural and food systems function including the sustainable use of natural resources and the production, processing, and management of food, fiber, and energy.

Environment & Society

Analyze and interpret data about how different societies (economic and social systems) and cultures use and manage natural resources differently.

Watersheds & Wetlands

Develop a model to describe how watersheds and wetlands function as systems including the roles and functions, they serve.

Environmental Literacy Skills

Investigating environmental issues

Gather, read, and synthesize information from multiple sources to investigate how PA environmental issues affect Pennsylvania's human and natural systems.

Environmental Experiences

Collect, analyze, and interpret environmental data to describe a local environment.

Evaluating Solutions

Obtain and communicate information on how integrated pest management could improve indoor and outdoor environments.

Sustainability and Stewardship

Environmental Sustainability

Obtain and communicate information to describe how best management practices and environmental laws are designed to achieve environmental sustainability.

Environmental Stewardship

Design a solution to an environmental issue in which individuals and societies can engage as stewards of the environment.

Environmental Justice

Construct an explanation that describes regional environmental conditions and their implications on environmental justice and social equity.

Standards for Grades 9-12

Physical Science

Structure and Properties of Matter

1. Use the periodic table as a model to predict the relative properties of elements based on thepatterns of electrons in the outermost energy level of atoms.
2. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
3. Develop models to illustrate the changes in the composition of the nucleus of the atom andthe energy released during the processes of fission, fusion, and radioactive decay.
4. Communicate scientific and technical information about why the molecular-level structure isimportant in the functioning of designed materials.*

Chemical Reactions

1. Construct and revise an explanation for the outcome of a simple chemical reaction based onthe outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
2. Develop a model to illustrate that the release or absorption of energy from a chemicalreaction system depends upon the changes in total bond energy.
3. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which areaction occurs.
4. Refine the design of a chemical system by specifying a change in conditions that wouldproduce increased amounts of products at equilibrium.*
5. Use mathematical representations to support the claim that atoms, and therefore mass, areconserved during a chemical reaction.

Forces and Interactions

1. Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its

mass, and itsacceleration.

2. Use mathematical representations to support the claim that the total momentum of a systemof objects is conserved when there is no net force on the system.
3. Apply scientific and engineering ideas to design, evaluate and refine a device that minimizesthe force on a macroscopic object during a collision.*
4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law todescribe and predict the gravitational and electrostatic forces between objects.
5. Plan and conduct an investigation to provide evidence that an electric current can produce amagnetic field and that a changing magnetic field can produce an electric current.

Energy

1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out ofthe system are known.
2. Develop and use models to illustrate that energy at the macroscopic scale can be accountedfor as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
3. Design, build and refine a device that works within given constraints to convert one form ofenergy into another form of energy.*
4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system resultsin a more uniform energy distribution among the components in the system (second law of thermodynamics).
5. Develop and use a model of two objects interacting through electric or magnetic fields toillustrate the forces between objects and the changes in energy of the objects due to theinteraction.

Waves and Electromagnetic Radiation

1. Use mathematical representations to support a claim regarding relationships among thefrequency, wavelength, and speed of waves traveling in various media.

2. Evaluate questions about the advantages of using digital transmission and storage ofinformation.
3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiationcan be described either by a wave model or a particle model and that for some situations one model is more useful than the other.
4. Evaluate the validity and reliability of claims in published materials of the effects thatdifferent frequencies of electromagnetic radiation have when absorbed by matter.
5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and captureinformation and energy.*

Life Science

Structure and Function

1. Construct an explanation based on evidence for how the structure of DNA determines thestructure of proteins which carry out the essential functions of life through systems of specialized cells.
2. Develop and use a model to illustrate the hierarchical organization of interacting systemsthat provide specific functions within multicellular organisms.
3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintainhomeostasis.

