IOWA | Department of Education

IOWA ACADEMIC STANDARDS
ESSENTIAL ELEMENTS FOR

Science

for Students with Significant Cognitive Disabilities

May 2025

Contents

Background on the Dynamic Learning Maps® Essential Elements for Science Elements for Science

The Dynamic Learning Maps (DLM) science Essential Elements (EEs) were developed to include the three dimensions that underlie the Framework and Next Generation Science Standards (NGSS): disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). The development process involved a primary team with expertise in science content, curriculum, instruction, and assessment, with support from additional staff with further expertise in science content, alternate assessment, extended content standards, cognitive development, cognitive modeling, accessibility and instruction for students with significant cognitive disabilities, and universal design for learning (CAST, 2018). The EE development team used the following sources to inform their decisions on how to reduce depth, breadth, and complexity relative to general education standards:

- The Framework for K-12 Science Education Practices, Crosscutting Concepts, and Core Ideas (NRC, 2012)
- NGSS performance expectations (PEs) and progression appendices (E, F, and G) for each dimension (NGSS Lead States, 2013)
- Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993)
- The NSTA Atlas of the Three Dimensions (Willard, 2020)
- The NSTA Quick-Reference Guide to the NGSS (Willard, 2015)
- Atlas of Science Literacy (Volumes 1 and 2; American Association for the Advancement of Science, 2007, 2013)

The team began by focusing on reduction within the DCI and SEP dimensions, as the CCCs are inherent in the content and practices and are described in ways that span levels of complexity (NGSS Lead States, 2013, Appendix G). To prioritize knowledge, skills, and ideas (KSUs) in the DCI and SEP dimensions for development in the EEs, the team considered how KSUs could:

- provide opportunities for students to build deeper and broader scientific knowledge, thinking, and practices over multiple years.
- enable rich conceptual understanding and engagement in science practices, avoiding rote memorization of facts and procedures.
- support instruction and student engagement with the concepts and practices.
- be important for pursuing postsecondary opportunities.
- help students make sense of scientific phenomena and solve science and engineering problems encountered in everyday life.

For the DCI and SEP dimensions, the EE development team identified the critical KSUs that would be meaningful and accessible to students with significant cognitive disabilities at a reduced depth, breadth, and complexity. The team first organized the DCI content into families of related concepts or phenomena, making the concepts more accessible by describing the core KSUs at each grade band. This resulted in 14 DCI families that included conceptually-related KSUs that increase in complexity across grade bands (see Appendix for the list of families and the related NGSS DCIs). Next, the team generated progressions of SEP KSUs at reduced depth, breadth, and complexity to ensure accessibility for the range of students with significant cognitive disabilities, progressing from less complex skills in earlier grade levels to more complex skills at later grade levels. The team then identified intersections between these dimensions from the KSUs in the DCI families and SEP progressions to create draft EEs. The EEs were developed at grade band levels (K–2, 3–5, middle school, and high school) due to the NGSS endpoints being defined at grade bands, with significant overlap of skills between grades within grade bands.

Similar to the process by which the PEs were defined within NGSS, the EEs were derived by selectively combining the concepts and practices across the three dimensions into coherent, grade-appropriate learning objectives. Consequently, the EEs show one way to combine the underlying three dimensions and are not the only way for students to learn and understand science concepts and practices (similar to the NGSS PEs; see NRC, 2012 and NGSS Lead States, 2013). As a result, the EEs are not intended to align one-to-one with PEs from NGSS but rather link in each dimension to the Framework at reduced depth, breadth, and complexity. This allows the EEs to retain the same multi-dimensional structure as states' general education standards (whether aligned to the Framework or NGSS PEs). For each EE, the DCI content links to one or more PE in the same grade band through the connections between the DCI family KSUs and the NGSS DCIs (see Appendix). The SEP(s) selected for an EE may or may not be the same as the SEPs associated with the linked PE(s), as the EE development team chose DCI-SEP intersections to provide an appropriate level of complexity for the grade band and accessible entry points for a wide range of learners. The development team chose not to use only the SEPs in the linked PEs because the reduction of KSUs in each dimension could result in a different overall level of complexity when recombined than was appropriate for the grade band. Each EE integrated one or more component from each associated SEP, with the KSUs aligning to components of the practice described by NGSS (in Appendix F) in that grade band. CCCs are contextualized within the DCI-SEP intersection for each EE, providing the link to the Framework and NGSS in that dimension.

Following the initial phase of development, the draft EEs underwent internal review by ATLAS staff with expertise in alternate assessment design, extended content standards, science academic content, accessibility and instruction for students with significant cognitive disabilities, and Universal Design for Learning (CAST, 2018). Reviewers evaluated the EEs on multiple criteria related to the scope, complexity, and accessibility of the KSU, as well as the clarity of the language of the EE for educators. Using feedback from the internal review, the EE development team revised the draft set of EEs, resulting in an initial set of 75 draft EEs, grouped in three domains (life science, Earth and space science, physical science) for external review.

The Science EE External Review event was held October 27–28, 2022, in Chicago, Illinois. Panels were organized by domain (life science, Earth and space science, physical science) and grade band (K–5, 6–8, 9–12), such that each included at least one panelist in each of three roles: state education agency representatives, science content experts, or special education population experts. The review process included five stages to parallel the EE development process: (1) KSUs in each DCI family; (2) KSUs in the SEPs; (3) the draft EEs and linked NGSS PEs; (4) vertical alignment of EEs across grade band within domains; and (5) horizontal alignment of EEs within grade band across domains. Criteria across stages evaluated:

- the appropriateness of the breadth, depth, and complexity of KSUs in the DCI and SEP dimensions and the EEs.
- whether the KSUs in each dimension were meaningful, accessible, and appropriately rigorous for students with significant cognitive disabilities.
- alignment between the EE description and KSUs identified in each dimension.
- links between the EE and NGSS PE(s).
- grade band progressions of the KSUs and EEs.
- complexity at each grade band across science domains and relative to sample EEs from mathematics and English language arts.

In each stage of review, panelists first provided individual comments about any criteria for which they had concerns, then used table discussion to identify potential remedies for these concerns. The most frequent type of feedback addressed, respectively, how the dimensions of the EEs were presented, the content of the EEs, horizontal or vertical alignment, and links from EEs to NGSS PEs. The next most frequent comments related to SEP KSUs, followed by DCI KSUs, then accessibility and vocabulary. DLM staff synthesized the feedback and proposed remedies from panelists to generate potential revisions, which they implemented according to the following priorities:

- revisions related to scientific accuracy
- revisions in content that improved alignment to the Framework and links to NGSS PEs
- revisions in content that improved horizontal and vertical alignment across EEs
- revisions that increased clarity and accessibility without negatively impacting alignment, intended complexity, or links to NGSS PEs (e.g., vocabulary)
- additions and revisions that did not substantively change the EE (e.g., specifying CCCs, clarification statements, some aspects of SEP descriptions, and DCI families)

The EE development team created nine additional EEs in response to specific requests for additional EEs, or to address gaps in content that were evident after panelist recommendations were implemented in the draft EEs. These revisions resulted in a set of 84 EEs, which were then reviewed by DLM staff members with expertise in special education to ensure the revisions maintained or improved accessibility relative to the original drafts. Following this internal review of the revised EEs, they were provided to state representatives in May 2023 to review in advance of a final discussion and consensus vote at the DLM Governance Board meeting on July 12, 2023. One final round of revision resulted in minor wording changes to five of the 84 EEs. Table 1 presents the number of EEs in each grade band and domain within the final set of revised EEs.

Table 1

Number of Science Essential Elements per Grade Band and Domain

Domain	K–2 EEs	3–5 EEs	6–8 EEs	9–12 EEs	Total
Life science	6	8	7	8	29
Earth and space science	5	9	9	8	31
Physical science	3	5	8	8	24
Total	14	22	24	24	84

Although one-to-one alignment of DLM EE to NGSS PE is not intended, each of the EEs links to one or more NGSS PE within the grade band through the DCI content. Table 2 presents the number of NGSS PEs that are linked to the EEs across grade bands and domains.

Table 2

Coverage of Performance Expectations Linked through Disciplinary Core Ideas to the Science Essential Elements across Grade Bands and Domains

Domain	K–2 PEs	3–5 PEs	6–8 PEs	9–12 PEs	Total
Life science	7	10	15	19	51
Earth and space science	8	11	11	13	43
Physical science	6	13	9	12	40
Engineering, technology, and applications of science	1	2	2	4	9
Total	22	36	36	48	142

Each of the EEs incorporates one or more SEPs to intersect with the DCI content at the appropriate level of complexity for the grade band. The EE development team also identified one or more CCCs inherent in the DCI-SEP intersections for each EE. Tables 3 and 4 present the coverage of SEPs and CCCs, respectively, across grade bands.

Table 3

Coverage of Science and Engineering Practices across Grade Bands in the Science Essential Elements

Science and Engineering Practice	K–2 EEs	3–5 EEs	6–8 EEs	9–12 EEs	Total
Asking questions and defining problems	5	4	5	3	17
Developing and using models	0	2	9	7	18
Planning and carrying out investigations	5	5	5	7	22
Analyzing and interpreting data	6	9	9	14	38
Using mathematics and computational thinking	0	3	3	7	13
Constructing explanations and designing solutions	0	7	11	5	23
Engaging in argument from evidence	1	10	5	7	23
Obtaining, evaluating, and communicating information	7	7	6	2	22

Note. The total column sums to more than the total number of EEs (84) because an individual EE could have more than one (up to three) SEP incorporated.

Table 4

Coverage of Crosscutting Concepts across Grade Bands in the Science Essential Elements

Crosscutting Concept	K–2 EEs	3–5 EEs	6–8 EEs	9–12 EEs	Total
Patterns	9	7	8	5	29
Cause and effect	6	13	16	15	50
Scale, proportion, and quantity	0	3	2	7	12
Systems and system models	1	5	12	13	31
Energy and matter in systems	3	6	8	10	27
Structure and function	2	1	2	2	7
Stability and change of systems	2	5	4	8	19

Note. The total column sums to more than the total number of EEs (84) because an individual EE could have more than one (up to four) CCC specified as inherent in the DCI-SEP intersection.

Individual Essential Element Descriptions

This document presents the Dynamic Learning Maps® (DLM®) science Essential Elements (EEs) in a more detailed format to describe how each of the three dimensions is included in that EE, along with the linked Iowa Academic Science Standards performance expectations (PEs).

The tables presenting the information for each EE correspond to sections in NGSS tables providing similar information about each PE with a few exceptions. Specifically, NGSS includes clarification statements and assessment boundaries for some PEs, a connection box that lists other PEs that connect horizontally (within the domain) and vertically (across grade bands), and the Common Core State Standards that are relevant to the PEs. Standards do not typically include these types of information, and they are therefore not part of the Individual EE Descriptions.

The Individual EE Descriptions also differ from the tables presenting the previous DLM science EEs (Dynamic Learning Maps Science Consortium, 2015). The previous tables included linkage level descriptions, which have not yet been developed for the revised set of 84 science EEs because the map development is not yet complete. These previous tables also included links to EEs in mathematics and English language arts, which have not yet been identified for the revised science EEs.

In this section, the tables for each EE include six rows presenting (1) the EE text; (2) the DCI family knowledge, skills, and understandings (KSUs); (3) the science and engineering practices (SEPs); (4) the crosscutting concepts (CCCs); (5) the linked PEs; and (6) articulation of the DCI family across the grade bands.

The table includes the EE text and the linked Iowa science standard(s). This is the standard itself, which describes what students are expected to know, learn, and do for each grade band. EEs are numbered in a manner similar to NGSS PEs, with a numeral indicating the grade band (i.e., 2 for grades K–2, 5 for grades 3–5, 8 for grades 6–8, and 12 for grades 9–12), followed by the domain abbreviation (e.g., ESS for Earth and space science, LS for life science, PS for physical science), then a shortened DCI family name (e.g., SolSys for Earth in the Solar System), and the number within the grade band and family. For example, the first EE in the list is SCI.EE.2.PS.Forces-1, which is for K–2, in physical science, the DCI family “Interacting Forces” and the first EE in that DCI family and grade band.

The first row under the table includes the KSUs within the DCI family that relate to this EE. These KSUs are interrelated concepts that represent the content knowledge relevant to the mastery of the EE. When there is more than one EE within a grade band and DCI family, some of the DCI KSUs will overlap between the EEs.

The next row lists the SEPs used to construct the EE. All EEs will have one or more SEP outlining the practices students can use to develop their scientific thinking and engage with the content described in the DCI KSUs. Under each SEP are descriptions of the ways the SEP could be incorporated in the EE. The EE development team selected SEPs to provide meaningful and accessible learning objectives when combined with DCI KSUs.

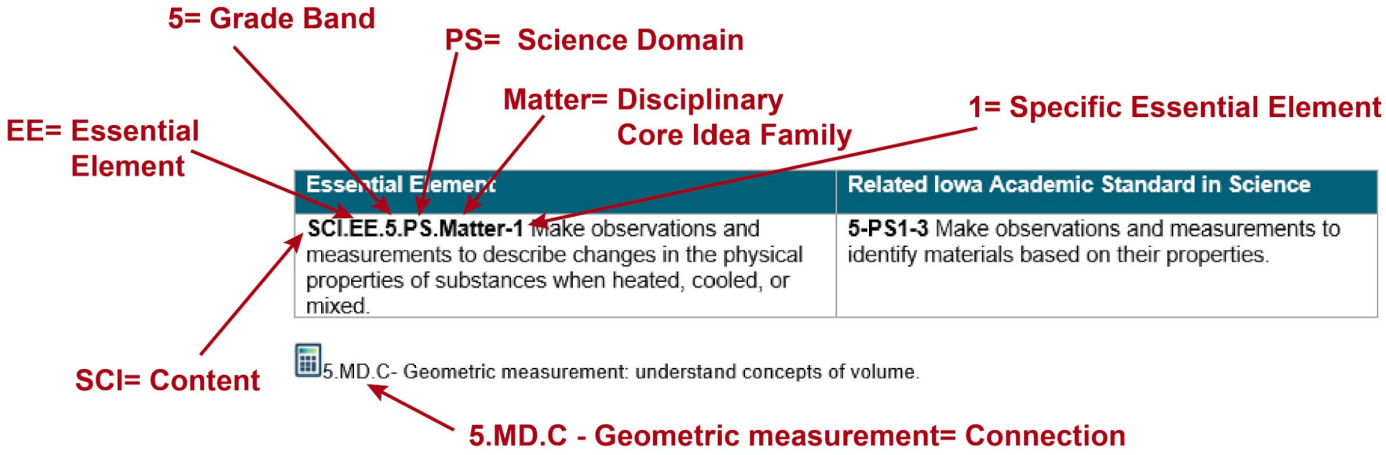
The selection of SEPs was also designed to provide coverage across different SEPs within the grade band. As described in the Framework for K–12 Science Education (National Research Council, 2012) and NGSS (NGSS Lead States, 2013, Appendix F), the eight SEPs are intentionally interconnected and overlapping. For many EEs, the development team selected multiple SEPs to reflect how science can be taught using multiple practices. Note that the order in which the SEPs are listed follows the ordering in NGSS and should not be interpreted as indicating relevance or importance to the EE.

The last row lists the CCCs specified for the EE. Each EE has one or more CCC associated through the DCI content. The NGSS CCCs are described in ways that can be applied across varying levels of complexity (NGSS Lead States, Appendix G). Therefore, the EEs do not include a description of the CCCs at reduced depth, breadth, and complexity, as this reduction is accomplished through the other dimensions. As with the NGSS specification of CCCs for the PEs, the lists of CCCs for each EE are not exhaustive and are not intended to limit instruction. The text in these rows of the EE tables is quoted from the National Science Teachers Association (NSTA) Matrix of CCCs (NSTA, 2013), which was developed from the same sources used in the development of the EEs: The Framework for K–12 Science Education (National Research Council, 2012) and NGSS Appendix G (NGSS Lead States, 2013). The order in which the CCCs are listed in the tables follows the ordering in NGSS and the NSTA matrix.

Organization and Structure of the Standards

The Iowa Academic Essential Elements Standards for Science are organized by grade band. K-5 standards are organized to reflect the developmental nature of learning for elementary students and attend to the learning progressions that build foundational understandings of science. By the time students reach middle school (Grades 6-8), they build on this foundation in order to develop more sophisticated understandings of science concepts through high school.

The Iowa Academic Essential Elements Standards for Science are designated with the following coding system.



- **Grade Level:** The standards are grade-specific in grades kindergarten through eighth grade. High school standards will be designated with HS.
- **Science Domain:** The standards are broken into the domains of life science (LS), physical science (PS), earth/space science (ESS), and engineering and technical sciences (ETS).
- **Big Idea:** Each science domain has several big ideas that make up the content within that domain. A list of the big ideas encased in each domain is above in the description of the disciplinary content dimension.
- **Specific Standard:** The big ideas are finally broken into three-dimensional specific standards that outline what students should know and be able to do when engaging with these standards. These standards each contain a scientific practice, conceptual frame, and disciplinary content that should be referenced when planning three-dimensional instruction.

Connections

Many standards include possible connections that teachers can leverage when planning their instruction. The identified connections are not required in the way that the standards are required but are instead meant to add depth and breadth to classroom instruction. These connections highlight key links to various aspects of the science ecosystem, enriching the content and deepening students' understanding. While connections are provided for some standards, they are not identified for all. They are not intended to be an exhaustive list and teachers should continue to seek connections for other standards when appropriate. Below is a list of the connections that may be found throughout the document:

ELA Connections

Decisions about how to connect and integrate content should be guided by the specific contexts, disciplines, and learning objectives. Language and literacy provide students with essential tools and practices for understanding and communicating the world around them. Through speaking, drawing, writing and reading, students express their ideas and deepen their understanding particularly in subjects like science and engineering.

Mathematics Connections

Decisions about how to connect and integrate content should be driven by the specific contexts, disciplines, and learning goals. Mathematics serves as a key tool for modeling concepts in science and engineering. Science practices include skills such as counting, measuring, spatial reasoning, data analysis, multiplicative thinking and scaling, pattern recognition, and logical problem-solving—all of which are grounded in mathematical thinking.

Iowa Connections

Opportunities to teach science using topics directly relevant to our state (e.g. Mississippi River, agriculture, Iowa-specific flora and fauna, Iowa's rich geologic history, etc.) are listed throughout the standards as "Iowa Connections." These connections allow educators to use local, regional, and state-specific contexts for teaching, learning, and assessment. Educators should use these as recommendations for investigation with students. Additionally, assessment developers have the opportunity to use the Iowa contexts to develop Iowa-specific examples or scenarios from which students would demonstrate their general understanding. This approach provides the opportunity for educators to draw upon Iowa's natural environment and rich history and resources in engineering design and scientific research to support student learning.

Career Connections

Exposing science students to career clusters is crucial for helping them understand the diverse opportunities available within and beyond traditional scientific fields. By exploring various career pathways early on, students can connect their academic learning to real-world applications, gaining insights into how their skills might align with specific industries such as healthcare, environmental science, or technology. This exposure not only broadens their perspectives but also enables them to make informed decisions about their future careers, motivating them to pursue education and training that aligns with their interests and the evolving demands of the workforce.

The following career clusters are identified in many of our standards: Agriculture, Food and Natural Resources, Architecture and Construction, Manufacturing, Science, Technology, Engineering, Mathematics, Health Sciences, and Information Technology.

