SCIENCE STANDARDS
THE NEXT GENERATION

NGSS@NSTA
STEM STARTS HERE

An Introduction to The Next Generation Science Standards

National Congress on Science Education

San Juan, Puerto Rico

July 17-20, 2013

National Science Teachers Association

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Goals of the Workshop

Participants will understand:

- How NGSS was developed
- How the integration of the three dimensions described in the Framework come together in NGSS
- How performance expectations are directives about assessment, but not about instruction
- How the scientific and engineering practices are central to good instruction of NGSS
- How NGSS is related to STEM and the Common Core State Standards

Key Points

- This isn't going to be easy
- It's worth doing
- When doing PD on NGSS, start with the *Scientific and Engineering Practices*
- When reading NGSS, start with the *Disciplinary Core Ideas*
- There are still a lot of decisions to make
- It's going to take time

Developing the Standards

NGSS@NSTA
STEM STARTS HERE

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Achieve

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

NSTA National Science Teachers Association

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

About the National Academies

NGSS@NSTA STEM STARTS HERE

NATIONAL ACADEMY OF SCIENCES

NATIONAL ACADEMY OF ENGINEERING

INSTITUTE OF MEDICINE

- Chartered by Congress
- Separate Academies dealing with Science, Engineering, and Medicine
- Honorary membership organization with over 6000 members
- Do not conduct independent research
- Serves as advisors producing independent recommendations and policy reports
- The National Research Council carries out most studies done by the Academies

About Achieve

NGSS@NSTA STEM STARTS HERE

Created in 1996 by the nation's governors and corporate leaders, Achieve is an independent, bipartisan, non-profit education reform organization that helps states raise academic standards and graduation requirements, improve assessments and strengthen accountability.

Achieve is involved in implementation of the Common Core State Standards (CCSS) effort and the Partnership for Assessment of Readiness for College and Careers (PARCC) Consortium.

About AAAS

- The **American Association for the Advancement of Science** was founded in Philadelphia in 1848 and it is the world's largest general science organization.
- Bridges gaps among scientists, policy-makers, and the public to advance science and science education.
- Authoritative source for information on the latest developments in science and publisher of the peer-reviewed journal *Science*
- In 1985, the AAAS launched Project 2061, a long-term effort to reform science, mathematics, and technology education for the 21st century.

About NSTA

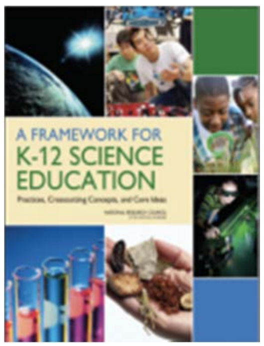
The National Science Teachers Association (NSTA), founded in 1944, is the largest organization in the world committed to promoting excellence and innovation in science teaching and learning for all.

NSTA's current membership of 60,000 includes science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in and committed to science education.

NSTA holds five conferences every year, publishes four journals, and organizes numerous competitions for teachers and students. In addition the NSTA Learning Center provides a wealth of online resources for educators.