Matter and Energy in Organisms and Ecosystems

1. Use a model to illustrate how photosynthesis transforms light energy into storedchemical energy.
2. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/orother large carbon-based molecules.
3. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds offood molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

4. Construct and revise an explanation based on evidence for the cycling of matter and flow ofenergy in aerobic and anaerobic conditions.
5. Use mathematical representations to support claims for the cycling of matter and flow ofenergy among organisms in an ecosystem.
6. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cyclingof carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Interdependent Relationships in Ecosystems

1. Use mathematical and/or computational representations to support explanations of factorsthat affect carrying capacity of ecosystems at different scales.
2. Use mathematical representations to support and revise explanations based on evidenceabout factors affecting biodiversity and populations in ecosystems of different scales.
3. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystemsmaintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
4. Design, evaluate, and refine a solution for reducing the impacts of human activities on theenvironment and biodiversity.*
5. Evaluate the evidence for the role of group behavior on individual and species' chances tosurvive and reproduce.
6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activityon biodiversity.*

Inheritance and Variation of Traits

1. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producingand maintaining complex organisms.
2. Ask questions to clarify relationships about the role of DNA and chromosomes in coding theinstructions for characteristic traits passed from parents to offspring.
3. Make and defend a claim based on evidence that inheritable genetic variations may resultfrom (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

4. Apply concepts of statistics and probability to explain the variation and distribution ofexpressed traits in a population.

Natural Selection and Evolution

1. Communicate scientific information that common ancestry and biological evolution aresupported by multiple lines of empirical evidence.
2. Construct an explanation based on evidence that the process of evolution primarily resultsfrom four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction,

(3) competition for limited resources, and (4) the proliferation of those organisms that arebetter able to survive and reproduce in the environment.

3. Apply concepts of statistics and probability to support explanations that organisms with anadvantageous heritable trait tend to increase in proportion to organisms lacking this trait.
4. Construct an explanation based on evidence for how natural selection leads to adaptation ofpopulations.
5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence ofnew species over time, and (3) the extinction of other species.

Earth and Space Science

Space Systems

1. Develop a model based on evidence to illustrate the life span of the sun and the role ofnuclear fusion in the sun's core to release energy in the form of radiation.
2. Construct an explanation of the Big Bang theory based on astronomical evidence of lightspectra, motion of distant galaxies, and composition of matter in the universe.
3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.
4. Use mathematical or computational representations to predict the motion of orbiting objectsin the solar system.

History of Earth

1. Evaluate evidence of the past and current movements of continental and oceanic crust andthe theory of plate tectonics to explain the ages of crustal rocks.
2. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and otherplanetary surfaces to construct an account of Earth's formation and early history.
3. Develop a model to illustrate how Earth's internal and surface processes operate at differentspatial and temporal scales to form continental and ocean-floor features.

Earth's Systems

1. Analyze geoscience data to make the claim that one change to Earth's surface can createfeedback that causes changes to other Earth systems.
2. Develop a model based on evidence of Earth's interior to describe the cycling of matter bythermal convection.
3. Plan and conduct an investigation of the properties of water and its effects on Earthmaterials and surface processes.
4. Develop a quantitative model to describe the cycling of carbon among the hydrosphere,atmosphere, geosphere, and biosphere.
5. Construct an argument based on evidence about the simultaneous coevolution of Earth'ssystems and life on Earth.

Weather and Climate

1. Use a model to describe how variations in the flow of energy into and out of Earth's systemsresult in changes in climate.
2. Analyze geoscience data and the results from global climate models to make an evidence- based forecast of the current rate of global or regional climate change and associated futureimpacts to Earth systems.

Human Sustainability

1. Construct an explanation based on evidence for how the availability of natural resources,occurrence of natural hazards, and changes in climate have influenced human activity.
2. Evaluate competing design solutions for developing, managing, and utilizing energy andmineral resources based on cost-benefit ratios.*

3. Create a computational simulation to illustrate the relationships among management ofnatural resources, the sustainability of human populations, and biodiversity.
4. Evaluate or refine a technological solution that reduces impacts of human activities onnatural systems.*
5. Use a computational representation to illustrate the relationships among Earth systems andhow those relationships are being modified due to human activity.