Engineering & Technology Connections

Performance indicators for the engineering design process are intentionally embedded in all grade levels. These indicators allow students to demonstrate their ability to define problems, develop possible solutions, and improve designs. These indicators should be reinforced whenever students are engaged in practicing engineering design during instruction. Having students engage in the engineering design process will prepare them to solve challenges both in and out of the classroom. The nature of technology, broadly defined, recognizes the interaction between technology and society and raises questions about the trade-offs and values embedded within technological artifacts and systems.

Nature of Science Connections

A key goal of K-12 science education is to cultivate scientifically literate individuals who understand the nature of science. Defining features of scientific knowledge, across all disciplines, include its openness to revision in response to new evidence and that robust scientific knowledge is vetted and justified through evidence and consensus building among scientists. While the integration of scientific and engineering practices, disciplinary core ideas, and crosscutting concepts provides a foundation for teaching and learning about the nature of science, understanding these constructs requires that teachers pose questions encouraging students to reflect on the nature of science.

For more detailed information on the Iowa Academic Standards for Science please refer to the standards document.

Kindergarten – Second Grade

Grade K-2 Physical Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.PS.Forces-1 Make observations to compare the effects of different strengths and directions of pushes and pulls on the motion of an object.	**K-PS2-1** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. **K-PS2-2** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

 EE.RI.K.1 With guidance and support, identify a detail in a familiar text. Students can explore questions related to causes and effects of pushes and pulls, strengthening comprehension skills.

 EE.K.CC.4 - Demonstrate one-to-one correspondence, pairing each object with one and only one number and each number with one and only one object. Counting objects pushed or pulled supports understanding of one-to-one correspondence.

 A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.

DLM Disciplinary Core Idea Family

Interacting Forces

- Pushes and pulls can have different strengths and directions.
- The motion of an object depends on the pushes and pulls on that object.
    - Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.
    - Pushes and pulls can keep an object in place.
    - A stronger (or bigger) push or pull makes things go faster.
- When objects collide, they push on one another.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in K–2 builds on prior experiences and progresses to exploring questions to gain information.

- In exploring how the natural world works, ask questions that lead to observations, descriptions, and explanations.

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations to collect and use data.

- Collect and compare observations to determine and describe relationships in the natural world.

Analyzing and Interpreting Data: Analyzing data in K–2 builds on prior experiences and progresses to identifying and describing observations and patterns in the natural world.

- Identify and describe patterns in observations and measurements.
- Make classifications and comparisons based on observations and measurements.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower).
- Standard units are used to measure length.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.PS.Energy-1 Make observations that energy exists.	**K-PS3-1** Make observations to determine the effect of sunlight on Earth's surface. **1-PS4-2** Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.

Instruction could use local examples, like how sunlight warms playground equipment, soil in fields, or water in ponds, to help students notice how sunlight affects different surfaces around Iowa.

EE.SL.K.5 - With guidance and support, add or select drawings or other visual or tactual displays that relate to familiar people, places, things, and events. Students can illustrate the sun's effects on objects, enhancing communication and descriptive skills.

Students can explore how farm machinery or reflective road signs become visible at night when illuminated by headlights or flashlights. This can help students understand the importance of light in visibility, especially in rural areas where nighttime lighting is limited.

EE.W.1.8: With guidance and support from adults, identify information related to personal experiences and answer simple questions about those experiences. EE.SL.1.1: Participate in conversations with adults.

DLM Disciplinary Core Idea Family

Energy

- Energy is how things change, grow, and move.
- Evidence of the presence of energy includes moving objects, sound, light, or heat (e.g., a rolling marble, hearing or feeling a sound, feeling warmth from the Sun or a light source, seeing light from a light bulb or flame).

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations to collect and use data.

- Collect and compare observations to determine and describe relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Objects may break into smaller pieces, be put together into larger pieces, or change shapes.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.PS.Matter-1 Make observations to classify different kinds (e.g., wood, metal, water) and forms (i.e., solid, liquid) of matter.	**2-PS1-1** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. **2-PS1-2** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

 EE.W.2.8: Identify information related to personal experiences and answer simple questions about those experiences.

 SMP 4: Model with Mathematics SMP 2: Reason abstractly and quantitatively SMP 4: Model with Mathematics SMP 5: Use appropriate tools strategically EE.2.MD.9-10: Create picture graphs from collected measurement data.

 Many human-made products are designed by applying some knowledge of the natural world and are built using materials derived from the natural world.

 Agricultural products such as corn and soybeans can be used to make food products and non-food products

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Different kinds of matter exist (e.g., wood, metal, water), and many of them can be either solid or liquid, depending on temperature.
- Matter can be described and classified by its observable properties.
- Different properties are suited to different purposes.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in K–2 builds on prior experiences and progresses to exploring questions to gain information.

- In exploring how the natural world works, ask questions that lead to observations, descriptions, and explanations.

Analyzing and Interpreting Data: Analyzing data in K–2 builds on prior experiences and progresses to identifying and describing observations and patterns in the natural world.

- Identify and describe patterns in observations and measurements.
- Make classifications and comparisons based on observations and measurements.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Objects may break into smaller pieces, be put together into larger pieces, or change shapes.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

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

Grade K-2 Life Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS.Org-1 Use information to identify that different organisms have different external parts for specific functions.	**1-LS1-1** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. **2-LS2-2** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. **2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats.

 Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. Plants and animal structures can give rise to human technology (e.g., burdock-type seed pods inspired the invention of Velcro).

 In Iowa, hunters use camouflage clothing with colors and patterns that mimic the natural environment, similar to how certain animals blend in to avoid predators. Inspired by animal adaptations, this design helps hunters remain hidden in fields, forests, and prairies.

 W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions).

 Detasseling involves removing the tassel at the very top of the corn plant, mechanically and by hand, to prevent unwanted pollination. This results in the plant producing pure hybrid seeds. When going for walks in prairies, fields, or the woods, sometimes humans or animals pick up cockleburs and relocate them to other areas. Burrs are used as the model for Velcro.

 SMP 4: Model with Mathematics EE.2.MD.9-10: Create picture graphs from collected measurement data.

 Use local Iowa habitats to identify the many different kinds of living things in an area. Include land, moving water, and still water environments.

 Scientists look for patterns when making observations about the world.

 SMP 2: Reason abstractly and quantitatively SMP 4: Model with Mathematics EE.W.2.8: Identify information related to personal experiences and answer simple questions about those experiences.

DLM Disciplinary Core Idea Family

Organisms: Structure and Function, Growth and Development

- Organisms include plants, animals, and humans.
- All animals have external parts that perform daily functions.
- Different animals use their body parts in different ways.
- Plants have different parts (e.g., roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants.

DLM Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

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

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS.Plant-1 Investigate what plants need to grow.	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive. **2-LS2-1** Plan and conduct an investigation to determine if plants need sunlight and water to grow. **2-LS2-2** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.


Scientists look for patterns and order when making observations about the world.


Incorporate examples from Iowa's ecosystem, such as local plants and animals, to make these patterns relatable. For example, discuss how deer eat plants while sunflowers need sunlight and water. In Iowa's natural environment, animals need food to live and grow, which they get from plants or other animals. Plants, such as the crops we see across Iowa, need water and light to live and grow.


EE.RI.K.7 - With guidance and support, identify illustrations or objects/tactual information that go with a familiar text. By linking images to information, students can better understand how visuals depict plant and animal needs.


K.MD.A.1 - Describe measurable attributes (e.g., length or weight). Students can observe plant growth and describe its measurable properties, building descriptive math skills.


EE.W.2.8: Identify information related to personal experiences and answer simple questions about those experiences.


SMP 2: Reason abstractly and quantitatively SMP 4: Model with Mathematics SMP 5: Use appropriate tools strategically.


Detasseling involves removing the tassel at the very top of the corn plant, mechanically and by hand, to prevent unwanted pollination. This results in the plant producing pure hybrid seeds. When going for walks in prairies, fields, or the woods, sometimes humans or animals pick up cockleburs and relocate them to other areas. Burrs are used as the model for Velcro.

 SMP 4: Model with Mathematics EE.2.MD.9-10: Create picture graphs from collected measurement data.

DLM Disciplinary Core Idea Family

Plants: Cycling of Matter and Flow of Energy

- Plants need water and light to grow.
- Plants grow and change.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in K–2 builds on prior experiences and progresses to exploring questions to gain information.

- In exploring how the natural world works, ask questions that lead to observations, descriptions, and explanations.

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations to collect and use data.

- Collect and compare observations to determine and describe relationships in the natural world.

Analyzing and Interpreting Data: Analyzing data in K–2 builds on prior experiences and progresses to identifying and describing observations and patterns in the natural world.

- Identify and describe patterns in observations and measurements.
- Make classifications and comparisons based on observations and measurements.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS.Ecosys-1 Use information to support that animals need food to live and grow.	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive.

 Scientists look for patterns and order when making observations about the world.

 Incorporate examples from Iowa's ecosystem, such as local plants and animals, to make these patterns relatable. For example, discuss how deer eat plants while sunflowers need sunlight and water. In Iowa's natural environment, animals need food to live and grow, which they get from plants or other animals. Plants, such as the crops we see across Iowa, need water and light to live and grow.

 EE.RI.K.7: With guidance and support, identify illustrations or objects/tactual information that go with a familiar text. By linking images to information, students can better understand how visuals depict plant and animal needs.

 EE.K.MD.1-3: Classify objects according to attributes (big/small, heavy/light). Students can observe plant growth and describe its measurable properties, building descriptive mathematics skills.

DLM Disciplinary Core Idea Family

Ecosystem: Cycling of Matter and Flow of Energy

- Animals grow and change.
- Animals need food to live and grow.
- Animals get food they need from plants or other animals.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in K–2 builds on prior experiences and progresses to exploring questions to gain information.

- In exploring how the natural world works, ask questions that lead to observations, descriptions, and explanations.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system’s behavior.

- Objects may break into smaller pieces, be put together into larger pieces, or change shapes.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS-EcoHlth-1 Use information to describe that many kinds of living things live in different habitats.	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats. **K-ESS3-1** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. **K-PS3-1** Make observations to determine the effect of sunlight on Earth's surface.

Use local Iowa habitats to identify the many different kinds of living things in an area. Include land, moving water, and still water environments.

Scientists look for patterns when making observations about the world.

EE.W.2.8: Identify information related to personal experiences and answer simple questions about those experiences.

SMP 2: Reason abstractly and quantitatively SMP 4: Model with Mathematics EE.2.MD.9-10: Create picture graphs from collected measurement data.

Connect to Iowa's natural resources, such as the importance of water from rivers, soil for farming, and forests that support local wildlife like deer, showing students how people and animals depend on these resources.

Instruction could use local examples, like how sunlight warms playground equipment, soil in fields, or water in ponds, to help students notice how sunlight affects different surfaces around Iowa.

EE.SL.K.5: With guidance and support, add or select drawings or other visual or tactual displays that relate to familiar people, places, things, and events. Students can illustrate the sun's effects on objects, enhancing communication and descriptive skills.

DLM Disciplinary Core Idea Family

Ecosystem Health

- There are many different kinds of living things, and they live in different places.
- Living things need resources (e.g., water, air, and land) to live; living things live where they can find these resources.
- A habitat meets all the environmental conditions an organism needs to survive.

DLM Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Objects and organisms can be described in terms of their parts.
- Systems in the natural and designed world have parts that work together.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS.Group-1 Use information to identify that offspring learn survival behaviors.	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive. **1-LS1-1** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. **1-LS1-2** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

 Scientists look for patterns and order when making observations about the world.

 Incorporate examples from Iowa's ecosystem, such as local plants and animals, to make these patterns relatable. For example, discuss how deer eat plants while sunflowers need sunlight and water. In Iowa's natural environment, animals need food to live and grow, which they get from plants or other animals. Plants, such as the crops we see across Iowa, need water and light to live and grow.

 EE.RI.K.7: With guidance and support, identify illustrations or objects/tactual information that go with a familiar text. By linking images to information, students can better understand how visuals depict plant and animal needs.

 EE.K.MD.1-3: Classify objects according to attributes (big/small, heavy/light). Students can observe plant growth and describe its measurable properties, building descriptive mathematics skills.

 Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. Plants and animal structures can give rise to human technology (e.g., burdock-type seed pods inspired the invention of Velcro).

 In Iowa, hunters use camouflage clothing with colors and patterns that mimic the natural environment, similar to how certain animals blend in to avoid predators. Inspired by animal adaptations, this design helps hunters remain hidden in fields, forests, and prairies.

 EE.W.1.7: With guidance and support, participate in shared research and writing projects.

 Bobwhite quail parents engage in distraction displays, pretending to be injured to lure predators away from their vulnerable young, demonstrating behaviors that increase the chicks' chances of survival. Many songbirds fly at the predators to distract and lead the predators away from their nests.

 EE.RI.1.1 Identify details in familiar text. EE.RI.1.10 Actively engage in shared reading of informational text.

DLM Disciplinary Core Idea Family

Group Survival Behavior

- Animals use their senses to gain information.
- Adult animals can have young (i.e., offspring).
- Offspring learn behaviors from parents that help them survive. Offspring also learn from other family members, community members, and past experience.
- Parents behave in ways to help their offspring survive.
- Behaviors can include protecting, nesting, feeding, hunting, cleaning, grooming, and migrating.

DLM Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS.Trait-1 Use information to show that organisms (both plants and animals) may resemble their biological parents but are not identical to their parents.	**1-LS3-1** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

 EE.W.1.8 With guidance and support from adults, identify information related to personal experiences and answer simple questions about those experiences.

 SMP.2 Reason abstractly and quantitatively. SMP.5 Use appropriate tools strategically.

DLM Disciplinary Core Idea Family

Traits of Organisms

- Young plants and animals are similar, not identical, to their parents.
- Characteristics of individuals of the same kind can vary.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in K–2 builds on prior experiences and progresses to identifying and describing observations and patterns in the natural world.

- Identify and describe patterns in observations and measurements.
- Make classifications and comparisons based on observations and measurements.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Grade K-2 Earth and Space Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.ESS.SolSys-1 Use observations to identify the daily patterns of celestial objects that can appear in the sky during daytime and nighttime.	**1-ESS1-1** Use observations of the sun, moon, and stars to describe patterns that can be predicted.


Science assumes natural events happen today as they happened in the past. The repeatability of events allows scientists to make predictions and inferences that help them support the models/ideas about the natural world.


EE.W.1.7: With guidance and support, participate in shared research and writing projects. EE.W.1.8 With guidance and support from adults, identify information related to personal experiences and answer simple questions about those experiences.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- We live on a planet called Earth.
- From Earth, the Sun, other stars, and the Moon (i.e., celestial objects) can be seen in the sky.
- Stars give off light.
- The Sun, which is a star, provides light during the daytime. Daily, the Sun appears to rise in the morning and set in the evening.
- Except for the Sun, stars can mainly be seen in the sky at nighttime.
- Earth's Moon can mainly be seen in the sky at nighttime. It looks different than stars.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations to collect and use data.

- Collect and compare observations to determine and describe relationships in the natural world.

Analyzing and Interpreting Data: Analyzing data in K–2 builds on prior experiences and progresses to identifying and describing observations and patterns in the natural world.

- Identify and describe patterns in observations and measurements.
- Make classifications and comparisons based on observations and measurements.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.ESS.Earth-1 Use information to describe that different types of bodies of water are found in different locations on Earth's surface.	**2-ESS2-2** Develop a model to represent the shapes and kinds of land and bodies of water in an area. **2-ESS2-3** Obtain information to identify where water is found on Earth and that it can be solid or liquid.


Iowa DNR maps can be used to show land and water across the state. These maps can be used to learn more about the area in which the students live. Field trips to these local areas could be used for students to create their own maps to identify features of the area in which they live.


EE.SL.2.5 - Select visual, audio, or tactual representations to depict a personal experience.


SMP 2: Reason abstractly and quantitatively SMP 4: Model with Mathematics EE.2.NBT.A.3 Identify numerals 1 to 30.


Maps (including topographic maps) of Iowa can be used to locate lakes and rivers. Pictures of bodies of water in different seasons showing water and ice can also be used.


EE.W.2.8: Identify information related to personal experiences and answer simple questions about those experiences.

DLM Disciplinary Core Idea Family

Earth Systems

- Water is found in the ocean, rivers, lakes, ponds, streams, ice caps, and glaciers.
- Water exists as solid ice and in liquid form.

DLM Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.ESS.Earth-2 Use observations to describe that wind and water can change the shape of the land.	**2-ESS1-1** Use information from several sources to provide evidence that Earth events can occur quickly or slowly. **2-ESS2-1** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

 Some of Iowa's landforms were the result of glaciers. These may include Loess Hills, Iowa Great Lakes. Other Iowa landforms (Backbone State Park, Ledges and Dolliver State Parks) also were impacted by glacier action. Fast changes could include tornadoes, derechos, floods, etc. Wind and water erosion could be included as sometimes fast, sometimes slow changes.

 EE.RI.2.1: Answer *who* and *what* questions to demonstrate understanding of details in a familiar text.

 SMP 4: Model with Mathematics EE.2.NBT.1: Represent numbers up to 30 with sets of tens and ones using objects in columns or arrays.

 Iowa’s landscape has been changed due to wind events such as derechos and tornadoes. Flooding has also impacted many Iowa communities across the state in multiple years. Flooding can cause damage to crops, human-designed structures (buildings, bridges, etc.) and natural structures (river banks, shoreline, etc.) One flooding event caused fossils to be revealed (Devonian Gorge).

 EE.RI.2.9: Identify a common element between two texts on the same topic.

 SMP 2: Reason abstractly and quantitatively SMP 4: Model with Mathematics SMP 5: Use appropriate tools strategically EE.2.NBT.B.5.b: Using concrete examples, compose and decompose numbers up to 10 in more than one way.

DLM Disciplinary Core Idea Family

Earth Systems

- Water is found in the ocean, rivers, lakes, ponds, streams, ice caps, and glaciers (see SCI.EE.2.ESS-Earth1).
- Water and wind can change the shape of land.
    - Water carries soil and rocks from one place to another.
    - Wind carries soil from one place to another and wears down rock.
- The change in the shape of land can occur quickly or slowly.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations to collect and use data.

- Collect and compare observations to determine and describe relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Some things stay the same while other things change.
- Things may change slowly or rapidly.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.ESS.Weath-1 Use local weather condition data to describe patterns over time.	**K-ESS2-1** Use and share observations of local weather conditions to describe patterns over time. **K-ESS3-2** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.

 Connect this to Iowa's seasonal changes, helping students observe local patterns, like colder temperatures in the morning during fall and winter, or comparing sunny days in summer versus cloudy days in spring.

 RI.K.3 - Describe connections between individuals, events, ideas, or steps. Students can identify weather patterns and describe their effects on people and nature, building sequence skills.

 EE.K.MD.B.3 - Classify objects according to attributes (big/small, heavy/light).

 People encounter questions about the natural world every day. People depend on various technologies in their lives; human life would be very different without technology.

 Focus on Iowa's local severe weather, such as thunderstorms, tornadoes, and snowstorms, to help students understand how weather forecasting aids in preparing for these events.

DLM Disciplinary Core Idea Family

Weather and Climate

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time.
- "Local" refers to a localized area for weather data, not necessarily the location of the student.
- Recorded measurements or observations of weather conditions can be used to notice patterns over time.
    - The time scale includes a day (a.m. versus p.m.), days, months, seasons, and years (but no more than a two-decade time span).

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in K–2 builds on prior experiences and progresses to identifying and describing observations and patterns in the natural world.