Developing the Standards

NGSS@NSTA
STEM STARTS HERE

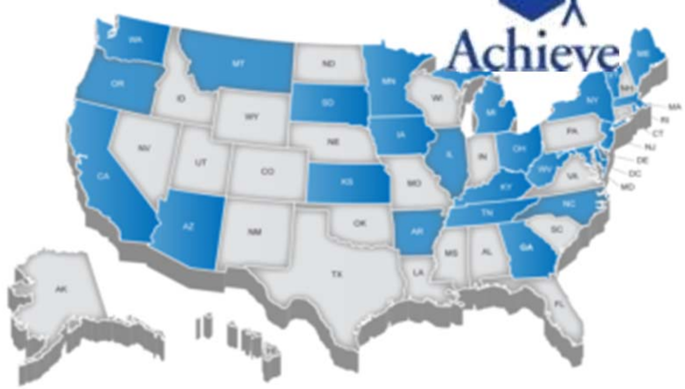


THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

July 2011

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

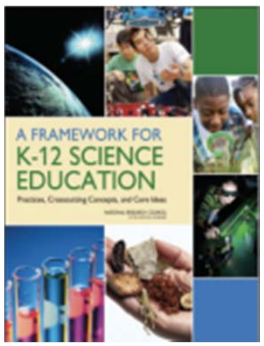
Achieve



- Assessments
- Curricula
- Instruction
- Teacher Development

Developing the Standards

NGSS@NSTA
STEM STARTS HERE

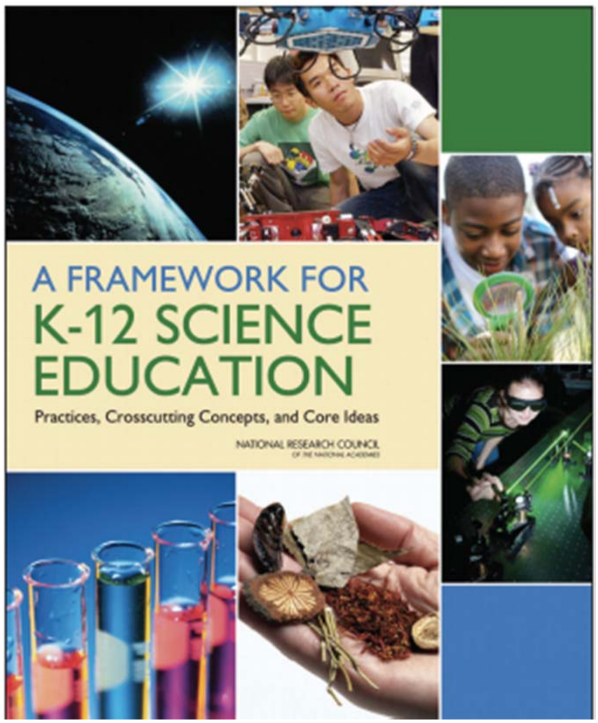


THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

July 2011

A Framework for K-12 Science Education

NGSS@NSTA
STEM STARTS HERE



View free PDF form The National Academies Press at www.nap.edu

Secure your own copy from

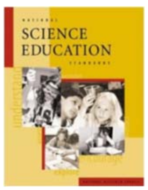
NSTApress
National Science Teachers Association

www.nsta.org/store

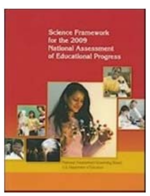
Resources for the Framework

NGSS@NSTA
STEM STARTS HERE

- *Science for All Americans, Benchmarks for Scientific Literacy and Atlas of Science Literacy*



- *National Science Education Standards*



- 2009 NAEP Science Framework
  (National Assessment of Educational Progress)

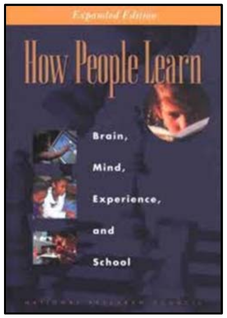
- *College Board Standards for College in Science*