Engineering, Technology, and Applications of Science

Engineering Design (Define Problems, Develop Solutions and Improve Designs)

1. Analyze a major global challenge to specify qualitative and quantitative criteria andconstraints for solutions that account for societal needs and wants.
2. Design a solution to a complex real-world problem by breaking it down into smaller, moremanageable problems that can be solved through engineering.
3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and betweensystems relevant to the problem

Environmental Literacy and Sustainability

Agricultural and Environmental Systems and Resources

Agricultural Systems

Analyze and interpret how issues, trends, technologies, and policies impact agricultural, food and environmental systems and resources.

Environment & Society

Apply research and analytical skills to evaluate the conditions and motivations that lead to conflict, cooperation, and change among individual, groups, and nations.

Watersheds & Wetlands

Analyze and interpret how issues, trends, technologies, and policies impact watersheds and water resources.

Environmental Literacy Skills

Investigating environmental issues

Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those that are regional or global in scope.

Environmental Experiences

Plan and conduct an investigation utilizing environmental data about a local environmental issue.

Evaluating Solutions

Evaluate and communicate the effect of integrated pest management practices on indoor and outdoor environments.

Sustainability and Stewardship

Environmental Sustainability

Analyze and evaluate how best management practices and environmental laws achieve sustainability of natural resources.

Environmental Stewardship

Design and evaluate solutions in which individuals and societies can promote stewardship in environmental quality and community well-being.

Environmental Justice

Analyze and interpret data on a regional environmental condition and its implications on environmental justice and social equity.

Anatomy of a Standard

Three Dimensions of a Standard

The standards are written as grade-specific *performance expectations*, integrating science, environment, ecology, agriculture, technology and engineering under unifying Disciplinary Core Ideas. The standards are built around three dimensions that are integrated into a set of specific standards at each grade level—Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs)—described below:

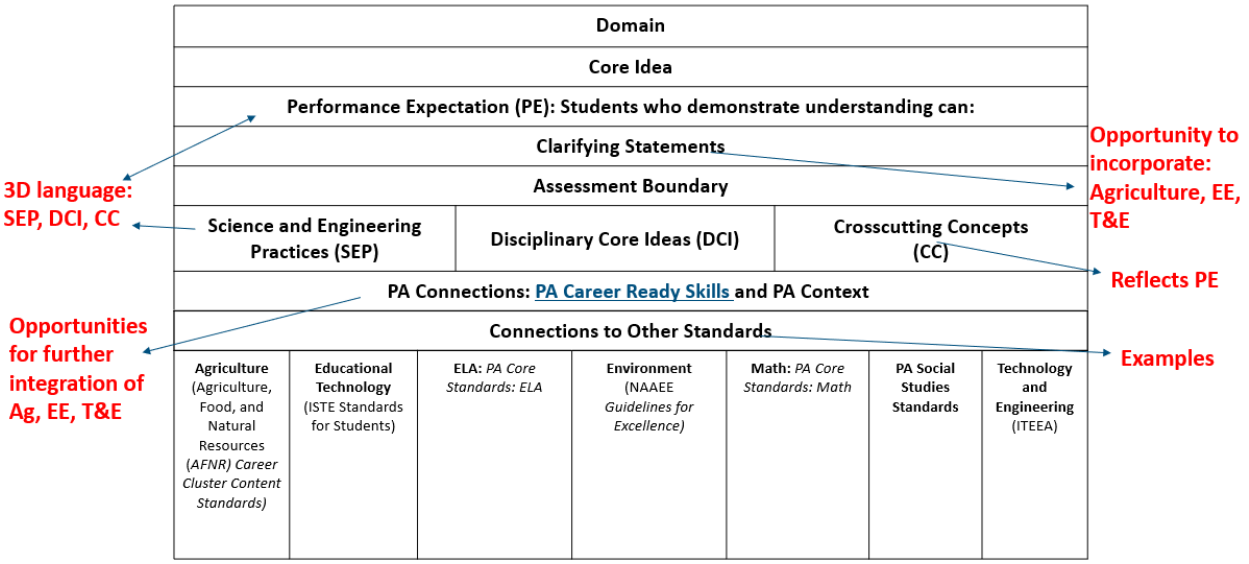
- **Disciplinary Core Ideas (DCIs)** reflect essential ideas in science that all students should understand by the end of grade 12.
- The **Science and Engineering Practices** (SEPs) are behaviors that are critical in investigating, modeling, explaining the world, and developing solutions to societal problems.
- The **Crosscutting Concepts** (CCCs) bridge disciplinary boundaries and unite core ideas in science. The PA Standards incorporate the seven Crosscutting Concepts of the NRC Framework.