- Identify and describe patterns in observations and measurements.
- Make classifications and comparisons based on observations and measurements.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.ESS.Impact-1 Use information to identify the impacts of severe weather on humans.	**K-ESS2-1** Use and share observations of local weather conditions to describe patterns over time. **K-ESS3-2** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. **2-ESS1-1** Use information from several sources to provide evidence that Earth events can occur quickly or slowly. **K-2-ETS1-1** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

 Connect this to Iowa's seasonal changes, helping students observe local patterns, like colder temperatures in the morning during fall and winter, or comparing sunny days in summer versus cloudy days in spring.

 RI.K.3: Describe connections between individuals, events, ideas, or steps. Students can identify weather patterns and describe their effects on people and nature, building sequence skills.

 EE.K.MD.B.3 - Classify objects according to attributes (big/small, heavy/light).

 People encounter questions about the natural world every day. People depend on various technologies in their lives; human life would be very different without technology.

 Focus on Iowa's local severe weather, such as thunderstorms, tornadoes, and snowstorms, to help students understand how weather forecasting aids in preparing for these events.

 Some of Iowa's landforms were the result of glaciers. These may include Loess Hills, Iowa Great Lakes. Other Iowa landforms (Backbone State Park, Ledges and Dolliver State Parks) also were impacted by glacier action. Fast changes could include tornadoes, derechos, floods, etc. Wind and water erosion could be included as sometimes fast, sometimes slow changes.

 RI.2.1: Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.

 SMP 4: Model with Mathematics 2.NBT.A: Understand place value.

DLM Disciplinary Core Idea Family

Reducing Impacts of Severe Weather

- Severe weather can cause people harm (see SCI.EE.2.ESS-Weath-1).
- Harmful impacts could include loss of shelter, power, and access to food.
- Severe weather is forecasted, so people can prepare and respond.
- A situation that people want to change or create can be approached as a problem to be solved.
- Before solving a problem, it is important to clearly understand the problem.
- Asking questions, making observations, and gathering information help to understand problems.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in K–2 builds on prior experiences and progresses to exploring questions to gain information.

- In exploring how the natural world works, ask questions that lead to observations, descriptions, and explanations.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and other media to identify scientific ideas.

- Use observations, images, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, maps) to answer questions and identify scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

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- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Some things stay the same while other things change.
- Things may change slowly or rapidly.

Third Grade – Fifth Grade

Grade 3-5 Physical Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.PS.Matter-1 Make observations and measurements to describe changes in the physical properties of substances when heated, cooled, or mixed.	**5-PS1-3** Make observations and measurements to identify materials based on their properties.

 EE.5.MD.3- Identify common three-dimensional shapes.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Observations and measurements of a variety of properties can be used to describe physical changes in matter.
    - Measurements could include mass (weight), size (length, width, height), temperature, or volume.
    - Observations could include color, texture, or state of matter.
- A phase change is a physical process in which a substance goes from one phase, or state, to another.
    - Usually, the change occurs when adding or removing heat. The nature of the phase change depends on the direction of the heat transfer.
    - Heat going into a substance changes it from a solid to a liquid or a liquid to a gas.
    - Removing heat from a substance changes a gas to a liquid or a liquid to a solid.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in grades 3–5 builds on K–2 experiences and progresses to using tools and observations in investigations to record data and support claims.

- Collect and record data using tools to determine and support an explanation of a phenomenon.
- Use observations and measurements to determine and describe relationships.

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is made of particles.
- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Change is measured in terms of differences over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.PS.Matter-2 Use evidence to support a claim that matter exists even when it cannot be seen.	**5-PS1-1** Develop a model to describe that matter is made of particles too small to be seen.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Matter is anything (i.e., any substance) that has mass or weight and takes up space in all three states (i.e., solids, liquids, gases).
- Matter, or any substance, exists as particles that are too small to see and can be detected by other means.
    - Observations and measurements of a variety of properties can be used as evidence that matter is made of particles too small to be seen (e.g., syringe not being compressible, tire or balloon inflating or deflating, bubbles, mass of liquid in a closed system before and after evaporation).
- Matter is always conserved (i.e., it is always present even when you can't see it).
    - Matter is conserved even if it seems to disappear.
    - Matter is conserved when matter changes state, phase, or form.
    - Matter is conserved when mixed or combined or heated or cooled.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system’s behavior.

- Matter is made of particles.
- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.PS.Forces-1 Make observations to determine the effects of balanced and unbalanced forces on the motion (i.e., speed and direction) of an object.	**3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. **4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide.

 Science investigations use a variety of methods, tools, and techniques.

 EE.3.OA.9: Identify arithmetic.

 Science findings are based on recognizing patterns.

 EE.L.3.6: Demonstrate understanding of words that signal spatial and temporal relationships (e.g., *behind*, *under*, *after*, *soon*, *next*, *later*).

DLM Disciplinary Core Idea Family

Interacting Forces

- Each force acts on one particular object and has both strength and direction.
- Objects in contact exert forces on each other. One object applies a force on the other and vice versa (i.e., they push on each other).
- A change in the forces acting on an object can cause changes in the motion of that object.
- An object typically has multiple forces acting on it. The motion of an object depends on the total forces acting on that object.
    - When the multiple forces acting on an object balance each other out (i.e., balanced forces have zero net force on the object), there is no change in that object's motion.
    - An object at rest has balanced forces acting on it.
    - An object moving at a constant speed has balanced forces acting on it.
    - Forces acting on an object that are not balanced (i.e., do not sum to zero) can change the object's motion (i.e., speed it up, slow it down, stop it, and change direction).

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in grades 3–5 builds on K–2 experiences and progresses to using tools and observations in investigations to record data and support claims.

- Collect and record data using tools to determine and support an explanation of a phenomenon.
- Use observations and measurements to determine and describe relationships.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 3–5 builds on K–2 experiences and progresses to using data and mathematical concepts to describe the natural and designed world.

- Use simple data tables and graphs to determine and describe relationships in the natural world.
- Use measurements and simple mathematical representations to describe characteristics of the natural world.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.
- Use information to determine and explain relationships in the designed world.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.
- Patterns of change can be used to make predictions.
- Patterns can be used as evidence to support explanation.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.PS.Forces-2 Provide evidence that some objects (e.g., magnets, metals, pith balls, objects falling toward Earth) exert forces on each other even when the objects are not in contact.	**3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. **3-PS2-4** Define a simple design problem that can be solved by applying scientific ideas about magnets. **5-PS2-1** Support an argument that the gravitational force exerted by Earth on objects is directed down.

 EE.RI.3.3 Order two events from a text as “first” and “next.”

 Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.

 EE.W.5.2: Write to share information supported by details.

DLM Disciplinary Core Idea Family

Interacting Forces

- Attraction and repulsion (i.e., motion toward or away from) between objects are evidence of forces between objects that are not in contact.
- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center (i.e., down toward Earth's surface).
- Electric and magnetic forces can act on objects that are not in contact.
    - The magnitudes (or sizes) of the forces acting on objects depend on the objects' distances apart and their orientation relative to each other.
    - Electric forces include static electricity.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.
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- Events that occur together with regularity might or might not be a cause and effect relationship.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.PS.Energy-1 Use observations to support a claim about the amount of energy moved from one place to another by sound, light, heat, and moving objects.	**4-PS3-1** Use evidence to construct an explanation relating the speed of an object to the energy of that object. **4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

EE.RL.4.1 Use details from the text to recount what the text says. EE.W.4.2 Write to share information supported by details.

DLM Disciplinary Core Idea Family

Energy

- Energy is the ability to do work. It is how things change, grow, and move. It's everywhere around us and takes all sorts of forms.
- Moving objects, sound, light, or heat move energy from one place to another. The amount of energy moved (or transferred) can be inferred from the degree to which sound can be heard, light can be seen, heat can be felt, and an object moves.
- The faster a given object moves, the more energy it possesses. The slower the object, the less energy it possesses.
- Sound can make matter vibrate, and vibrating matter can make sound.
    - The louder a sound, the more energy it possesses.
    - The softer a sound, the less energy it possesses.
- Light travels from its source to another location in a straight path.
    - The brighter (or more intense) a light, the more energy it possesses.
    - The dimmer (or less intense) a light, the less energy it possesses.
- Heat is a form of energy.
    - Heat flows from warmer objects to cooler objects.
    - When something is hot, it has a lot of heat energy; when it is cold, it has less.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in grades 3–5 builds on K–2 experiences and progresses to using tools and observations in investigations to record data and support claims.

- Collect and record data using tools to determine and support an explanation of a phenomenon.
- Use observations and measurements to determine and describe relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is made of particles.
- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.

Grade 3-5 Life Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.Org-1 Use information to describe how the parts of organisms help them survive, grow, and reproduce.	**3-LS4-2** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. **4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. **3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles, but all have in common birth, growth, reproduction, and death. **4-LS1-2** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

 EE.W.4.2 Write to share information supported by details.

 Variety of plants and animals include: only some trees have leaves that change color, deer shed their antlers (rutting), beavers log wood, owl pellets show a unique eating/digestion process.

 Science findings are based on recognizing patterns.

 EE.RI.3.7 Use information gained from visual elements and words in the text to answer explicit who and what questions.

 Squirrels use their tails for balance. Birds call to other birds when there is danger.

DLM Disciplinary Core Idea Family

Organisms: Structure and Function, Growth and Development

- Plants and animals have both internal and external structures for growth, survival, and behavior (major structures at the macroscale level and not the cellular level).
- Organisms have unique and diverse life cycles.
- All living things must reproduce in order for the species to survive.

DLM Science and Engineering Practices

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.
- Use information to determine and explain relationships in the designed world.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 3–5 builds on K–2 experiences and progresses to describing scientific ideas.

- Use observations, images, simple texts, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, graphs, maps) to answer questions and support scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

- Different materials have different substructures, which can sometimes be observed.
- Substructures have shapes and parts that serve functions.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.Plant-1 Use data to show that plants use energy (i.e., sunlight) and matter (i.e., air and water) for growth.	**5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water. **5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. **5-PS3-1** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. **5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.


Iowa has many plants and animals that are native to its prairie lands (ex: native grasses, red-winged blackbird, etc.). Energy and matter cycle through this prairie ecosystem.


There are many careers in the agricultural and natural resources job clusters that can be highlighted here, such as botanist, farmer, agronomist, forestry engineer or county conservationist.

DLM Disciplinary Core Idea Family

Plants: Cycling of Matter and Flow of Energy

- Plants acquire materials for growth mainly from the air and water and process matter and obtain energy from sunlight, which is used for body repair and growth.
- Organisms get gases (air) and water from the environment.
- Energy (stored) in plant matter is used for body repair and growth.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

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Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is made of particles.
- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.Ecosys-1 Use data to support that food provides animals with the materials and energy they need for body repair, growth, warmth, and motion.	**3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles, but all have in common birth, growth, reproduction, and death. **5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. **5-PS3-1** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

 Science findings are based on recognizing patterns.

 EE.RI.3.7: Use information gained from visual elements and words in the text to answer explicit who and what questions.

 There are many careers in the Agricultural, Food, and Natural Resources career cluster such as botanist, farmer, environmental scientist, and forestry engineer.

DLM Disciplinary Core Idea Family

Ecosystem: Cycling of Matter and Flow of Energy

- Animals acquire matter and energy from their environment.
- Organisms live where they can find enough food.
- Some animals eat plants for food, and other animals eat the animals that eat plants.
- Food provides animals with the materials they need for body repair, growth, warmth, and motion.
- Energy stored in food can be used for body repair, growth, warmth, and motion.

DLM Science and Engineering Practices

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- Energy can be transferred in various ways and between objects.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.EcoHlth-1 Use information to support that healthy ecosystems meet the needs of many varieties and types of organisms.	**3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. **5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. **3-ESS2-2** Obtain and combine information to describe climates in different regions of the world. **5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

 Iowa plants and animals live in specific habitats such as cactus in Eddyville Sand Dunes or Black Squirrels living in Council Bluffs.

 The introduction of invasive species, such as Zebra mussels in Iowa's waterways or Emerald Ash Borer to Iowa's communities, can be used as examples of changes to an environment which then affect the organisms living there.

 Naturalists and conservation officers work to maintain Iowa's natural ecosystems.

 There are many careers in the Agricultural, Food, and Natural Resources career cluster such as farmer, agronomist, or county conservationist.

 Science findings are limited to questions that can be answered with empirical evidence.

DLM Disciplinary Core Idea Family

Ecosystem Health

- Organisms live in ecosystems. In a healthy ecosystem, organisms can find enough food, water, and space, as well as a place to raise their young.
- Healthy ecosystems have a diversity of plants and animals in a fairly stable environment.
- Healthy ecosystems provide a way for pollination and seed dispersal to occur.
    - Plants depend on seed dispersal and pollination.
    - Seeds are dispersed by wind, water, and animals.
    - Plant pollination occurs by wind, water, and animals.
- Healthy ecosystems meet the survival needs of diverse organisms.

DLM Science and Engineering Practices

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Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 3–5 builds on K–2 experiences and progresses to describing scientific ideas.

- Use observations, images, simple texts, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, graphs, maps) to answer questions and support scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
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System and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.EcoHlth-2 Ask questions to determine how living things (both plants and animals) impact the habitat in which they live. (See 4-ESS2-1)	**3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. **4-ESS2-1** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. **5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. **5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

 Iowa plants and animals live in specific habitats such as cactus in Eddyville Sand Dunes or Black Squirrels living in Council Bluffs.

 The introduction of invasive species, such as Zebra mussels in Iowa's waterways or Emerald Ash Borer to Iowa's communities, can be used as examples of changes to an environment which then affect the organisms living there.

 Naturalists and conservation officers work to maintain Iowa's natural ecosystems.

 MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics.

 There are lots of examples of where weathering and erosion play out in Iowa including Carter Lake, Loess Hills, and erosion of stream banks. Farmers use many agricultural practices that reduce erosion.

 There are many careers in the Agricultural, Food, and Natural Resources career cluster such as farmer, agronomist, or county conservationist.

 Science findings are limited to questions that can be answered with empirical evidence.

DLM Disciplinary Core Idea Family

Ecosystem Health

- Healthy ecosystems have a diversity of plants and animals in a fairly stable environment.
- Organisms live where they can find enough food, water, space, and place to raise their young.
- Living things can impact the physical characteristics of where they live.
    - Animals aid in plant pollination and seed dispersal.
    - Impacts can be positive or negative.
- Populations live in a variety of habitats and change in those habitats affects the organisms living there.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 3–5 builds on K–2 experiences and progresses to identifying questions to gain information through investigation.

- Develop questions that can help determine relationships.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 3–5 builds on K–2 experiences and progresses to describing scientific ideas.

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- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Change is measured in terms of differences over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.Group-1 Provide evidence that animals gain information for survival through their senses.	**4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. **4-LS1-2** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. **3-LS2-1** Construct an argument that some animals form groups that help members survive.

 EE.W.4.2: Write to share information supported by details.

 Variety of plants and animals include: only some trees have leaves that change color, deer shed their antlers (rutting), beavers log wood, owl pellets show a unique eating/digestion process.

 Squirrels use their tails for balance. Birds call to other birds when there is danger.

DLM Disciplinary Core Idea Family

Group Survival Behavior

- Animals, including people, use their senses to learn about the world around them and guide their actions.
- Animals receive light and sound information. Their brains process that information and help them respond with survival behaviors.
- Sound can make matter vibrate, and vibrating matter can make sound (see SCI.EE.5.PS.Energy-1).
    - Objects can be seen when light reflects from the surface of the object and enters the eyes (see SCI.EE.5.PS.Energy-1).
- People and animals share (i.e., communicate) important information with other members of their group or family.

DLM Science and Engineering Practices

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

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Crosscutting Concepts (NSTA, 2013)

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- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.Trait-1 Use information to describe that different organisms vary in how they look due to the traits passed down from their parents.	**3-LS3-1** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

DLM Disciplinary Core Idea Family

Traits of Organisms

- Offspring acquire a mix of traits from their biological parents.
- Organisms resemble their parents and other organisms of the same kind.
- Organisms (both plants and animals) have characteristics that can be similar or different.
- Different organisms vary in how they look and function because they have different inherited information.
- Different characteristics (i.e., differences in phenotype) help individuals survive.

DLM Science and Engineering Practices

Constructing Explanation and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 3–5 builds on K–2 experiences and progresses to describing scientific ideas.

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- Events that occur together with regularity might or might not be a cause and effect relationship.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.LS.Human-1 Use information to describe how humans impact a variety of ecosystems	**3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. **4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. **5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

 Iowa plants and animals live in specific habitats such as cactus in Eddyville Sand Dunes or Black Squirrels living in Council Bluffs.

 The introduction of invasive species, such as Zebra mussels in Iowa's waterways or Emerald Ash Borer to Iowa's communities, can be used as examples of changes to an environment which then affect the organisms living there.

 Naturalists and conservation officers work to maintain Iowa's natural ecosystems.

 Phenomena to use include abandoned coal mines in Iowa, wind turbines, dams, and ethanol production and use.

 Science findings are limited to questions that can be answered with empirical evidence.

 There are many careers in the Agricultural, Food, and Natural Resources career cluster such as farmer, agronomist, or county conservationist.

DLM Disciplinary Core Idea Family

Human Impacts on Ecosystems

- Humans live in many different kinds of ecosystems.
- Change in a habitat affects the organisms living there.
    - Humans live where they can find enough food, water, space, and other natural resources.
    - Healthy ecosystems have a diversity of plants and animals in a fairly stable environment.
- Humans' use of energy and fuels comes from natural sources. Use of resources impacts the ecosystem.
- Humans live in a variety of habitats, and their activities impact those habitats. Impacts can be positive or negative.
- There are changes humans can make to reduce negative or increase positive impacts.
- A situation that people want to change or create can be approached as a problem to be solved.
- Before solving a problem, it is important to clearly understand the problem.
- Asking questions, making observations, and gathering information help to understand problems.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 3–5 builds on K–2 experiences and progresses to identifying questions to gain information through investigation.

- Develop questions that can help determine relationships.

Constructing Explanation and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.
- Use information to determine and explain relationships in the designed world.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 3–5 builds on K–2 experiences and progresses to describing scientific ideas.

- Use observations, images, simple texts, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, graphs, maps) to answer questions and support scientific ideas.

Crosscutting Concepts (NSTA, 2013)

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- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Change is measured in terms of differences over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.

Grade 3-5 Earth and Space Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.SolSys-1 Use data to support that the Sun appears to be the largest and brightest star in the sky because it is the closest star to Earth.	**5-ESS1-1** Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

EE.W.5.2: Write to share information supported by details.

Iowa has strong ties with NASA through the Iowa Space Grant Consortium. Several astronauts have either lived in, or went to school in Iowa such as Peggy Whitson, Clayton Anderson, Raja Chari, Walter Cunningham, Laurel Clark, George Nelson, Dale Gardner, James Kelly, and Loren Shiver.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- The Sun, a star, gives off light.
- Light transfers energy from one place (i.e., a star or the Sun) to another (i.e., Earth) (see SCI.EE.5.PS.Energy-1).
- The Sun is one of many stars that can be seen in the sky.
- The Sun appears as the largest and brightest star in the sky because it is closest to Earth.
- The other stars (i.e., suns) may be larger or smaller than the Sun, but they are farther away and appear dimmer.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.SolSys-2 Use a model to explain the relationship between Earth's rotation on its axis and the 24-hour cycle of nighttime and daytime.	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- The Sun, a star, gives off light, transferring energy to Earth (see SCI.EE.5.ESS-SolSys-1).
- Earth's axis is an imaginary line through Earth that Earth spins around (i.e., rotates).
- Earth spins, or rotates, upon an imaginary axis. This spin results in daytime and nighttime.
- The part of Earth facing the Sun experiences day, or sunlight, while the part of Earth facing away from the Sun experiences nighttime, or darkness.
- Earth completes one full spin upon its axis every 24 hours.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 3–5 builds on K–2 experiences and progresses to using models (e.g., diagram, drawing, physical replica, maps, diorama, dramatization, graphs, storyboard) that represent relationships and events.

- Use and compare models to represent amounts, relationships, and patterns in the natural world.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.
- Patterns of change can be used to make predictions.
- Patterns can be used as evidence to support explanation.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.SolSys-3 Use data from different times of the year to determine seasonal patterns in the number of daylight hours.	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Earth completes one full rotation upon its axis every 24 hours (see SCI.EE.5.ESS-SolSys-2).
    - The part of Earth facing the Sun experiences daytime, or sunlight, while the part of Earth facing away from the Sun experiences nighttime, or darkness.
- The number of daylight hours can vary throughout the year. This variation may result in seasonal patterns.
    - Examples of patterns in the Northern Hemisphere could include that the number of hours of daylight in summer months is generally greater than in winter months, and the number of hours of daylight generally decreases from summer months to winter months.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 3–5 builds on K–2 experiences and progresses to using data and mathematical concepts to describe the natural and designed world.

- Use simple data tables and graphs to determine and describe relationships in the natural world.
- Use measurements and simple mathematical representations to describe characteristics of the natural world.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.
- Patterns of change can be used to make predictions.
- Patterns can be used as evidence to support explanation.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.SolSys-4 Make observations to support that Earth's gravity exerts a downward force on all objects on its surface.	**3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. **5-PS2-1** Support an argument that the gravitational force exerted by Earth on objects is directed down. **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Science investigations use a variety of methods, tools, and techniques.

EE.3.OA.D.9 Identify arithmetic patterns.

EE.W.5.2: Write to share information supported by details.

Science findings are based on recognizing patterns.

EE.L.3.6: Demonstrate understanding of words that signal spatial and temporal relationships (e.g., *behind*, *under*, *after*, *soon*, *next*, *later*).

DCI Family DLM Disciplinary Core Idea Family

Earth in the Solar System

- Some forces act through contact, while other forces act even when the objects are not in contact (see SCI.EE.5.PS.Forces-2).
- Gravity is the force that pulls all objects on Earth's surface downward (i.e., toward the center of Earth).
- Gravity pulls both heavy and light objects downward.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in grades 3–5 builds on K–2 experiences and progresses to using tools and observations in investigations to record data and support claims.

- Collect and record data using tools to determine and support an explanation of a phenomenon.
- Use observations and measurements to determine and describe relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

- Identify relevant evidence to support a claim.
- Use observations, information, data, or a model to support claims.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

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- Patterns of change can be used to make predictions.
- Patterns can be used as evidence to support explanation.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.Earth-1 Use a model to describe the distribution of fresh and salt water on Earth's surface.	**5-ESS2-2** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

DLM Disciplinary Core Idea Family

Earth Systems

- Nearly all of Earth's available water is in the ocean, which is salt water.
- Drinkable water is fresh water, not salt water, and is found in streams, lakes, wetlands, and glaciers.
- There is a limited amount of fresh water on Earth. Most fresh water is in glaciers, and only a tiny fraction is in streams, lakes, and wetlands.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 3–5 builds on K–2 experiences and progresses to using models (e.g., diagram, drawing, physical replica, maps, diorama, dramatization, graphs, storyboard) that represent relationships and events.

- Use and compare models to represent amounts, relationships, and patterns in the natural world.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 3–5 builds on K–2 experiences and progresses to using data and mathematical concepts to describe the natural and designed world.

- Use simple data tables and graphs to determine and describe relationships in the natural world.
- Use measurements and simple mathematical representations to describe characteristics of the natural world.

Crosscutting Concepts (NSTA, 2013)

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower).
- Standard units are used to measure length.
- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.Earth-2 Use information to describe that water is found in different forms almost everywhere on Earth.	**5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. **5-ESS2-2** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

 There are many careers in the Agricultural, Food, and Natural Resources career cluster such as farmer, agronomist, or county conservationist.

DLM Disciplinary Core Idea Family

Earth Systems

- Depending on temperature, water exists in different states: solid, liquid, or gas.
- Water is found almost everywhere on Earth.
    - It is found as water vapor (gas) in the air.
    - It is found in the clouds as tiny water droplets (liquid).
    - It is found in the sky and as rain (liquid), ice (solid), or snow (solid) falling from clouds.
    - It is found as ice, snow, and standing water on Earth's surface.
    - It is found in bodies of water on Earth's surface (e.g., lakes, streams, oceans).
    - It is found as running water on land.

DLM Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 3–5 builds on K–2 experiences and progresses to describing scientific ideas.

- Use observations, images, simple texts, and other media to understand problems and determine how the natural world works.
- Use information (e.g., observations, images, graphs, maps) to answer questions and support scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is made of particles.
- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.Earth-3 Use observations to explain how water, ice, wind, organisms, and gravity break rocks, soil, and sediments into smaller particles and move them around.	**4-ESS2-1** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. **5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

 MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics.

 There are lots of examples of where weathering and erosion play out in Iowa including Carter Lake, Loess Hills, and erosion of stream banks. Farmers use many agricultural practices that reduce erosion.

 There are many careers in the Agricultural, Food, and Natural Resources career cluster such as farmer, agronomist, or county conservationist.

DLM Disciplinary Core Idea Family

Earth Systems

- Water, ice, wind, organisms, and gravity break rocks, soil, and sediments into smaller particles and move them around.
    - This includes weathering, erosion, and deposition.
    - Examples could include sand dunes, potholes, gullies, creeks, mudslides, and rivers carving out canyons.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in grades 3–5 builds on K–2 experiences and progresses to using tools and observations in investigations to record data and support claims.

- Collect and record data using tools to determine and support an explanation of a phenomenon.
- Use observations and measurements to determine and describe relationships.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Change is measured in terms of differences over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.Weath-1 Determine patterns in weather data to help predict future weather.	**3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

 Recorded data from Iowa weather services.

 Meteorologists and Climatologists study weather to help keep us safe.

 EE.3.MD.4 Measure length of objects using standard tools, such as rulers, yardsticks, and meter sticks.

DLM Disciplinary Core Idea Family

Weather and Climate

- Weather is the daily local changes in atmosphere (e.g., wind, amount of sunlight, precipitation, and temperature).
- Patterns in measurements or observations of weather conditions can be used to make and support predictions about future weather.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 3–5 builds on K–2 experiences and progresses to using and interpreting data to support claims and relationships.

- Represent and interpret data in tables or graphs to determine and identify patterns that indicate relationships.
- Use data as evidence for constructing and supporting claims about relationships.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 3–5 builds on K–2 experiences and progresses to identifying information that can support claims about the natural world.

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Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

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- Patterns of change can be used to make predictions.
- Patterns can be used as evidence to support explanation.

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- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.5.ESS.Impact-1 Explain how a design solution reduces the impacts of severe weather on humans	**3-ESS3-1** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. **4-ESS2-1** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. **4-ESS3-2** Generate and compare multiple solutions to reduce the impacts of natural Earth hazards on humans. **5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones).

Reviewing and evaluating solutions such as flood walls along Iowa river banks, snow fences on roads, or application of salt and sand on icy roads can be used to determine the effectiveness of reducing the impact of weather-related hazards.

MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics.

There are lots of examples of where weathering and erosion play out in Iowa including Carter Lake, Loess Hills, and erosion of stream banks. Farmers use many agricultural practices that reduce erosion.

Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.

Iowans can experience tornadoes, forest fires, droughts, floods, and erosion.

Science findings are limited to questions that can be answered with empirical evidence.

There are many careers in the Agricultural, Food, and Natural Resources career cluster such as farmer, agronomist, or county conservationist.

DLM Disciplinary Core Idea Family

Reducing Impacts of Severe Weather

- Natural hazards (e.g., floods, tornadoes, blizzards, mudslides) cannot be stopped, but humans can take steps to reduce their impacts.
- A variety of harmful impacts result from severe weather (see SCI.EE.5.ESS-Weath-1).
- Examples of harmful impacts could include unpassable roads, building damage, and restricted power and communication systems.
- A situation that people want to change or create can be approached as a problem to be solved through engineering.
- Before understanding how a solution works, it is important to clearly understand the problem to be solved.
- Asking questions, making observations, and gathering information help to understand problems.
- Examples of solutions could include lightning rods, wind-resistant roofs, advanced warning systems, and community emergency plans.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 3–5 builds on K–2 experiences and progresses to identifying questions to gain information through investigation.

- Develop questions that can help determine relationships.
- Ask questions about how a simple design solution is used.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 3–5 builds on K–2 experiences and progresses to describing and explaining processes or relationships in the natural or designed world.

- Identify observations, information, data, or models to describe and explain processes or relationships in the natural world.
- Use information to determine and explain relationships in the designed world.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Change is measured in terms of differences over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.

Sixth Grade – Eighth Grade

Grade 6-8 Physical Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Matter-1 Use a particle model of matter to describe the relationships between the states of matter, their characteristics and properties, and temperature.	**6-PS1-4** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Matter (i.e., substance) is made of different types of particles.
- Matter can exist as solids, liquids, or gases depending on temperature. The changes of state that occur with variations in temperature can be described and predicted using particle models of matter.
- In a solid, particles are closely spaced and vibrate in position but do not change relative locations.
- Gases and liquids are made of particles that are moving about relative to each other.
    - In a liquid, the particles are constantly in contact with each other; in a gas, they are widely spaced except when they happen to collide.
    - Gases are made of particles that are moving freely around in space.
- The changes of state that occur with variations in temperature can be described and predicted using these particle models of matter (see SCI.EE.8.PS.Energy-1 and SCI.EE.8.PS.Energy-2).
    - Usually, the change occurs when adding or removing heat. The nature of the phase change depends on the direction of the heat transfer.
    - Heat going into a substance changes it from a solid to a liquid or a liquid to a gas.
    - Particles of matter generally move more or faster when heated.
    - Removing heat from a substance changes a gas to a liquid or a liquid to a solid.
    - Particles of matter generally move less or slower when cooled.
- Bulk properties of states of matter that can be observed or measured can include the ability to move or flow, the ability to take the shape of a container, and the ability to hold its shape or volume.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 6–8 builds on K–5 experiences and progresses to developing and using models (e.g., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop and use models to identify, describe, and compare components of a system.
- Use models to explain and predict relationships between variables and components of a system.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.
    - Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
- Models are limited in that they only represent certain aspects of the system under study.

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is conserved because atoms are conserved in physical and chemical processes.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
- Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).
- The transfer of energy can be tracked as energy flows through a designed or natural system.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Matter-2 Gather and use data to determine whether an interaction between substances results in the formation of a new substance.	**8-PS1-2** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Science knowledge is based upon logical and conceptual connections between evidence and explanations.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Matter (i.e., any substance) is made of different types of particles.
- When two or more substances interact, they can chemically react to form a new substance (or substances). The properties of the new substance or substances are different than the properties of the original substances.
- Pure substances have characteristic physical and chemical properties that can be used to identify them (for any bulk quantity under given conditions).
    - Bulk properties that can be observed or measured can include mass, hardness, brittleness, moldability, volume, odor, solubility, flammability, combustibility, conductivity, ability to flow or move, ability to take shape of container, and pressure.
    - If substances have different properties, they must be comprised of different particles.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 6–8 builds on K–5 experiences and progresses to collecting data during investigations to examine and support claims.

- Gather and use data to determine answers to scientific questions.
- Use observations and measurements to determine and support relationships between variables.

Analyzing and Interpreting Data: Analyzing data in grades 6–8 builds on K–5 experiences and progresses to representing and evaluating data to support explanations about relationships and solutions to problems in the natural world.

- Gather and represent data to determine and describe patterns.
- Evaluate data to construct and support explanations.
- Analyze data to evaluate solutions to problems.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is conserved because atoms are conserved in physical and chemical processes.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
- Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).
- The transfer of energy can be tracked as energy flows through a designed or natural system.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Matter-3 Gather and use data to support the law of conservation of mass when substances change.	**8-PS1-5** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Theories provide explanations in science based on evidence and laws are statements or descriptions of the relationships among observable phenomena. Differentiating between laws and theories and how they are not hierarchical in their nature laws and theories are different types of scientific information. Both theories and laws are well-supported by evidence and the consensus of the scientific community.

Iowa is a leader in ethanol production. Iowa ranks first in the nation for electricity produced by renewable energy per capita.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Conservation of matter: Matter is neither created nor destroyed.
    - The mass of starting substances equals the mass of the ending substances during a chemical or physical phase change in a closed system.
    - Data that can serve as evidence of the conservation of matter could include observations like smoke, bubbles, odor, balloon expansion, and masses of ending and beginning substances.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 6–8 builds on K–5 experiences and progresses to collecting data during investigations to examine and support claims.

- Gather and use data to determine answers to scientific questions.
- Use observations and measurements to determine and support relationships between variables.

Analyzing and Interpreting Data: Analyzing data in grades 6–8 builds on K–5 experiences and progresses to representing and evaluating data to support explanations about relationships and solutions to problems in the natural world.

- Gather and represent data to determine and describe patterns.
- Evaluate data to construct and support explanations.
- Analyze data to evaluate solutions to problems.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 6–8 builds on K–5 experiences and progresses to use information to make and evaluate claims about the natural world.

- Use observations, information, data, or a model to evaluate a claim.
- Gather and use information as evidence to support a claim.
- Use information to make claims.

Crosscutting Concepts (NSTA, 2013)

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is conserved because atoms are conserved in physical and chemical processes.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
- Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).
- The transfer of energy can be tracked as energy flows through a designed or natural system.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Forces-1 Use observations and measurements to determine how an object's mass affects the force needed to change its motion.	**7-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. **7-PS2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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

 Careers in Building Trades: Architecture, Construction and Engineering.

 Theories provide explanations in science based on evidence and laws are statements or descriptions of the relationships among observable phenomena. Both are well-supported with evidence and consensus of the scientific community.

 A pony truss bridge in Maxwell, IA is different from other truss bridges because it allows traffic to go through it and is not connected by braces over the top.

DLM Disciplinary Core Idea Family

Interacting Forces

- The motion of an object depends on the total forces acting on that object (see SCI.EE.5.PS.Forces-1).
- Newton's third law of motion: For any pair of interacting objects, the forces exerted by each object on the other are equal and opposite. In other words, the force exerted by the first object on the second object is equal to the force that the second object exerts on the first but in the opposite direction.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 6–8 builds on K–5 experiences and progresses to representing and evaluating data to support explanations about relationships and solutions to problems in the natural world.

- Gather and represent data to determine and describe patterns.
- Evaluate data to construct and support explanations.
- Analyze data to evaluate solutions to problems.

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 6–8 builds on K–5 experiences and progresses to collecting data during investigations to examine and support claims.

- Gather and use data to determine answers to scientific questions.
- Use observations and measurements to determine and support relationships between variables.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 6–8 builds on K–5 experiences and progresses to using and applying data and mathematical concepts to understand relationships in the natural and designed world.

- Apply mathematical concepts and processes to determine and describe relationships between variables.
- Use mathematical representations and reasoning to compare characteristics of components of a system.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Forces-2 Make observations of the motion of two colliding objects to provide evidence of Newton's third law.	**7-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. **7-PS2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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

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DLM Disciplinary Core Idea Family

Interacting Forces

- The motion of an object depends on the total forces acting on that object (see SCI.EE.5.PS.Forces-1).
- The greater the mass of the object, the greater the force needed to achieve the same change in motion.
    - A stronger force is needed to move a more massive object.
    - A stronger force moves a more massive object faster or farther.

DLM Science and Engineering Practices

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Engaging in Argument from Evidence: Engaging in argument from evidence in grades 6–8 builds on K–5 experiences and progresses to use information to make and evaluate claims about the natural world.

- Use observations, information, data, or a model to evaluate a claim.
- Gather and use information as evidence to support a claim.
- Use information to make claims.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Energy-1 Develop a model to infer the relationship between the kinetic energy and temperature of an object or particles of a substance.	**6-PS1-4** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **7-PS3-1** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

 Car racing is very prominent in Iowa. Iowa Speedway in Newton holds NASCAR Cup and other races. There are also several racetracks that host drag racing including Cedar Falls, Earlville, Eddyville, and the I-29 Speedway. There are dozens of smaller dirt-car tracks around the state.

DLM Disciplinary Core Idea Family

Energy

- Motion energy is called kinetic energy (at both the macro and micro scales).
- The faster particles or objects move or vibrate, the greater the kinetic energy.
- Temperature* can serve as a measure of the average kinetic energy (i.e., motion) of particles of matter.
    - The higher the total kinetic energy of particles or objects, the higher the temperature (i.e., thermal energy of matter).
    - The term heat refers to the motion of particles of matter (i.e., the thermal energy of matter). The particles of hot substances move more or faster relative to particles of cold substances.
    - Because the energy of an object cannot be directly observed or measured, the energy of a system can be inferred from a measurement of its temperature.

* The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present (see SCI.EE.8.PS.Matter-1).

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 6–8 builds on K–5 experiences and progresses to developing and using models (e.g., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop and use models to identify, describe, and compare components of a system.
- Use models to explain and predict relationships between variables and components of a system.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.
- Use information to evaluate solutions in the designed world.

Crosscutting Concepts (NSTA, 2013)

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
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Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is conserved because atoms are conserved in physical and chemical processes.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
- Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).
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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Energy-2 Provide evidence that kinetic energy is transferred between two objects when they collide with each other.	**7-PS3-1** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. **7-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.


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DLM Disciplinary Core Idea Family

Energy

- Energy cannot be created or destroyed.
- When objects collide, kinetic energy can flow (i.e., transfer) from one object to another.
    - When two objects are in contact, each one exerts a force on the other that can cause kinetic energy to be transferred from one object to another (see SCI.EE.8.PS.Forces-2).
    - When kinetic energy is transferred from one object to another, the motion of those objects can change.
    - Examples could include the changes in motion that occur when a moving marble collides with a stationary marble or when two moving marbles collide.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to developing and using questions to clarify information and define problems.

- Classify and compare information that answers questions about how the natural world works.
- Develop questions that can be answered by an investigation.
- Ask questions that help to define a simple design problem.

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 6–8 builds on K–5 experiences and progresses to collecting data during investigations to examine and support claims.

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- Use observations and measurements to determine and support relationships between variables.

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- Use observations, information, data, or a model to evaluate a claim.
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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.PS.Energy-3 Develop a model to describe the behavior of light (i.e., transmission, reflection, scattering) that comes into contact with objects made of different materials.	**6-PS4-2** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

DLM Disciplinary Core Idea Family

Energy

- Light allows us to see our world and gain visual information.
- Light waves can move through empty spaces. This is why we can see stars even though they are far away.
- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material.
    - Light will behave differently depending on the type of matter it comes into contact with.
    - Sometimes light will pass directly through the matter, like with air or water (i.e., transparent matter).
    - Other objects, like an animal or a book (i.e., opaque matter), blocks light from passing through them. Reflection of light occurs when it hits a surface that, instead of absorbing light, bounces the light away from the surface. Absorption of light occurs when light is neither reflected by nor transmitted through an object.
    - A third type of object (i.e., translucent matter) does some of both (i.e., transmit and reflect) and tends to scatter the light in all directions.

- Light travels from its source to another location in a straight path, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 6–8 builds on K–5 experiences and progresses to developing and using models (e.g., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop and use models to identify, describe, and compare components of a system.
- Use models to explain and predict relationships between variables and components of a system.