Anatomy of a Pennsylvania Integrated Standards for Science, Environment, Ecology, Agriculture, Technology and Engineering Standard

The standards for each Core Idea are organized in four main sections: (1) performance expectation(s), (2) the foundation boxes, and (3) PA connections, and Connections to other Standards Content and Domains.

- **Performance expectations:** Written as tasks that students at the specified grade level should be able to complete to demonstrate mastery of the content
- **Foundation boxes**: Below the Performance Expectations box are three foundation boxes, which list (from left to right) the specific Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts
- **PA Connections:** The PA Career Ready Skills (CRS) continuum describes what students should know and do from Pre-Kindergarten through grade 12. The PA CRS Continuum is organized by domain and related employability skills, and grade-level band. A student should acquire each Career Ready Skill by the end of the grade-level band. The PA Context will allow for integrated science instruction that leverages local and regional context.
- **Connections to other Standards Content and Domains:** These boxes represent the connections between the performance expectation (PE) in each standard and disciplinary core ideas and domains in other content areas within the same grade level. Students may learn the connections in relation to the PE, as prerequisite knowledge, or components of understanding at other grade levels.

Opportunities to Integrate Content: DRAFT Anatomy of a Standard



Explanation of Revisions

The following table details revisions made to the originally proposed Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering. These changes were made by the committees, based on the charges from the State Board of Education.

Original Proposed Standard	Revisions	Rationale
Examine and express their own views on environmental issues.	This standard was eliminated, but the committee wants to emphasize that this added domain should emphasize the importance of environmental literacy and the development of beliefs and values are to be included in guidance documents.	*This standard was not deemed necessary because this is the overarching rationale for the Environmental Literacy and Sustainability Domain.*
Determine whether action is needed on selected environmental issues and whether they should be involved. They describe their reasoning.	Construct an argument to support whether action is needed on a selected environmental issue and propose possible solutions.	*This standard was rewritten in three-dimensional language and to be more developmentally appropriate for 3–5 students.*
Develop an action strategy or design solution for a specific local environmental issue of their choosing.	This standard was eliminated.	*This standard was eliminated due to redundancy in K–2 EE6-4 "Identify environmental and social consequences of design solutions and civic actions, including their own actions."*
Identify environmental and social consequences of design solutions and civic actions, including their own actions.	Make a claim about the environmental and social impacts of design solutions and civic actions, including their own actions.	*This standard was rewritten in three-dimensional language.*
Describe their basic rights and responsibilities as members of a community and the importance of these rights and responsibilities in promoting environmental quality and community well-being.	This standard was eliminated.	*This standard was eliminated for lack of clarity and three-dimensional language. It was replaced by a new standard.*

Original Proposed Standard	Revisions	Rationale
Describe how they can realistically and meaningfully contribute to their community and environmental quality.	This standard was eliminated.	*This standard was eliminated for lack of clarity and three-dimensional language. It was replaced by a new standard.*
Identify ways in which they are responsible for the environmental and social effects of their actions.	This standard was eliminated.	*This standard was eliminated for lack of clarity and three-dimensional language. It was replaced by a new standard.*
New Standard	Examine ways you influence your local environment and community by collecting and displaying data.	*This is a new standard added to enhance the three-dimensional clarity of EE 7-1 "Describe their basic rights and responsibilities as members of a community and the importance of these rights and responsibilities in promoting environmental quality and community well-being", EE 7-2 "Describe how they can realistically and meaningfully contribute to their community and environmental quality", and EE 7-3 "Identify ways in which they are responsible for the environmental and social effects of their actions".*
Describe characteristics of Earth's physical systems, including air, water, and land. They explain how these systems interact with one another and identify changes in the physical environment over time. They provide examples of how physical systems affect living organisms, including humans.	This standard was eliminated.	*This standard was eliminated for redundancy. It is found elsewhere in K–4 Standards: 5-ESS 2-1 "Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact."*
Identify basic similarities and differences among a wide variety of living organisms. They explain ways that living	Analyze how living organisms, including humans, affect the environment in	*This standard was edited to increase three-dimensionality and strengthen connections to Science and Engineering*