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Grade 6-8 Life Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.Org-1 Provide evidence that living things are made of cells, some of which are unicellular while others are multicellular.	**6-LS1-1** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. **6-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function. **6-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

 Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

 Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

 Our rich agricultural landscape in Iowa provides evidence of various body systems that interact as subsystems of the functioning organism. For example, cows have one stomach with four distinct compartments that work together to digest and distribute nutrients (digestive system).

 Careers in the medical field tie directly to this standard (doctors, physical therapists, occupational therapists, speech therapists, nurses). Elmer L. DeGowin MD, an Iowan, developed in 1939, modern-day blood banking which demonstrated that it is safe to refrigerate, ship, and use banked blood.

DLM Disciplinary Core Idea Family

Organisms: Structure and Function, Growth and Development

- Living things are made of cells.
  - Cells are the smallest unit of life.
  - Most cells have a nucleus and a membrane.
  - Nuclei contain hereditary materials and control the cells.
  - Membranes protect the cell and control materials moving into and out of the cell.
- There are unicellular and multicellular living things.
  - Multicellular organisms are made of multiple cells, and possibly different types of cells.
  - The cell of a unicellular organism handles all the organism's functions.
  - The cells of a multicellular organism work together to support all the organism's functions.

DLM Science and Engineering Practices

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 6–8 builds on K–5 experiences and progresses to use information to make and evaluate claims about the natural world.

- Use observations, information, data, or a model to evaluate a claim.
- Gather and use information as evidence to support a claim.
- Use information to make claims.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 6–8 builds on K–5 experiences and progresses to combining information to describe and support scientific claims and ideas.

- Decide which observations, images, texts, data, and other media are useful for defining problems and determining how the natural world works.
- Combine information (e.g., observations, texts, tables, images, graphs, maps) to answer scientific questions and evaluate scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

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Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.
- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.Plant-1 Use data to explain that plants use energy (i.e., sunlight) and matter (i.e., air and water) to produce food (i.e., plant matter) for growth.	**8-LS1-6** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Science knowledge is based upon logical connections between evidence and explanations.

EE.RI.8.8 - Determine the argument made by an author in an informational text.

DLM Disciplinary Core Idea Family

Plants: Cycling of Matter and Flow of Energy

- Plants use light energy (i.e., sunlight) and matter (i.e., air and water) from the environment to produce food.
- The food produced by plants is used for growth, used for energy, or stored for later use.
- The apparent increase in plant matter or material (e.g., increase in mass, height of stalk, number of leaves) is evidence of the transfer of matter from the environment to the plant.

DLM Science and Engineering Practices

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- Gather and represent data to determine and describe patterns.
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- Analyze data to evaluate solutions to problems.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.Ecosys-1 Use a model to describe the transfer of food (i.e., matter and energy) between plants, animals, and decomposers.	**7-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

DLM Disciplinary Core Idea Family

Ecosystem: Cycling of Matter and Flow of Energy
Energy (i.e., sunlight) is required for plants to produce food (i.e., plant matter). Therefore, the energy released from food was once energy from the Sun that was captured by plants in the process that forms plant matter (from air and water) (see SCI.EE.8.LS.Plant-1).

- The food produced by plants is used for growth, used for energy, or stored for later use.
- Some animals eat plants; some animals eat both plants and animals; some animals eat only animals.
- Organisms are interconnected in food webs. Food webs model how matter and energy are transferred among producers, consumers, and decomposers.
- Decomposers break down dead plants and animals, recycling nutrients to the soil.

DLM Science and Engineering Practices

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- Develop and use models to identify, describe, and compare components of a system.
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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.EcoHlth-1 Use data to explain the relationship between organisms' survival and growth and their interactions with both living and nonliving factors in their ecosystem.	**7-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **7-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **7-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **7-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **7-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

 Iowa has many keystone species like crawfish, oak trees, river otters, and freshwater mussels that affect ecosystems.

 Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

 Careers in Agriculture, Food, and Natural Resources (Department of Natural Resources, water treatment, and water lab chemists).

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

 Trojan Carp Project in the Missouri River involves reducing invasive species.

 Iowa Living Roadways Community Visioning: Iowa Department of Transportation (DOT) program to plant Iowa native plants along roadways for prairie restoration.

DLM Disciplinary Core Idea Family

Ecosystem Health

- Organisms, including humans, depend on their habitat (biosphere, hydrosphere, atmosphere, and geosphere) for many living and nonliving resources. These resources are not evenly distributed.
- The survival of organisms is dependent upon their interactions with both other living things (biosphere) and nonliving factors (geosphere, hydrosphere, and atmosphere).
- Interactions could include predation, competition, disease, immigration of species, cooperation or symbiosis, drought, flood, food availability, and nesting and sheltering.
- Limiting factors slow or stop population growth. Examples include predation, competition, disease, immigration of species, weather, food, and water availability.
- Limiting factors affect populations' access to living and nonliving resources.
- Ecosystems can change over time.
- Living organisms (biosphere) have impacted Earth's spheres (hydrosphere, geosphere, and atmosphere).
    - Human activity can disrupt or improve ecosystems.
    - Focus is on the interactions or impacts and not on identifying or naming spheres.

DLM Science and Engineering Practices

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Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

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Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.
- Small changes in one part of a system might cause large changes in another part.
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time.
- Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.Group-1 Use information to explain the relationship between animals' abilities to sense and communicate information and the response behaviors that help them grow and survive.	**7-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. **6-LS1-8** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

 Native flowers, crops, and pollinators local to Iowa are examples.

 Careers in Agriculture, Food, and Natural Resources: (e.g., agronomists, fisheries and wildlife biologists).

DLM Disciplinary Core Idea Family

Group Survival Behavior

- Animals sense and communicate information and respond with behaviors that help them grow and survive.
- Sense receptors capture different types of information that is processed by the brain to guide behavior.
- Sound transmits through a medium (e.g., air, land) via vibrations, which are detected by the ears and through touch.
- Light travels through space, and when shined on a nonluminous object, it is reflected. The object can be seen when the reflected light enters the eyes (see 8.PS.Energy-3).
- Luminous objects can be seen when their light enters the eyes.
- Emphasis is on behavior leading to individual survival, not population survival.

DLM Science and Engineering Practices

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- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

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- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.
- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.Trait-1 Use information to determine how the environment affects organisms' traits and their survival.	**8-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. **7-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **7-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **7-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **8-LS4-4** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. **8-LS4-6** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

EE.RI.8.8 - Determine the argument made by an author in an informational text.

Trojan Carp Project in the Missouri River involves reducing invasive species.

Careers in Agriculture, Food, and Natural Resources: (e.g., agronomists, fisheries and wildlife biologists).

Iowa has many keystone species like crawfish, oak trees, river otters, and freshwater mussels that affect ecosystems.

SMP 5: Use appropriate tools strategically: Graphs are charts are mathematical representations of how natural selection may increase or decrease populations over time.

DLM Disciplinary Core Idea Family

Traits of Organisms

- Particular organisms can survive only in particular environments.
- Species can change over time in response to changes in environmental conditions through adaptation by natural selection that acts over generations.
    - Characteristics of individuals result from interactions with their environments. These interactions are diverse and can include diets based on food availability, behaviors learned within a community, roots growing longer and deeper to reach the water table during drought, and outer layers (e.g., skin, fur, bark) becoming thicker due to varying climate.
    - The environment also affects the traits that a population develops; differences in where they grow or in the food they consume may cause organisms that are related (i.e., the population) to end up looking or behaving differently.
    - Certain traits help with or increase the chance of survival and are passed down from parents to offspring, becoming more common over time (see 8.LS.Org-1). Traits that do not help with or increase the chance of survival are not passed down to offspring, becoming less common over time.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to developing and using questions to clarify information and define problems.

- Classify and compare information that answers questions about how the natural world works.
- Develop questions that can be answered by an investigation.
- Ask questions that help to define a simple design problem.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 6–8 builds on K–5 experiences and progresses to combining information to describe and support scientific claims and ideas.

- Decide which observations, images, texts, data, and other media are useful for defining problems and determining how the natural world works.
- Combine information (e.g., observations, texts, tables, images, graphs, maps) to answer scientific questions and evaluate scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

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- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
- Models are limited in that they only represent certain aspects of the system under study.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.
- Small changes in one part of a system might cause large changes in another part.
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time.
- Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.LS.Human-1 Define problems caused by human activities on ecosystems.	**7-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **7-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **7-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **7-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **6-8-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **8-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

 All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

 Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

 Iowa's agriculture is directly affected by changes in climate, including shifts in growing seasons, increased frequency of extreme weather events, and rainfall variability.

 Trojan Carp Project in the Missouri River involves reducing invasive species.

 Careers in Agriculture, Food, and Natural Resources (e.g., agronomists, fisheries and wildlife biologists).

 Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

 New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choice, impact technology. All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

 The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. New technologies can have deep impacts on society and the environment, including some that were not anticipated.

DLM Disciplinary Core Idea Family

Human Impacts on Ecosystems

- Human activity can disrupt ecosystems.
- Organisms, including humans, depend on their habitat (biosphere, hydrosphere, atmosphere, and geosphere) for many living and nonliving resources. These resources are not evenly distributed.
- Humans' use of energy and fuels comes from natural sources.
- Organisms are dependent on their interactions with both other living things (biosphere) and nonliving factors (geosphere, hydrosphere, and atmosphere).
    - Interactions could include predation, competition, disease, immigration of species, cooperation or symbiosis, weather, food availability, nesting, and sheltering.
- Limiting factors slow or stop population growth. Examples include predation, competition, disease, immigration of species, weather, food, and water availability.
- Unstable environments experience changes that impact populations, such as floods, drought, disease, too many predators, or immigration of other species.
    - Unstable environments can decrease biodiversity.
    - Changes in biodiversity affect populations' access to living and nonliving resources. This includes humans.
- Living organisms (biosphere) have impacted Earth's spheres (hydrosphere, geosphere, and atmosphere).
    - Focus is on the interactions or impacts and not on identifying or naming spheres.

DLM Science and Engineering Practices

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Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

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- Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.

Grade 6-8 Earth and Space Science

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.SolSys-1 Use models to compare the components of our solar system and describe the motions of those components.	**7-ESS1-2** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. **7-ESS1-3** Analyze and interpret data to determine scale properties of objects in the solar system.

 Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. This includes Moon landings and sending probes to Mars and other solar system bodies.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Our solar system is within the Milky Way galaxy, which is one of many galaxies.
- A galaxy is a group of stars that we see in the night sky.
- The Sun is one of many stars in the galaxy.
- Earth, as well as other planets, rotate upon (or spin around) an axis as they orbit the Sun.
- The time it takes a planet to complete a full rotation upon its axis is the length of a day. Earth takes 24 hours to complete a full rotation.
- A moon orbits (or revolves around) a planet. It takes about a month for the Moon to orbit Earth.
- Earth and the other planets orbit the Sun. It takes a year, or about 365 days, for Earth to orbit the Sun.
- The distances of the planets from the Sun vary. Earth is the third closest to the Sun.
- The apparent motion of the Sun in the sky can be explained by Earth's motion.
- The east–west pattern of sunrise and sunset can be observed, described, and predicted by modeling the rotation of Earth relative to the Sun.

DLM Science and Engineering Practices

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Developing and Using Models: Modeling in grades 6–8 builds on K–5 experiences and progresses to developing and using models (e.g., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop and use models to identify, describe, and compare components of a system.
- Use models to explain and predict relationships between variables and components of a system.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 6–8 builds on K–5 experiences and progresses to using and applying data and mathematical concepts to understand relationships in the natural and designed world.

- Apply mathematical concepts and processes to determine and describe relationships between variables.
- Use mathematical representations and reasoning to compare characteristics of components of a system.

Crosscutting Concepts (NSTA, 2013)

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
- The observed function of natural and designed systems may change with scale.
- Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
- Scientific relationships can be represented through the use of algebraic expressions and equations.
- Phenomena that can be observed at one scale may not be observable at another scale.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.SolSys-2 Use a model of the Sun-Earth-Moon system to explain the relationships between the motion of the Moon and the cyclical patterns of its phases.	**7-ESS1-1** Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

 Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Earth rotates upon (or spins around) an axis as it orbits the Sun.
- The parts of Earth experiencing night are turned away from the Sun.
- Earth takes 24 hours to complete a full rotation.
- The cyclical patterns of the Moon's phases can be modeled by the Sun-Earth-Moon system.
- Light transfers energy from one place (i.e., the Sun) to another (i.e., the Moon and Earth) (see 8.PS.Energy-3).
    - The Moon does not produce light.
    - The Moon's light we see is the Sun's light reflected off the Moon's surface. Thus, light energy spontaneously transfers from the Sun to the Moon, and then to Earth.

DLM Science and Engineering Practices

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- Develop and use models to identify, describe, and compare components of a system.
- Use models to explain and predict relationships between variables and components of a system.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

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- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.SolSys-3 Use a model to explain the relationships between the orientation of Earth's axis in relation to the Sun, Earth's motion, and the seasonal patterns in the number of daylight hours.	**7-ESS1-3** Analyze and interpret data to determine scale properties of objects in the solar system. **7-ESS1-1** Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

 Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. This includes Moon landings and sending probes to Mars and other solar system bodies.

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DLM Disciplinary Core Idea Family

Earth in the Solar System

- Light energy is spontaneously transferred from the Sun to Earth (see SCI.EE.8.SolSys-1).
- Earth orbits, or revolves around, the Sun.
- Earth rotates upon an axis that is tilted.
- As Earth orbits the Sun, Earth's tilt in relation to the Sun (toward or away from the Sun) results in seasonal patterns in the number of daylight hours.

DLM Science and Engineering Practices

Developing and Using a Model: Modeling in grades 6–8 builds on K–5 experiences and progresses to developing and using models (e.g., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop and use models to identify, describe, and compare components of a system.
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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.SolSys-4 Use a model to describe the role of gravity in the motions of planets and their moons within the solar system.	**7-ESS1-2** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. **7-PS2-4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.


Astronauts Peggy Whitson, Clayton Anderson, Raja Chari, Walter Cunningham, Laurel Clark, George Nelson, Dale Gardner, James Kelly, and Loren Shiver are all from Iowa. Iowa has strong ties with NASA through our Iowa Space Grant Consortium.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Gravitational forces are always attractive.
- Gravity is the force that holds together the solar system and controls orbital motions within it.
- Gravity exists between all objects everywhere in the universe.
- Every celestial body in the universe attracts every other celestial body.
- The planets within our solar system are held in orbit around the Sun by its gravitational pull on them.
- Moons are held in orbit around their planets by their gravitational pull on the moons.

DLM Science and Engineering Practices

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.Earth-1 Use a model to explain how water continuously cycles between the surface of Earth and the atmosphere.	**7-ESS2-4** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. **7-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.


Waterfalls (Dunning's Springs State Park, Decorah, IA) and crop growth due to evapotranspiration.

DLM Disciplinary Core Idea Family

Earth Systems

- Water cycles among land, bodies of water (e.g., ocean, lakes, rivers, streams) and the atmosphere (or air).
    - Matter is neither created nor destroyed (see SCI.EE.8.PS-Matter-2). Therefore, the same water particles continually cycle between the atmosphere (i.e., air) and Earth's surface.
- The processes that cycle water include evaporation, condensation, precipitation, and gravity pulling water downhill.
    - During evaporation, liquid water particles absorb the Sun's energy and change to gas (i.e., water vapor) (see SCI.EE.8.PS-Energy-1 and SCI.EE.8.PS-Energy-2).
    - During condensation, gaseous water particles in the air lose energy, cooling and changing to liquid, which forms clouds.
- During precipitation, liquid and solid water particles fall from clouds to Earth's surface.
- Depending on temperature, water particles exist in different states: solid, liquid, or gas.

- The kinetic energy of water particles in vapor is greater than in liquid, which is greater than in solid (see SCI.EE.8.PS-Matter-1).

DLM Science and Engineering Practices

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Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is conserved because atoms are conserved in physical and chemical processes.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).
- The transfer of energy can be tracked as energy flows through a designed or natural system.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.Earth-2 Use information to evaluate a claim about how the hydrosphere affects the shape of land (i.e., the geosphere) over time.	**6-ESS2-2** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. **7-ESS2-4** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

 Various natural events in Iowa (e.g. flooding or frost boils) provide evidence for geoscience processes that impact Earth's surface.

 Waterfalls (Dunning's Springs State Park, Decorah, IA) and crop growth due to evapotranspiration.

DLM Disciplinary Core Idea Family

Earth Systems

- The geosphere refers to Earth features and components such as rocks, minerals, and landforms.
- The hydrosphere refers to all water on Earth's surface. This includes water that is part of the general water cycle (e.g., clouds, rain) (see SCI.EE.8.ESS-Earth-1).
- Gravity directs the flow of water (including glaciers) downhill.
    - Moving water carries soil and rocks from one place to another.
    - Over time, this affects the shape of land.
- The force of precipitation (i.e., rain, sleet, hail) can also affect the shape of land over time (see SCI.EE.8.ESS-Earth-1 and SCI.EE.5.PS-Forces-2).

DLM Science and Engineering Practices

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 6–8 builds on K–5 experiences and progresses to use information to make and evaluate claims about the natural world.

- Use observations, information, data, or a model to evaluate a claim.
- Gather and use information as evidence to support a claim.
- Use information to make claims.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 6–8 builds on K–5 experiences and progresses to combining information to describe and support scientific claims and ideas.

- Decide which observations, images, texts, data, and other media are useful for defining problems and determining how the natural world works.
- Combine information (e.g., observations, texts, tables, images, graphs, maps) to answer scientific questions and evaluate scientific ideas.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.Weath-1 Determine the weather data needed to describe patterns in the movement of air masses that likely cause changes in weather.	**8-ESS2-5** Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

 Careers in Meteorology could include weatherpersons, research scientists, and weather consultation experts.

DLM Disciplinary Core Idea Family

Weather and Climate

- Weather is affected by the Sun's heat, movement of water in the atmosphere, and interactions between moving air masses.
- Weather is defined by temperature, humidity (i.e., water vapor in the air), precipitation, and wind.
- Air masses are large bodies of air that have roughly the same temperature and humidity throughout.
- Air masses take on the weather characteristics of where they were formed (arctic, tropical, polar, and equatorial).
    - Air masses that form over the poles tend to be cold.
    - Air masses that form near the equator tend to be warm.
    - Air masses that form over water tend to be wet.
- Air masses that form over land tend to be dry.
- Air masses move around in the atmosphere because of winds. When winds move air masses, the air masses carry their weather conditions (hot or cold, dry or moist) from the source region to a new region.
- This can lead to major changes in the weather.
    - For example, colder weather occurs when a cold air mass pushes a warm air mass out of the way.

DLM Science and Engineering Practices

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- Develop questions that can be answered by an investigation.
- Ask questions that help to define a simple design problem.

Analyzing and Interpreting Data: Analyzing data in grades 6–8 builds on K–5 experiences and progresses to representing and evaluating data to support explanations about relationships and solutions to problems in the natural world.

- Gather and represent data to determine and describe patterns.
- Evaluate data to construct and support explanations.
- Analyze data to evaluate solutions to problems.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 6–8 builds on K–5 experiences and progresses to combining information to describe and support scientific claims and ideas.

- Decide which observations, images, texts, data, and other media are useful for defining problems and determining how the natural world works.
- Combine information (e.g., observations, texts, tables, images, graphs, maps) to answer scientific questions and evaluate scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.Weath -2 Use information to describe the relationships between regional climates, location on Earth, geographic features, and weather.	**8-ESS2-6** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. **8-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choice, impact technology. All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

DLM Disciplinary Core Idea Family

Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, ice, bodies of water, and landforms. These interactions vary with latitude, altitude, and local and regional geography.
- Weather is a specific event, such as a rainstorm or hot day that happens over a few hours, days, or weeks. Weather can change from hour to hour or even year to year.
- Climate is the long-term pattern of weather in a particular area. The region's average weather patterns, usually tracked for at least 30 years, are considered its climate.
- Different parts of the world have different climates.
    - Tropical wet climates occur in parts of the world near the equator that are hot and rainy nearly every day.
    - Polar climates occur in parts of the world near the poles that are cold and snow-covered most of the year.
    - Between the icy poles and the steamy tropics are many other climates that contribute to Earth's biodiversity.
- The climate of an area in which air masses originate eventually affects the weather in other areas.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 6–8 builds on K–5 experiences and progresses to representing and evaluating data to support explanations about relationships and solutions to problems in the natural world.

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- Evaluate data to construct and support explanations.
- Analyze data to evaluate solutions to problems.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to constructing explanations about processes or relationships in the natural or designed world.

- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 6–8 builds on K–5 experiences and progresses to combining information to describe and support scientific claims and ideas.

- Decide which observations, images, texts, data, and other media are useful for defining problems and determining how the natural world works.
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- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
- The observed function of natural and designed systems may change with scale.
- Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
- Scientific relationships can be represented through the use of algebraic expressions and equations.
- Phenomena that can be observed at one scale may not be observable at another scale.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.8.ESS.Impact-1 Evaluate solutions that reduce the impacts of severe weather on humans.	**6-ESS3-2** 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. **8-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **8-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

 Iowans experience natural hazards (e.g. (e.g. tornadoes, flooding and blizzards) and utilize various technologies to predict time and location of events.

 Meteorologists work to keep us safe in dangerous weather. This includes local weather people and national organizations like NOAA.

 New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choice, impact technology. All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

DLM Disciplinary Core Idea Family

Reducing Impacts of Severe Weather

- A variety of harmful impacts can result from severe weather, which can occur suddenly with little warning.
- Severe weather in a specific region can be predicted, but sometimes predictions are inaccurate.
- A situation that people want to change or create can be approached as a problem to be solved through engineering.
- Before designing a solution to solve a problem, it is important to clearly understand the problem.
- Asking questions, making observations, and gathering information help to understand problems.
- The success of a designed solution is determined by considering the desired features of a solution (i.e., criteria).
- Different solutions need to be evaluated in order to determine which of them best solves the problem, given the criteria and constraints.

DLM Science and Engineering Practices

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- Use information, data, or models to construct descriptions and explanations of processes and relationships in the natural world.
- Use information to evaluate solutions in the designed world.

Crosscutting Concepts (NSTA, 2013)

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Ninth Grade - Twelfth Grade

High School Physical Science Standards

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Matter-1 Use a model to describe that substances are made of different types and numbers of atoms.	**HS-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- Atoms are the smallest particle of matter that comprises a substance (i.e., compounds, molecules).
- A molecule or compound (i.e., a substance) is composed of specific types and numbers of atoms.
    - Limit to simple and common substances such as sodium chloride (NaCl- salt), carbon dioxide (CO2), oxygen (O2), and water (H2O).
- Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different numbers and types of atoms.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop, use, and evaluate models to describe relationships between variables and components of a system.
- Use models to construct and evaluate explanations in the natural world.

Crosscutting Concepts (NSTA, 2013)

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems can be designed to do specific tasks.
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- The total amount of energy and matter in closed systems is conserved.
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
- Energy drives the cycling of matter within and between systems.

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Matter-2 Use a model to describe that in chemical reactions, the atoms in the starting substances (i.e., the reactants) rearrange to form new substances (i.e., the products).	**HS-PS1-2** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- A chemical reaction occurs when the atoms comprising substances are rearranged or regrouped to form new substances (i.e., the groupings of atoms in starting substances are different than in the ending substances).

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Matter-3 Based on data, describe how the temperature and amount (i.e., concentration) of reacting substances affect the rates of chemical reactions.	**HS-PS1-5** 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 a reaction occurs. **HS-PS1-6** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.


Iowa winters call for additives to be used in diesel vehicles.


Design a solution for a complex real-world problem by breaking down into smaller manageable steps.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- The rearrangement of atoms that occurs during chemical reactions results from particle collisions.
  - The atoms or molecules involved in the reaction move about and collide with each other.
  - When they collide, the original groupings or arrangements of atoms change.
  - The faster the atoms or molecules move (i.e., the higher the kinetic energy), the more they collide.
  - The higher the temperature, the faster the atoms or molecules move and the more they collide.
  - The greater the number of atoms or molecules, the more they collide.
  - The more the atoms or molecules collide, the faster new substances are produced (i.e., the faster the atom rearrangement occurs).

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 9–12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world.

- Use mathematical reasoning to construct and support claims about the relationships between variables.

- Analyze and interpret data to investigate the relationships and characteristics of the components of a system.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 9–12 builds on K–8 experiences and progresses to evaluating information to construct arguments about the natural world.

- Use observations, information, data, models, and mathematical reasoning to develop and evaluate claims.
- Use information to construct an argument.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
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- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Change and rates of change can be quantified and modeled over very short or very long periods of time.
- Some system changes are irreversible.
- Feedback (negative or positive) can stabilize or destabilize a system.
- Systems can be designed for greater or lesser stability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Matter-4 Use a model to support the law of the conservation of matter during chemical reactions.	**HS-PS1-7** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

 Science assumes the universe is a vast single system in which basic laws are consistent. Differentiating between laws and theories and how they are not hierarchical in their nature. Laws and theories are different types of scientific information.

 SMP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics.

DLM Disciplinary Core Idea Family

Matter and Chemical Reactions

- A molecule or compound is a substance composed of groupings of atoms with specific types and numbers of atoms.
    - Limit to very simple and common compounds such as sodium chloride (NaCl, salt), carbon dioxide (CO2), oxygen (O2), and water (H2O).
- An atom is the smallest particle of matter that comprises a substance (i.e., molecule, compound).
- A chemical reaction occurs when the atoms comprising substances are rearranged or regrouped to form new substances (i.e., the groupings of atoms in starting substances are different than in the ending substances).
- The rearrangement of atoms that occurs during chemical reactions results from particle collisions.
    - The atoms or molecules involved in the reaction move about and collide with each other.
    - When they collide, the original groupings or arrangements of atoms change.
    - The faster the atoms or molecules move (i.e., the higher the kinetic energy), the more they collide.
    - The higher the temperature, the faster the atoms or molecules move and the more they collide.
    - The greater the amount of atoms or molecules, the more they collide.
    - The more the atoms or molecules collide, the faster new substances are produced (i.e., the faster the atom rearrangement occurs).
- The same types and numbers of atoms are present at the beginning and end of a chemical reaction in a closed system.
- The total mass of beginning substances is equal to the total mass of ending substances in a closed system.
- Limit to counting atoms in a provided model or image or measuring the mass of starting and ending substances in a closed system.
- Evidence of conservation of matter includes the types and numbers of atoms as well as the masses of the substances involved in the reaction.
- Models can include mathematical representations such as mass data, chemical equations, and physical models such as ball and stick models.

DLM Science and Engineering Practices

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Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 9–12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world.

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- Systems can be designed for greater or lesser stability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Forces-1 Conduct an investigation to describe the relationships between force, mass, and acceleration.	**HS-PS2-1** 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 its acceleration.

 Theories provide explanations in science based on evidence and laws are statements or descriptions of the relationships among observable phenomena.

 SMP.2 Reason abstractly and quantitatively. SMP.4 Model with mathematics.

DLM Disciplinary Core Idea Family

Interacting Forces

- Acceleration is the rate of change of velocity of a macroscopic object.
    - Usually, acceleration means the speed or direction of an object's motion is changing. o If an object is not changing its speed or direction, then the object is not accelerating.
- Newton's second law of motion is F = ma, where F = (net) force, m = mass, and a = acceleration.
    - When acceleration is constant, there is a direct relationship between force and mass. A larger force is needed for a more massive object to experience the same acceleration as a less massive object.
    - When mass is constant, there is a direct relationship between force and acceleration. A larger force is needed to increase the acceleration of an object.
    - When force is constant, there is an inverse relationship between mass and acceleration. When the same force is applied to two objects of differing masses, the acceleration of the more massive object is less than that of the less massive object.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions.

- Manipulate variables and collect data to serve as evidence for claims about the natural world.
- Gather and use data to inform the improvement of a design solution.

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 9–12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world.

- Use mathematical reasoning to construct and support claims about the relationships between variables.
- Analyze and interpret data to investigate the relationships and characteristics of the components of a system.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
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Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
- Patterns observable at one scale may not be observable or exist at other scales.
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Forces-2 Conduct an investigation to describe the factors that affect the strength of electrical and magnetic forces between interacting objects.	**HS-PS2-4** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. **HS-PS3-5** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

 Theories provide explanations in science while laws are statements or descriptions of the relationships among observable phenomena.

 SMP.2: Reason abstractly and quantitatively. SMP.4: Model with mathematics.

DLM Disciplinary Core Idea Family

Interacting Forces

- Electric and magnetic forces can be attractive and repulsive, and their strengths or sizes depend on 1) the magnitudes of the electric charges or the strengths of the magnets involved and 2) the distances between the interacting objects.
- Focus only on the qualitative relationships of variables in Coulomb's law. (The greater the magnitudes of electric charges or strengths of magnets involved, the greater the attractive or repulsive force between objects. The greater the distance between the objects involved, the less the attractive or repulsive force between them.)
- Limit to static electricity only.

DLM Science and Engineering Practices

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- Analyze and interpret data to investigate the relationships and characteristics of the components of a system.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus, requiring improved investigations and experiments.
- Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
- Mathematical representations are needed to identify some patterns.
- Empirical evidence is needed to identify patterns.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

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- Patterns observable at one scale may not be observable or exist at other scales.

- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Energy-1 Gather data to describe the thermal energy transfer between two objects or substances in contact with each other.	**HS-PS3-1** 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 of the system are known. **HS-PS3-2** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). **HS-PS3-4** 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 results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

 Science assumes the universe is a vast single system in which basic laws are consistent.

 A1. N-Q. A: Reason quantitatively and use units to solve problems.

 Opening a compost pile on a chilly morning allows heat to escape and a thermometer stuck into a compost pile near the surface and deep into the pile, shows radically different temperatures on a spring day. In 2025, Iowa ranks in the top 10 for power grid reliability while maintaining some of the lowest electricity prices in the country for residential, commercial, and industrial customers. (U.S. Energy Information Administration Annual Electric Power Industry Report, Oct 2025)

DLM Disciplinary Core Idea Family

Energy

- Energy can neither be created nor destroyed (see SCI.EE.8.PS.Energy-2).
- The term heat refers to the motion of particles of matter (i.e., the thermal energy of matter). The particles of hot substances move more or faster relative to particles of cold substances (see SCI.EE.8.PS.Energy-1).
    - The higher the total kinetic energy of particles of objects, the higher the temperature (i.e., thermal energy of matter).
    - Heat, or thermal energy, can be transferred from one object or substance to another when those objects or substances are in contact and are at different temperatures.
- When two objects or particles are in contact, each one exerts a force on the other that can cause kinetic energy to be transferred from one of the objects or particles to the other (see SCI.EE.8.Energy2 and SCI.EE.8.PS.Forces-2).
- Heat energy continuously flows from hotter objects (i.e., objects comprised of particles moving more or faster) to cooler objects (i.e., objects comprised of particles moving less or slower) until those objects are at equal temperatures (i.e., their comprising particles have equal, average kinetic energy).
- The type of matter (i.e., particles) comprising an object or substance, the size or amount of the object or substance, and the temperature of the environment in which the object or substance is found affect the amount of heat (i.e., thermal energy transfer) needed to change the object's or substance's temperatures.
    - A substance may absorb heat without a change in temperature by changing its state of matter (i.e., melting, boiling, and condensing) (see SCI.EE.8.PS.Matter-1).

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions.

- Manipulate variables and collect data to serve as evidence for claims about the natural world.
- Gather and use data to inform the improvement of a design solution.

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 9–12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world.

- Gather and use information to construct descriptions and explanations of processes and relationships in the natural world.
- Use data and models to evaluate and improve design solutions.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Systems can be designed to cause a desired effect.
- Changes in systems may have various causes that may not have equal effects.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
- Patterns observable at one scale may not be observable or exist at other scales.
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems can be designed to do specific tasks.
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- The total amount of energy and matter in closed systems is conserved.
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
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- Energy drives the cycling of matter within and between systems.
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.PS.Energy-2 Ask questions to describe the relationship between sound energy and the vibrations of particles of matter.	**HS-PS4-1** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. **HS-PS3-2** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). **HS-PS3-1** 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 of the system are known.

 Sundogs are colored spots of light that develop due to the refraction of light through ice crystals. The colored spots of light are seen around 22 degrees either to the left or right or on both sides of the sun.

 SMP.2 Reason abstractly and quantitatively. SMP.4 Model with mathematics.

 Science assumes the universe is a vast single system in which basic laws are consistent.

 A1. N-Q. A: Reason quantitatively and use units to solve problems.

 Opening a compost pile on a chilly morning allows heat to escape and a thermometer stuck into a compost pile near the surface and deep into the pile, shows radically different temperatures on a spring day. In 2025, Iowa ranks in the top 10 for power grid reliability while maintaining some of the lowest electricity prices in the country for residential, commercial, and industrial customers. (U.S. Energy Information Administration Annual Electric Power Industry Report, Oct 2025)

DLM Disciplinary Core Idea Family

Energy

- Sound allows us to hear and communicate.
- Sound usually travels in all directions.
- Sound transmits through a medium (e.g., air, land) via vibrations, which are detected by the ears and through touch.

    - Sound travels through air, water, and solid objects as vibrations (i.e., shaking or moving back and forth).
    - Sound results from the back-and-forth vibrations of the particles of the medium through which the sound wave is moving. When the medium is a solid, vibrations may be felt through touch.
    - When an object vibrates back and forth, it pushes on neighboring air particles. This causes air particles to vibrate. When these vibrating air particles reach the ears, sound is heard.
- The louder a sound, the greater the vibrations of the particles of the medium through which it travels. Therefore, a louder sound possesses more energy than a softer sound.
- The volume or loudness of a sound decreases the farther it is from its source. Therefore, sound decreases in energy as it moves away from its source.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 9–12 builds on K–8 experiences and progresses to developing and refining questions that lead to explanations.

- Develop and evaluate testable questions.
- Gain information through questioning to describe relationships.

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions.

- Manipulate variables and collect data to serve as evidence for claims about the natural world.
- Gather and use data to inform the improvement of a design solution.

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High School Life Science Standards

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.Org-1 Use a model to construct an explanation of how systems of specialized cells within organisms work together to perform essential functions of life.	**HS-LS1-2** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

 Many careers in the health sciences work with how systems of the body work together.

DLM Disciplinary Core Idea Family

Organisms: Structure and Function, Growth and Development

- Living things are made up of a system of specialized cells.
- Groups of cells work together to form systems of cells (examples of tissue could include muscle or nerve).
- Systems of cells form organs (e.g., heart, lung, ear) and organ systems (e.g., circulatory system, respiratory system).
- Organs and organ systems perform specific body functions.
- Organs and organ systems interact to perform life functions of an organism.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop, use, and evaluate models to describe relationships between variables and components of a system.
- Use models to construct and evaluate explanations in the natural world.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 9– 12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world.

- Gather and use information to construct descriptions and explanations of processes and relationships in the natural world.

Crosscutting Concepts (NSTA, 2013)

System and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems can be designed to do specific tasks.
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- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.Plant-1 Use a model to explain the role of plants in the flow of energy and matter among organisms in the ecosystem.	**HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. **HS-LS1-7** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy. **HS-LS2-4** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.


Maple syrup is produced in Iowa by tapping trees.


Agriculture, food, and natural resources are all areas where careers exist that relate to this content.


All careers in the Health Sciences career cluster depend on how systems of the body work together.


SMP.2: Reason abstractly and quantitatively. SMP.4: Model with mathematics.

DLM Disciplinary Core Idea Family

Plants: Cycling of Matter and Flow of Energy

- The energy released from food was once energy from the Sun that was captured by plants in the process that forms plant matter (from air and water).
    - The main way solar energy is captured and stored on Earth is through the process of plants making food.
    - Plants make their own food and are a source of food for animals.
    - Plants capture and use energy from the Sun and matter in the environment (water and air) to make food (plant matter), releasing air (i.e., oxygen). (The chemical equation, elements, and compounds in the process of photosynthesis are not included.)
    - Matter for much of life comes from this process (i.e., plants capture sunlight, water, and air from the environment to produce plant matter that is transferred to the rest of the ecosystem).
    - As food matter is transferred among organisms in a living system, the matter is broken down and rearranged into new groupings of atoms (see SCI.EE.12.PS.Matter-2).
- Energy for much of life comes from this process (i.e., the sunlight captured by plants is transferred to the rest of the ecosystem via food). o Energy is transferred from organism to organism within (i.e., flows through) an ecosystem.
    - Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.
    - Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.
    - Energy and matter from plants are used by animals for body repair, growth, reproduction, and motion or are stored for later use.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop, use, and evaluate models to describe relationships between variables and components of a system.
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Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 9– 12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world.

- Gather and use information to construct descriptions and explanations of processes and relationships in the natural world.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.Ecosys-1 Develop a model that describes how matter (plant or animal matter) and energy (i.e., sunlight and food energy) are cycled within an ecosystem.	**HS-LS2-3** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. **HS-LS2-4** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-5** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. **HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

 Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.

 Ethanol production is an example of a common Iowa product that relies on energy transfer during aerobic and anaerobic conditions for its production. This is a strong economic factor in Iowa.

 SMP.2: Reason abstractly and quantitatively. SMP.4: Model with mathematics.

 Prairie ecosystems were once the predominant land systems in Iowa that participated in the carbon cycle and built Iowa's rich soil.

 Maple syrup is produced in Iowa by tapping trees.

 Agriculture, food, and natural resources are all areas where careers exist that relate to this content.

DLM Disciplinary Core Idea Family

Ecosystem: Cycling of Matter and Flow of Energy

- Matter and energy flow through living systems.
- Matter and energy are cycled and transferred from one system to another.
- Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.
- The energy released from food was once energy from the Sun that was captured by plants in the process that forms plant matter (from air and water) (see SCI.EE.12.LS.Plant-1).
- As food matter is transferred among organisms in a living system, the matter is broken down and rearranged into new groupings of atoms (see SCI.EE.12.PS.Matter-2). This process provides organisms with matter and energy for life.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop, use, and evaluate models to describe relationships between variables and components of a system.
- Use models to construct and evaluate explanations in the natural world.

Crosscutting Concepts (NSTA, 2013)

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.EcoHlth-1 Use data to make an argument about the effects of unstable environments on the health of ecosystems.	**HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-6** Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem. **HS-LS2-7** Design, evaluate, and refine a solution for increasing environmental sustainability and biodiversity. **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

 The Iowa DNR uses the idea of carrying capacity to manage the population of deer, fish, and other wildlife.

 Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.

 Iowa bald eagle populations have changed over time as well as invasive species (e.g., ash borer disease, Asian beetles, zebra mussels).

 SMP.2: Reason abstractly and quantitatively. SMP.4: Model with mathematics.

 Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.

 Loss of prairie habitat, habitat restoration, and impacts on species (example: pheasant populations, oak savannah, etc.) are all important topics in Iowa.

 Agricultural practices, water quality, Iowa's alternative energy sources (biofuels, wind energy, etc.).