Original Proposed Standard	Revisions	Rationale
organisms, including humans, affect the environment in which they live, and how their environment affects them.	which they live, and how their environment affects them.	*Practices and Disciplinary Core Ideas.*
Generate examples of how people act, as individuals, as members of a group, and as members of society, toward the environment. They articulate their own beliefs and the beliefs of family and community members about the environment and environmental issues.	This standard was eliminated.	*Standards K–2 EE3-1 "Generate examples of how people act, as individuals, as members of a group, and as members of society, toward the environment. They articulate their own beliefs and the beliefs of family and community members about the environment and environmental issues" and K–2 EE3-2 "Identify ways that people express different cultural backgrounds and how these can influence environmental perceptions and activities" were combined to reduce redundancy and increase three-dimensionality.*
Identify ways that people express different cultural backgrounds and how these can influence environmental perceptions and activities.	Examine how people from different cultures and communities, including one's own, interact and express their beliefs about nature.	*Standards K–2 EE3-1 "Generate examples of how people act, as individuals, as members of a group, and as members of society, toward the environment. They articulate their own beliefs and the beliefs of family and community members about the environment and environmental issues" and K–2 EE3-2 "Identify ways that people express different cultural backgrounds and how these can influence environmental perceptions and activities" were combined to reduce redundancy and increase three-dimensionality.*

Original Proposed Standard	Revisions	Rationale
Identify ways that people depend on, change, and are affected by the environment.	Critique ways that people depend on and change the environment.	*The committee eliminated the "affected by the environment" because it is a repeated theme with standard K–2 EE 2-2 "Identify basic similarities and differences among a wide variety of living organisms. They explain ways that living organisms, including humans, affect the environment in which they live, and how their environment affects them." The committee also replaced "Describe" with "Critique" to reach a higher depth of knowledge. This standard is written in three-dimensional language (see https://www.nextgenaset.org/wp-content/uploads/2020/08/200826_SEP7_ELEM_Argumentation.pdf).*
Describe ways people harvest, re-distribute, and use natural resources.	Categorize ways people harvest, re-distribute, and use natural resources.	*The committee replaced "Describe" with "Categorize" for higher depth of knowledge. To clarify the word "harvest," the word "obtain" was discussed as part of the understanding of how humans get what they want and need.*
Identify ways that places differ in their physical and human characteristics.	Explain ways that places differ in their physical characteristics, their meaning, and their value and/or importance.	*This standard was reworded to clarify the meaning of "places".*
Recognize that change is a normal part of individual and societal life.	Investigate how perspectives over the use of resources and the development of technology have changed over time and resulted in conflict over the development of societies and nations.	*The committee changed the wording in this standard to better cover the entire spectrum of the North American Association of Environmental Educators (NAAEE) standard.*

Original Proposed Standard	Revisions	Rationale
Identify and investigate issues in their local environment and community.	Plan and carry out an investigation to address an issue in their local environment and community.	*This standard was reworded for three-dimensional language.*
Use their knowledge of how ecological and human systems are interconnected to describe the environmental and social consequences of local environmental issues.	Develop a model to demonstrate how local environmental issues are connected to the larger local environment and human systems.	*This standard was reworded for three-dimensional language.*
Demonstrate openness and receptivity while listening to and working with others who have perspectives about the environment that are different from their own.	This standard was eliminated	*This standard was combined into K–2 EE 5-1 "Identify and investigate issues in their local environment and community."*
Develop plans, including possible design solutions, for addressing selected local environmental issues.	This standard was eliminated	*This standard was combined into K–2 EE 5-1 "Identify and* *investigate issues in their local environment and community."*

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