 Engineers design, evaluate, and refine a solution to complex real-world problems.

 Modern civilization depends on major technological systems. New technologies can have deep impacts on society and the environment, including some that were not anticipated.

 Agricultural and environmental professionals collaborate to study and make recommendations for soil and water conservation.

DLM Disciplinary Core Idea Family

Ecosystem Health

- A healthy ecosystem can support the needs of diverse populations. Therefore, a healthy ecosystem supports biodiversity.
- Resource availability determines where animals and humans live.
- Ecosystems have limits on organisms and populations.
    - Limits on ecosystems are based on resource availability (both living and nonliving resources). o Limiting factors slow or stop population growth. Examples may include predation, competition, disease, immigration of species, weather, food, and water availability.
- Unstable environments impact populations of animals and plants.
    - An unstable ecosystem is unable to resist disturbances and quickly returns to its average state after a disturbance.
    - Disturbances or disruptions to living and nonliving factors in ecosystems affect the populations living there.
    - Unstable environments may be caused by a variety of factors such as drought, flood, migration, immigration, invasive species, disease, or an unhealthy predator-to-prey ratio.
    - Unstable environments can decrease biodiversity.
    - Changes in biodiversity affect populations' access to living and nonliving resources. This includes humans.
    - Human activity can disrupt or disturb ecosystems.
    - Changes in weather and climate impact ecosystems.
- Earth's spheres interact, impacting ecosystems.
    - The biosphere and geosphere dynamically interact: Living organisms (biosphere) have impacted Earth's spheres (hydrosphere, geosphere, and atmosphere) and vice versa.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 9–12 builds on K–8 experiences and progresses to evaluating information to construct arguments about the natural world.

- Use observations, information, data, models, and mathematical reasoning to develop and evaluate claims.
- Use information to construct an argument.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

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Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
- Feedback (negative or positive) can stabilize or destabilize a system.
- Systems can be designed for greater or lesser stability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.2.LS.Group-1 Use data to support a claim about how group behavior affects individuals' and species' chances to survive.	**HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.

Migration of snow geese happened across Iowa each fall and spring.

DLM Disciplinary Core Idea Family

Group Survival Behavior

- Being part of a group helps animals meet their survival needs (e.g., obtain food and water, defend themselves, raise young, cope with changes). Therefore, being in a group within a community increases the survival chances of individuals in the group.
- An increased chance of individuals' survival, in turn, increases the chance of reproduction between individuals, sustaining the population (or species).
- Group behaviors might include hunting, migrating, swarming, flocking, and schooling.

DLM Science and Engineering Practices

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.Trait-1 Use information to support a claim that heredity and the environment influence the traits of an individual.	**HS-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. **HS-LS4-2** Construct an explanation based on evidence that the process of evolution primarily results from 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 are better able to survive and reproduce in the environment. **HS-LS4-3** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

 Livestock and crops are bred to have properties that make them more economical.

 Agriculture, Food and Natural Resources; Health Sciences such as breeding cattle, or genetically modifying crops.

 Avian influenza is something that the Department of Natural Resources (DNR) tracks.

 EE.S-ID.4: Calculate the mean of a given data set (limit the number of data points to fewer than five).

DLM Disciplinary Core Idea Family

Traits of Organisms

- Traits are passed down from parents to offspring. Therefore, characteristics of individuals are affected by heredity before they are born.
    - The characteristics inherited by offspring from the same parents vary, resulting in related organisms with diverse traits.
    - Offspring exhibit different phenotypes, affecting how they look and function.
- The environment also affects the traits an organism develops.
    - Environmental influences on traits can include resource availability, population density, ability to camouflage to escape predation, disease, change in climate (temperature, precipitation, wind, and amount of sunlight), and soil composition.
- Traits and characteristics of organisms influence the organisms' functions and behaviors. Behaviors and functions that allow for survival in a specific environment influence what traits are inherited. Traits that support survival become common in a population, and those that do not support survival become less common. Therefore, the distribution of traits in a population can change.

DLM Science and Engineering Practices

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 9–12 builds on K–8 experiences and progresses to evaluating information to construct arguments about the natural world.

- Use observations, information, data, models, and mathematical reasoning to develop and evaluate claims.
- Use information to construct an argument.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 9–12 builds on K–8 experiences and progresses to comparing and combining multiple sources of information to communicate and evaluate scientific claims and ideas.

- Combine multiple observations, images, texts, data, and other media to evaluate problems and explanations of how the natural world works.
- Combine information (e.g., observations, texts, tables, images, graphs, maps) to pose scientific questions and scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus, requiring improved investigations and experiments.
- Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
- Mathematical representations are needed to identify some patterns.
- Empirical evidence is needed to identify patterns.

Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

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- Changes in systems may have various causes that may not have equal effects.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.Trait-2 Use mathematical reasoning to support relationships between changing environmental conditions, adaptation by natural selection, and changes in the distribution of traits within a population.	**HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. **HS-LS4-1** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. **HS-LS4-2** Construct an explanation based on evidence that the process of evolution primarily results from 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 are better able to survive and reproduce in the environment. **HS-LS4-3** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. **HS-LS4-4** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. **HS-LS4-5** 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 of new species over time, and (3) the extinction of other species.

 Technological advances have influenced the progress of science and science has influenced advances in technology. Science and engineering are influenced by society and society is influenced by science and engineering.

 A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. Scientific knowledge assumes that natural laws operate today as they did in the past and they will continue to do so in the future.

 Devonian Fossil Gorge, Rockford Iowa Fossil and Prairie Park, Iowa Mastodon discoveries are all local Iowa resources.

 Avian influenza is something that the Department of Natural Resources (DNR) tracks.

 EE.S-ID.4: Calculate the mean of a given data set (limit the number of data points to fewer than five).

 Scientific knowledge assumes that natural laws operate today as they did in the past and they will continue to do so in the future.

 Monarch butterfly populations move through Iowa on their migrations.

 Clearing invasive species (example: musk thistle from prairies, carp) or the adaptation of native species (examples: prairie plants and prairie chickens) would be great phenomena to use with this topic.

DLM Disciplinary Core Idea Family

Traits of Organisms

- The distribution of expressed traits in a population result from (1) the potential for a species to reproduce and increase in number, (2) heritable traits due to reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- Adaptation impacts the distribution of traits in a population as changes in conditions occur.
    - Species' characteristics can change over generations in response to changes in environmental conditions. Environmental changes can occur naturally or due to human activities.
    - Natural selection may lead to increases and decreases of specific traits in populations over time.
    - Traits that increase the chance of survival are passed down from parents to offspring through reproduction, becoming more common within the population. Traits that do not increase the chance of survival are not passed down to offspring, becoming less common within the population.

DLM Science and Engineering Practices

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 9– 12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world.

- Use mathematical reasoning to construct and support claims about the relationships between variables.
- Analyze and interpret data to investigate the relationships and characteristics of the components of a system.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 9–12 builds on K–8 experiences and progresses to evaluating information to construct arguments about the natural world.

- Use observations, information, data, models, and mathematical reasoning to develop and evaluate claims.
- Use information to construct an argument.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Systems can be designed to cause a desired effect.
- Changes in systems may have various causes that may not have equal effects.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
- Patterns observable at one scale may not be observable or exist at other scales.
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems can be designed to do specific tasks.
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
- Feedback (negative or positive) can stabilize or destabilize a system.
- Systems can be designed for greater or lesser stability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.LS.Human-1 Evaluate design solutions that minimize the effects of human activities on the health of ecosystems.	**HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-6** Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem. **HS-LS2-7** Design, evaluate, and refine a solution for increasing environmental sustainability and biodiversity. **HS-LS4-5** 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 of new species over time, and (3) the extinction of other species. **HS-LS4-6** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. **HS-ESS3-3** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4** Evaluate or refine a technological solution that reduces society's influence on natural systems. **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-3** 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.

Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.

Iowa bald eagle populations have changed over time as well as invasive species (e.g., ash borer disease, Asian beetles, zebra mussels).

SMP.2: Reason abstractly and quantitatively. SMP.4: Model with mathematics

Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.

Loss of prairie habitat, habitat restoration, and impacts on species (example: pheasant populations, oak savannah, etc.) are all important topics in Iowa.

Agricultural practices, water quality, Iowa's alternative energy sources (biofuels, wind energy, etc.).

Engineers design, evaluate, and refine a solution to complex real-world problems.

Clearing invasive species (example: musk thistle from prairies, carp) or the adaptation of native species (examples: prairie plants and prairie chickens) would be great phenomena to use with this topic.

Create or revise a simulation of a phenomenon, designed device, process, or system.

New bee species, orchids, and fish are now found in Iowa.

Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choices impact technology.

 Iowa connections include the use of wind turbines and biofuels and the use of prairie, buffer strips, cover crops, and riparian areas to reduce impact on the environment.

 Many careers (e.g., construction, agriculture, transportation) use modern technologies such as GPS, drones, and automation to increase efficiencies to reduce impacts.

 New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choice, impact technology. All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies. Although technology is typically intended to solve problems, not all problems can be solved with technology.'

DLM Disciplinary Core Idea Family

Human Impacts on Ecosystems

- Resource availability determines where animals and humans live. Limits on ecosystems are based on resource availability (both living and nonliving resources).
- Biodiversity is essential to maintain ecosystems and life on Earth. Changes to living and nonliving parts of an ecosystem affect the biodiversity of the organisms living there.
- Humans face challenges in meeting their needs and protecting the environment.
    - Human activity and their dependence on natural resources (see SCI.EE.12.ESS.Earth-2) are adversely affecting biodiversity. (Examples of activities could include deforestation, air and water pollution, soil health, and dramatic change in animal or plant population.)
    - To sustain both human life and biodiversity, humans need to make responsible decisions in how they use natural resources.
- Science and engineering can be used to reduce the impacts of human activity on natural resources and biodiversity.
- Different solutions need to be evaluated in order to determine which of them best solves the problem, given the criteria and constraints. (Examples of solutions could include planting trees and reintroducing species.)

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 9–12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world.

- Gather and use information to construct descriptions and explanations of processes and relationships in the natural world.
- Use data and models to evaluate and improve design solutions.

Crosscutting Concepts (NSTA, 2013)

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- Systems can be designed for greater or lesser stability.

High School Earth and Space Science Standards

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.SolSys-1 Use mathematical reasoning to describe the relationships between the amount of energy released by a star that reaches Earth and the star's mass and distance from Earth.	**HS-ESS1-1** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation, supplying Earth with energy.

 While models have limitations, scientists use models to generate and test their ideas about the natural world.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Stars (including the Sun) spontaneously release energy. Through sunlight, that energy is transferred from the Sun to Earth.
- The light from stars transferred to Earth varies depending on the stars' masses and distances from the Sun.
    - Generally, the larger a star's mass, the greater the energy it releases. o
    - Generally, the closer a star is to Earth, the brighter it appears.

- The brightness of a star as seen from Earth is directly related to the amount of energy it transfers to Earth.

DLM Science and Engineering Practices

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- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 9–12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world.

- Use mathematical reasoning to construct and support claims about the relationships between variables.
- Analyze and interpret data to investigate the relationships and characteristics of the components of a system.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus, requiring improved investigations and experiments.
- Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
- Mathematical representations are needed to identify some patterns.
- Empirical evidence is needed to identify patterns.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
- Patterns observable at one scale may not be observable or exist at other scales.
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- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.SolSys-2 - Gather data to determine the relationship between the intensity and directness of sunlight reaching Earth's surface and seasonal temperature patterns	**HS-ESS1-1** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.


While models have limitations, scientists use models to generate and test their ideas about the natural world.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Through sunlight, energy is transferred from the Sun to Earth (see SCI.EE.12.ESS.SolSys-1).
- As Earth orbits the Sun, Earth's tilt in relation to the Sun (toward or away from the Sun) results in seasonal temperature patterns.
- The seasonal temperature patterns are a result of the differential intensity of sunlight on different areas of Earth across the year.

DLM Science and Engineering Practices

Developing and Using Models: Modeling in grades 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world.

- Develop, use, and evaluate models to describe relationships between variables and components of a system.
- Use models to construct and evaluate explanations in the natural world.

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions.

- Manipulate variables and collect data to serve as evidence for claims about the natural world.
- Gather and use data to inform the improvement of a design solution.

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Crosscutting Concepts (NSTA, 2013)

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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- Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
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- Empirical evidence is needed to identify patterns.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.SolSys-3 Analyze and interpret data to describe the relationships between the gravitational force between objects in the solar system, their masses, and the distance between them.	**HS-PS2-4** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. **HS-ESS1-4** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

 Theories provide explanations in science while laws are statements or descriptions of the relationships among observable phenomena.

 SMP.2: Reason abstractly and quantitatively. SMP.4: Model with mathematics.

 Science and engineering complement each other in the cycle known as research and development (R&D). Modern civilization depends on major technological systems.

DLM Disciplinary Core Idea Family

Earth in the Solar System

- Gravity is an attractive force that results from mass and affects everything with mass. Therefore, every object with mass has gravity.
- The strength of the gravitational force between two objects depends on the mass of each object and the distance between them.

    - There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass (e.g., Earth and the Sun, Earth and its Moon) between them.
    - There is a gravitational force between any two masses, but its strength decreases the farther the objects are away from each other.
- The Sun is by far the most massive object in the solar system, so its gravitational pull is the strongest, which is why planets orbit the Sun.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Using Mathematics and Computational Thinking: Mathematical and computational thinking in grades 9–12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world.

- Use mathematical reasoning to construct and support claims about the relationships between variables.
- Analyze and interpret data to investigate the relationships and characteristics of the components of a system.

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- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.Earth-1 Use data to make a claim that a change to one of Earth's spheres can cause changes to other Earth's spheres (i.e., geosphere, hydrosphere, atmosphere, biosphere)	**HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. **HS-ESS2-7** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

 Modern civilization depends on major technological systems. New technologies can have deep impacts on society and the environment, including some that were not anticipated.

 Agricultural and environmental professionals collaborate to study and make recommendations for soil and water conservation.

 Wind and water both impact agriculture through soil erosion, nutrient interaction, and runoff. This erosion and runoff have implications for water quality throughout the state.

 All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

 MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics.

DLM Disciplinary Core Idea Family

Earth Systems

- Earth's major systems are the geosphere, hydrosphere, atmosphere, and biosphere.
  - The geosphere refers to rock, soil, sediments, and landforms.
  - The hydrosphere refers to water and ice.
  - The atmosphere refers to air.
  - The biosphere refers to living things.
- These spheres are dynamic and interact amongst themselves.
  - These interactions have occurred for a long time and will continue to occur.
  - The changes resulting from these interactions can occur on different time scales, from immediate to long-term.
  - These interactions both positively and negatively affect the life of organisms.
- Examples may include the following:
  - A rise in global temperatures that melts glacial ice, which increases surface temperatures, further reducing the amount of ice.
  - A loss of ground vegetation causes an increase in water runoff and soil erosion.
  - A loss of water from wetlands causes a decrease in local humidity that decreases rain, which reduces the population of plants and animals living there.

DLM Science and Engineering Practices

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.

- Analyze data to design and evaluate solutions to problems.

Engaging in Argument from Evidence: Engaging in argument from evidence in grades 9–12 builds on K–8 experiences and progresses to evaluating information to construct arguments about the natural world.

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Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.Earth-2 Ask questions to determine how a change in one of Earth's systems (i.e., spheres) affects humans.	**HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate changes and trends have influenced human civilizations. **HS-ESS3-3** Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-LS2-6** Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem.

Modern civilization depends on major technological systems. Society and technology interact in both positive and negative ways depending upon various perspectives. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choices impact technology.

Examples of Iowa natural resources include: soil, water, grain crops, livestock, and natural areas. Examples of Iowa natural hazards include: tornadoes, flooding, derechos, blizzards, droughts, and extreme cold and heat.

Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choices impact technology.

All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

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Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.

Loss of prairie habitat, habitat restoration, and impacts on species (example: pheasant populations, oak savannah, etc.) are all important topics in Iowa.

DLM Disciplinary Core Idea Family

Earth Systems

- Earth's major systems are the geosphere, hydrosphere, atmosphere, and biosphere (see SCI.EE.12.ESSEarth-1).
- These spheres are dynamic and interact amongst themselves (see SCI.EE.12.ESS-Earth-1).
    - Any natural substance that humans use can be considered a natural resource. o
    - Resource availability determines where humans live. o Limits on ecosystems are based on resource availability (both living and nonliving resources).
    - Changes in biodiversity affect humans' access to living and nonliving resources (see SCI.EE.12.LSEcoHlth-1).

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 9–12 builds on K–8 experiences and progresses to developing and refining questions that lead to explanations.

- Develop and evaluate testable questions.
- Gain information through questioning to describe relationships.

Crosscutting Concepts (NSTA, 2013)

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- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Change and rates of change can be quantified and modeled over very short or very long periods of time.
- Some system changes are irreversible.
- Feedback (negative or positive) can stabilize or destabilize a system.
- Systems can be designed for greater or lesser stability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.Weath-1 Use data to determine the relationship between the absorption of the Sun's energy by Earth's spheres (i.e., geosphere, hydrosphere, atmosphere, biosphere) and trends in average global temperature.	**HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in climate changes and trends. **HS-ESS2-6** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. **HS-ESS3-5** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

 Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

 Related Iowa careers and industry include biofuels, wind, solar and hydroelectric energy production.

 Manufacturing, Technology, Engineering such as environmental engineering.

 SMP.2: Reason abstractly and quantitatively. SMP.4: Model with Mathematics

 Agriculture leverages the connections among the hydrosphere, atmosphere, geosphere, and biosphere to improve agricultural processes (e.g., food, fuel, and fiber production).

 Science investigations use diverse methods and do not always use the same set of procedures to obtain data. That is, there is no single step-by-step "scientific method". New technologies advance scientific knowledge. Science knowledge is based on empirical evidence. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

 Careers in construction, engineering, and city planning must account for unpredictable weather due to regional and global climate trends.

 All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

DLM Disciplinary Core Idea Family

Weather and Climate

- Climate is the long-term pattern of weather in a particular area. The region's average weather patterns, usually tracked for at least 30 years, are considered its climate (see SCI.EE.8.ESS.Weath-1).
- The transfer of energy from the Sun to Earth drives average global temperature (see SCI.EE.12.ESS.SolSys-1 and SCI.EE.12.ESS.SolSys-2).
- The Sun's energy is absorbed and stored by Earth's systems (atmosphere, hydrosphere, geosphere), which increases surface temperature (see SCI.EE.12.ESS-Earth-1).
    - Climate changes and trends can occur when Earth's atmosphere and hydrosphere are altered.
    - Human activity adds gases to the atmosphere (i.e., air) and hydrosphere (i.e., oceans) that absorb the Sun's light energy and heat, which increases average global temperature.
    - Therefore, average global temperature is one indicator of a change in climate.
- Models predict that average global temperature will continue to rise.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions.

- Manipulate variables and collect data to serve as evidence for claims about the natural world.
- Gather and use data to inform the improvement of a design solution.

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.
Represent and analyze data to determine and describe relationships between variables.

- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Systems can be designed to cause a desired effect.
- Changes in systems may have various causes that may not have equal effects.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

- Systems can be designed to do specific tasks.
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- The total amount of energy and matter in closed systems is conserved.
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
- Energy drives the cycling of matter within and between systems.
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.Weath-2 Ask questions to describe the relationship between human activity and global average temperature.	**HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in climate changes and trends. **HS-ESS3-4** Evaluate or refine a technological solution that reduces society's influence on natural systems. **HS-ESS3-5** 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 changes and trends and associated future impacts to Earth's systems. **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified over time. **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Related Iowa careers and industry include biofuels, wind, solar and hydroelectric energy production.

Iowa connections include the use of wind turbines and biofuels and the use of prairie, buffer strips, cover crops, and riparian areas to reduce impact on the environment.

Many careers (e.g., construction, agriculture, transportation) use modern technologies such as GPS, drones, and automation to increase efficiencies to reduce impacts.

Science investigations use diverse methods and do not always use the same set of procedures to obtain data. That is, there is no single step-by-step "scientific method". New technologies advance scientific knowledge. Science knowledge is based on empirical evidence. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Careers in construction, engineering, and city planning must account for unpredictable weather due to regional and global climate trends.

All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics.

Modern civilization depends on major technological systems. New technologies can have deep impacts on society and the environment, including some that were not anticipated.

Agricultural and environmental professionals collaborate to study and make recommendations for soil and water conservation.

Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. Science knowledge indicates what can happen in natural systems — not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. Many decisions are not made using science alone but rely on social and cultural contexts to resolve issues.

Engineers continuously modify technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology.

DLM Disciplinary Core Idea Family

Weather and Climate

- Human activity adds gases to the atmosphere (i.e., air) and hydrosphere (i.e., oceans) that absorb the Sun's light energy and heat, which increases average global temperatures (see SCI.EE.12.ESS-Weath-1).
    - Models predict that the average global temperature will continue to rise.
- Through the use of science, models, and computers, humans have the potential to identify their impact on average global temperature.

DLM Science and Engineering Practices

Asking Questions and Defining Problems: Asking questions and defining problems in grades 9–12 builds on K–8 experiences and progresses to developing and refining questions that lead to explanations.

- Develop and evaluate testable questions.
- Gain information through questioning to describe relationships.

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in grades 9–12 builds on K–8 experiences and progresses to comparing and combining multiple sources of information to communicate and evaluate scientific claims and ideas.

- Combine multiple observations, images, texts, data, and other media to evaluate problems and explanations of how the natural world works.
- Combine information (e.g., observations, texts, tables, images, graphs, maps) to pose scientific questions and scientific ideas.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
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- Energy drives the cycling of matter within and between systems.

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

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- Much of science deals with constructing explanations of how things change and how they remain stable.
- Change and rates of change can be quantified and modeled over very short or very long periods of time.
- Some system changes are irreversible.
- Feedback (negative or positive) can stabilize or destabilize a system.
- Systems can be designed for greater or lesser stability.

Essential Element	Related Iowa Academic Standard in Science
SCI.EE.12.ESS.Impact-1 Improve a solution that reduces the impacts of severe weather on humans.	**HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate changes and trends have influenced human civilizations. **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3** 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. **HS-ETS1-4** 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 between systems relevant to the problem.

 Modern civilization depends on major technological systems. Society and technology interact in both positive and negative ways depending upon various perspectives. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choices impact technology.

 Examples of Iowa natural resources include: soil, water, grain crops, livestock, and natural areas. Examples of Iowa natural hazards include: tornadoes, flooding, derechos, blizzards, droughts, and extreme cold and heat.

 New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. Because technology influences how people think and act, technology impacts society. Yet, people and society, through their individual and collective choice, impact technology. All technologies come with trade-offs. When identified, these tradeoffs can improve the design and use of the technologies.

 Technologies are designed with a particular purpose; these embedded values influence how technology is used.

DLM Disciplinary Core Idea Family

Reducing Impacts of Severe Weather

- A variety of harmful impacts to human safety (e.g., access to resources and communication systems, housing, and local environments) can result from severe weather, which can occur suddenly with little warning.
- Severe weather in a specific region can be predicted, but sometimes predictions are inaccurate.

- A situation that people want to change or create can be approached as a problem to be solved through engineering.
- Before designing a solution to solve a problem, it is important to clearly understand the problem.
- Different solutions need to be evaluated to determine which one best solves the problem.
    - There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
    - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics.
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design.
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.

DLM Science and Engineering Practices

Planning and Carrying Out Investigations: Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions.

- Manipulate variables and collect data to serve as evidence for claims about the natural world.
- Gather and use data to inform the improvement of a design solution.

Analyzing and Interpreting Data: Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world.

- Represent and analyze data to determine and describe relationships between variables.
- Use data to construct and evaluate arguments.
- Analyze data to design and evaluate solutions to problems.

Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in grades 9–12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world.

- Gather and use information to construct descriptions and explanations of processes and relationships in the natural world.
- Use data and models to evaluate and improve design solutions.

Crosscutting Concepts (NSTA, 2013)

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Systems can be designed to cause a desired effect.
- Changes in systems may have various causes that may not have equal effects.

List of Disciplinary Core Idea Families for the DLM Science Essential Elements

Disciplinary Core Idea Family	Iowa Science Standards Disciplinary Core Ideas
Physical Science - Matter and Chemical Reactions	PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions
Physical Science - Interacting Forces	PS2.A: Forces and Motion PS2.B: Types of Interactions PS2.C: Stability and Instability in Physical Systems (adapted from *Framework*) PS3.C: Relationship Between Energy and Forces
Physical Science - Energy	PS3.A: Definitions of Energy* PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS4.A: Wave Properties
Life Science - Organisms: Structure and Function, Growth and Development	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms
Life Science - Plants: Cycling of Matter and Flow of Energy	LS1.C: Organization for Matter and Energy Flow in Organisms LS2.B: Cycles of Matter and Energy Transfer in Ecosystems* PS3.D: Energy in Chemical Processes and Everyday Life*
Life Science - Ecosystem: Cycling of Matter and Flow of Energy	LS1.C: Organization for Matter and Energy Flow in Organisms LS2.A: Interdependent Relationships in Ecosystems LS2.B: Cycles of Matter and Energy Transfer in Ecosystems* PS3.D: Energy in Chemical Processes and Everyday Life*
Life Science - Ecosystem Health	LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience* LS4.D: Biodiversity and Humans ESS2.A: Earth Materials and Systems ESS2.D: Weather and Climate ESS2.E: Biogeology ESS3.A: Natural Resources
Life Science - Group Survival Behavior	LS1.D: Information Processing* LS2.D: Social Interactions and Group Behavior* PS4.A: Wave Properties PS4.B: Electromagnetic Radiation

Disciplinary Core Idea Family	Iowa Science Standards Disciplinary Core Ideas
Life Science - Traits of Organisms	LS3.A: Inheritance of Traits LS3.B: Variation of Traits LS4.B: Natural Selection* LS4.C: Adaptation*
Life Science - Human Impacts on Ecosystems	LS4.D: Biodiversity and Humans LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience* ESS3.A: Natural Resources ESS3.C: Human Impacts on Earth Systems ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution
Earth and Space Science - Earth in the Solar System	ESS1.A: The Universe and Its Stars ESS1.B: Earth and the Solar System PS3.B: Conservation of Energy and Energy Transfer
Earth and Space Science - Earth Systems	ESS2.A: Earth Materials and Systems ESS2.C: The Roles of Water in Earth's Surface Processes ESS3.C: Human Impacts on Earth Systems
Earth and Space Science - Weather and Climate	ESS2.D: Weather and Climate ESS3.D: Global Climate Changes and Trends*
Earth and Space Science – Reducing Impacts of Severe Weather	ESS3.B: Natural Hazards ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution
Physical Science - Matter and Chemical Reactions	PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions
Physical Science - Interacting Forces	PS2.A: Forces and Motion PS2.B: Types of Interactions PS2.C: Stability and Instability in Physical Systems (adapted from *Framework*) PS3.C: Relationship Between Energy and Forces

Disciplinary Core Idea Family	Iowa Science Standards Disciplinary Core Ideas
Physical Science - Energy	PS3.A: Definitions of Energy* PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS4.A: Wave Properties

Note. Some DCIs in the Standards do not include component ideas in each grade band; these are indicated with an asterisk.

Articulation of the DCI Family Across Grade Bands

Disciplinary Core Idea Family	Science Essential Elements
Physical Science - Matter and Chemical Reactions	**SCI.EE.2.PS.Matter-**1 Make observations to classify different kinds (e.g., wood, metal, water) and forms (i.e., solid, liquid) of matter. **SCI.EE.5.PS.Matter-1** Make observations and measurements to describe changes in the physical properties of substances when heated, cooled, or mixed. **SCI.EE.5.PS.Matter-2** Use evidence to support a claim that matter exists even when it cannot be seen. **SCI.EE.8.PS.Matter-1** Use a particle model of matter to describe the relationships between the states of matter, their characteristics and properties, and temperature. **SCI.EE.8.PS.Matter-2** Gather and use data to support the law of conservation of mass when substances change. **SCI.EE.8.PS.Matter-3** Gather and use data to determine whether an interaction between substances results in the formation of a new substance. **SCI.EE.12.PS.Matter-1** Use a model to describe that substances are made of different types and numbers of atoms. **SCI.EE.12.PS.Matter-2** Use a model to describe that in chemical reactions, the atoms in the starting substances (i.e., the reactants) rearrange to form new substances (i.e., the products). **SCI.EE.12.PS.Matter-3** Based on data, describe how the temperature and amount (i.e., concentration) of reacting substances affect the rates of chemical reactions. **SCI.EE.12.PS.Matter-4** Based on data, describe how the temperature and amount (i.e., concentration) of reacting substances affect the rates of chemical reactions.
Physical Science - Interacting Forces	**SCI.EE.2.PS.Forces-1** Make observations to compare the effects of different strengths and directions of pushes and pulls on the motion of an object. **SCI.EE.5.PS.Forces-1** Make observations to determine the effects of balanced and unbalanced forces on the motion (i.e., speed and direction) of an object. **SCI.EE.5.PS.Forces-2** Provide evidence that some objects (e.g., magnets, metals, pith balls, objects falling toward Earth) exert forces on each other even when the objects are not in contact. **SCI.EE.8.PS.Forces-1** Use observations and measurements to determine how an object's mass affects the force needed to change its motion. **SCI.EE.8.PS.Forces-2** Make observations of the motion of two colliding objects to provide evidence of Newton's third law. **SCI.EE.12.PS.Forces-1** Conduct an investigation to describe the relationships between force, mass, and acceleration. **SCI.EE.12.PS.Forces-2** Conduct an investigation to describe the factors that affect the strength of electrical and magnetic forces between interacting objects.

Disciplinary Core Idea Family	Science Essential Elements
Physical Science - Energy	**SCI.EE.2.PS.Energy-1** Make observations that energy exists. **SCI.EE.5.PS.Energy-1** Use observations to support a claim about the amount of energy moved from one place to another by sound, light, heat, and moving objects. **SCI.EE.8.PS.Energy-1** Develop a model to infer the relationship between the kinetic energy and temperature of an object or particles of a substance. **SCI.EE.8.PS.Energy-2** Provide evidence that kinetic energy is transferred between two objects when they collide with each other. **SCI.EE.8.PS.Energy-3** Develop a model to describe the behavior of light (i.e., transmission, reflection, scattering) that comes into contact with objects made of different materials. **SCI.EE.12.PS.Energy-1** Gather data to describe the thermal energy transfer between two objects or substances in contact with each other. **SCI.EE.12.PS.Energy-2** Ask questions to describe the relationship between sound energy and the vibrations of particles of matter.
Life Science - Organisms: Structure and Function, Growth and Development	**SCI.EE.2.LS.Org-1** Use information to identify that different organisms have different external parts for specific functions. **SCI.EE.5.LS.Org-1** Use information to describe how the parts of organisms help them survive, grow, and reproduce. **SCI.EE.8.LS.Org-1** Provide evidence that living things are made of cells, some of which are unicellular while others are multicellular. **SCI.EE.12.LS.Org-1** Use a model to construct an explanation of how systems of specialized cells within organisms work together to perform essential functions of life.
Life Science – PLANT	**SCI.EE.2.LS.Plant-1** Investigate what plants need to grow. **SCI.EE.5.LS.Plant-1** Use data to show that plants use energy (i.e., sunlight) and matter (i.e., air and water) for growth. **SCI.EE.8.LS.Plant-1** Use data to explain that plants use energy (i.e., sunlight) and matter (i.e., air and water) to produce food (i.e., plant matter) for growth. **SCI.EE.12.LS.Plant-1** Use a model to explain the role of plants in the flow of energy and matter among organisms in the ecosystem.
Life Science – Eco System	**SCI.EE.2.LS.Ecosys-1** Use information to support that animals need food to live and grow. **SCI.EE.5.LS.Ecosys-1** Use data to support that food provides animals with the materials and energy they need for body repair, growth, warmth, and motion. **SCI.EE.8.LS.Ecosys-1** Use a model to describe the transfer of food (i.e., matter and energy) between plants, animals, and decomposers. **SCI.EE.12.LS.Ecosys-1** Develop a model that describes how matter (plant or animal matter) and energy (i.e., sunlight and food energy) are cycled within an ecosystem.

Disciplinary Core Idea Family	Science Essential Elements
Life Science - Ecosystem Health	**SCI.EE.2.LS.EcoHlth-1** Use information to describe that many kinds of living things live in different habitats. **SCI.EE.5.LS.EcoHlth-1** Use information to support that healthy ecosystems meet the needs of many varieties and types of organisms. **SCI.EE.5.LS.EcoHlth-2** Ask questions to determine how living things (both plants and animals) impact the habitat in which they live. **SCI.EE.8.LS.EcoHlth-1** Use data to explain the relationship between organisms' survival and growth and their interactions with both living and nonliving factors in their ecosystem. **SCI.EE.12.LS.EcoHlth-1** Use data to make an argument about the effects of unstable environments on the health of ecosystems.
Life Science –Group Survival Behavior	**SCI.EE.2.LS.Group-1** Use information to identify that offspring learn survival behaviors. **SCI.EE.5.LS.Group-1** Provide evidence that animals gain information for survival through their senses. **SCI.EE.8.LS.Group-1** Use information to explain the relationship between animals' abilities to sense and communicate information and the response behaviors that help them grow and survive. **SCI.EE.12.LS.Group-1** Use data to support a claim about how group behavior affects individuals' and species' chances to survive.
Life Science – Traits of Organisms	**SCI.EE.2.LS.Trait-1** Use information to show that organisms (both plants and animals) may resemble their biological parents but are not identical to their parents. **SCI.EE.5.LS.Trait-1** Use information to describe that different organisms vary in how they look due to the traits passed down from their parents. **SCI.EE.8.LS.Trait-1** Use information to determine how the environment affects organisms' traits and their survival. **SCI.EE.12.LS.Trait-1** Use information to support a claim that heredity and the environment influence the traits of an individual. **SCI.EE.12.LS.Trait-2** Use mathematical reasoning to support relationships between changing environmental conditions, adaptation by natural selection, and changes in the distribution of traits within a population.
Life Science - Human Impacts on Ecosystems	**SCI.EE.5.LS.Human-1** Use information to describe how humans impact a variety of ecosystems. **SCI.EE.8.LS.Human-1** Define problems caused by human activities on ecosystems. **SCI.EE.12.LS.Human-1** Evaluate design solutions that minimize the effects of human activities on the health of ecosystems.

Disciplinary Core Idea Family	Science Essential Elements
Earth and Space Science - Earth in the Solar System	**SCI.EE.2.ESS.SolSys-1** Use observations to identify the daily patterns of celestial objects that can appear in the sky during daytime and nighttime. **SCI.EE.5.ESS.SolSys-1** Use data to support that the Sun appears to be the largest and brightest star in the sky because it is the closest star to Earth. **SCI.EE.5.ESS.SolSys-2** Use a model to explain the relationship between Earth's rotation on its axis and the 24-hour cycle of nighttime and daytime. **SCI.EE.5.ESS.SolSys-3** Use data from different times of the year to determine seasonal patterns in the number of daylight hours. **SCI.EE.5.ESS.SolSys-4** Make observations to support that Earth's gravity exerts a downward force on all objects on its surface. **SCI.EE.8.ESS.SolSys-1** Use models to compare the components of our solar system and describe the motions of those components. **SCI.EE.8.ESS.SolSys-2** Use a model of the Sun-Earth-Moon system to explain the relationship between the motion of the Moon and the cyclical patterns of its phases. **SCI.EE.8.ESS.SolSys-3** Use a model to explain the relationships between the orientation of Earth's axis in relation to the Sun, Earth's motion, and seasonal patterns in the number of daylight hours. **SCI.EE.8.ESS.Solsys-4** Use a model to describe the role of gravity in the motions of planets and their moons within the solar system. **SCI.EE.12.ESS.SolSys-1** Use mathematical reasoning to describe the relationships between the amount of energy released by a star that reaches Earth and the star's mass and distance from Earth. **SCI.EE.12.ESS.SolSys-2** Gather data to determine the relationship between the intensity and directness of sunlight reaching Earth's surface and seasonal temperature patterns. **SCI.EE.12.ESS.SolSys-3** Analyze and interpret data to describe the relationships between the gravitational force between objects in the solar system, their masses, and the distance between them.

Disciplinary Core Idea Family	Science Essential Elements
Earth and Space Science - Earth Systems	**SCI.EE.2.ESS.Earth-1** Use information to describe that different types of bodies of water are found in different locations on Earth's surface. **SCI.EE.2.ESS.Earth-2** Use observations to describe that wind and water can change the shape of the land. **SCI.EE.5.ESS.Earth-1** Use a model to describe the distribution of fresh and salt water on Earth's surface. **SCI.EE.5.ESS.Earth-2** Use information to describe that water is found in different forms almost everywhere on Earth. **SCI.EE.5.ESS.Earth-3** Use observations to explain how water, ice, wind, organisms, and gravity break rocks, soil, and sediments into smaller particles and move them around. **SCI.EE.8.ESS.Earth-1** Use a model to explain how water continuously cycles between the surface of Earth and the atmosphere. **SCI.EE.8.ESS.Earth-2** Use information to evaluate a claim about how the hydrosphere affects the shape of land (i.e., the geosphere) over time. **SCI.EE.12.ESS.Earth-1** Use data to make a claim that a change to one of Earth's spheres can cause changes to other Earth's spheres (i.e., geosphere, hydrosphere, atmosphere, biosphere). **SCI.EE.12.ESS.Earth-2** Ask questions to determine how a change in one of Earth's systems (i.e., spheres) affects humans.
Earth and Space Science - Weather and Climate Changes and Trends	**SCI.EE.2.ESS.Weath-1** Use local weather condition data to describe patterns over time. **SCI.EE.5.ESS.Weath-1** Determine patterns in weather data to help predict future weather. **SCI.EE.8.ESS.Weath-1** Determine the weather data needed to describe patterns in the movement of air masses that likely cause changes in weather. **SCI.EE.8.ESS.Weath-2** Use information to describe the relationships between regional climates, locations on Earth, geographic features, and weather. **SCI.EE.12.ESS.Weath-1** Use data to determine the relationship between the absorption of the Sun's energy by Earth's spheres (i.e., geosphere, hydrosphere, atmosphere, biosphere) and trends in average global temperature. **SCI.EE.12.ESS.Weath-2** Ask questions to describe the relationship between human activity and global average temperature.
Earth and Space Science – Reducing Impacts of Severe Weather	**SCI.EE.2.ESS.Impact-1** Use information to identify the impacts of severe weather on humans. **SCI.EE.5.ESS.Impact-1** Explain how a design solution reduces the impacts of severe weather on humans. **SCI.EE.8.ESS.Impact-1** Evaluate solutions that reduce the impacts of severe weather on humans. **SCI.EE.12.ESS.Impact-1** Improve a solution that reduces the impacts of severe weather on humans.