SCIENCE Anchors

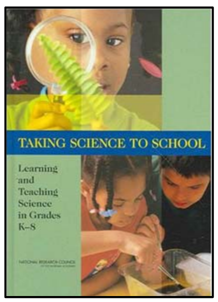
- *NSTA's Science Anchors project*

National Research Council Reports

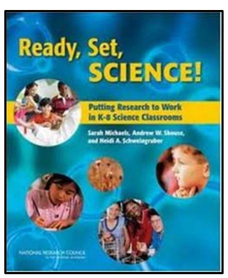
NGSS@NSTA
STEM STARTS HERE



- How People Learn

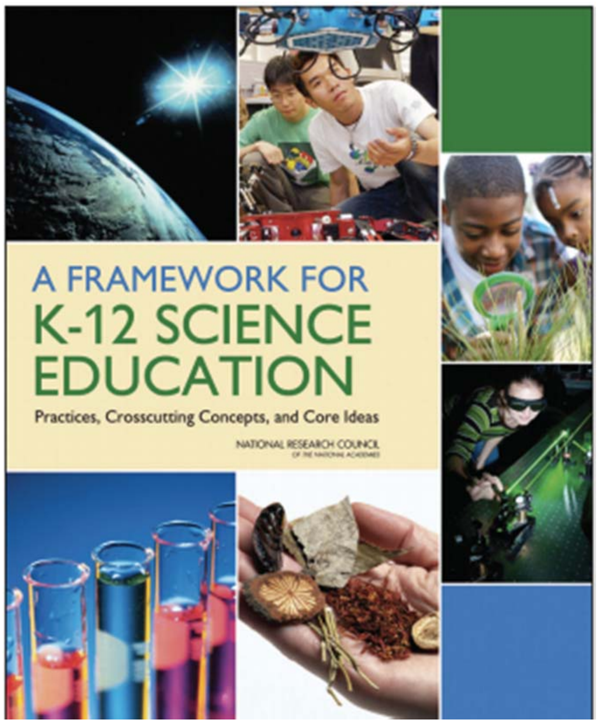


- Taking Science to School



- Ready, Set, Science

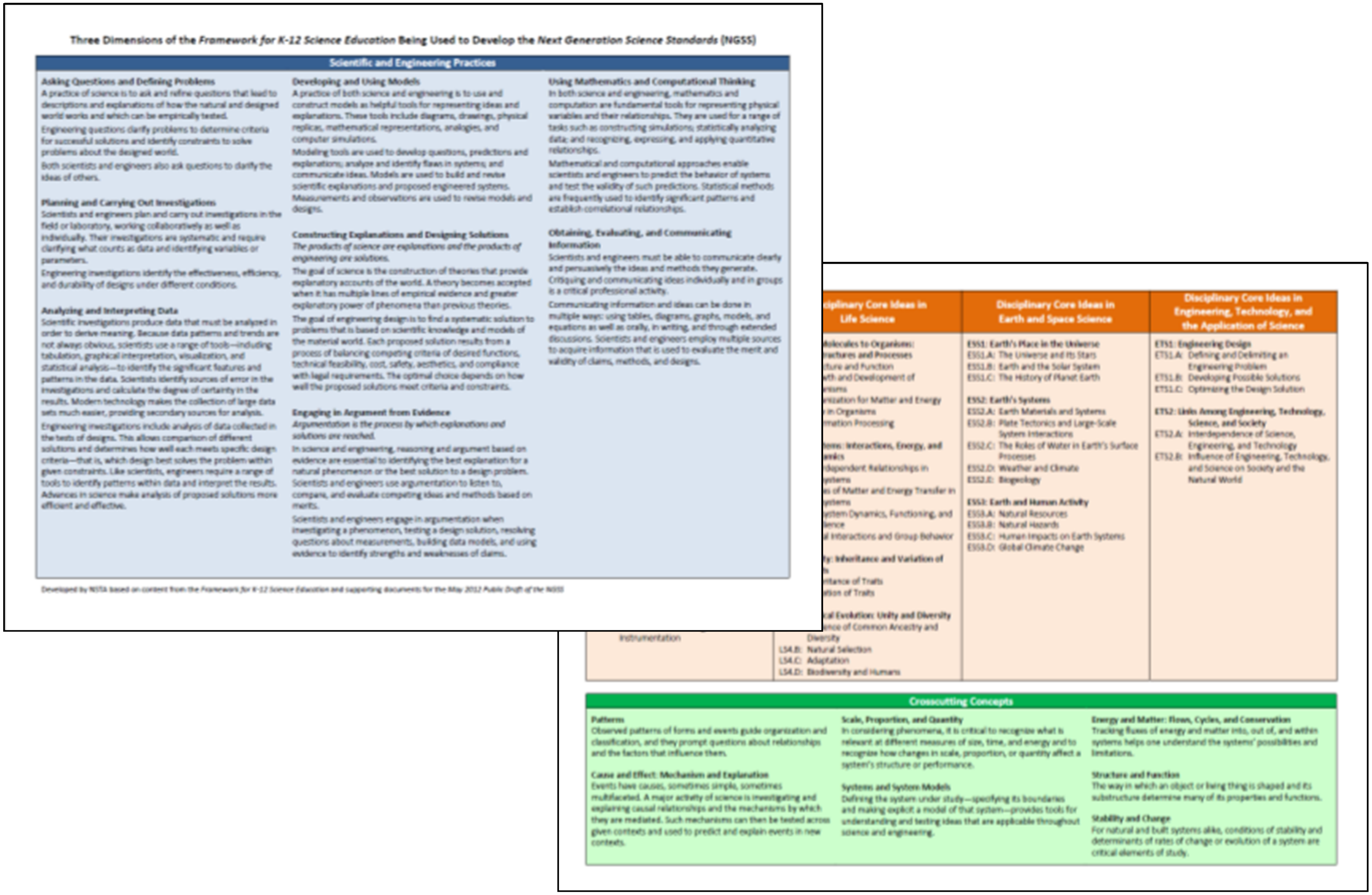
A Framework for K-12 Science Education



Three-Dimensions:

- **Scientific and Engineering Practices**
- **Crosscutting Concepts**
- **Disciplinary Core Ideas**

Handout about the Three Dimensions


Three Dimensions of the *Framework for K-12 Science Education* Being Used to Develop the *Next Generation Science Standards* (NGSS)

Scientific and Engineering Practices

Asking Questions and Defining Problems

Planning and Carrying Out Investigations

Analyzing and Interpreting Data

Developing and Using Models

Constructing Explanations and Designing Solutions

Engaging in Argument from Evidence

Using Mathematics and Computational Thinking

Obtaining, Evaluating, and Communicating Information

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the May 2012 Public Draft of the NGSS

Disciplinary Core Ideas in Earth and Space Science

ESS1: Earth's Place in the Universe
ESS1.A: The Universe and its Stars
ESS1.B: Earth and the Solar System
ESS1.C: The History of Planet Earth

ESS2: Earth's Systems
ESS2.A: Earth Materials and Systems
ESS2.B: Plate Tectonics and Large-Scale System Interactions
ESS2.C: The Roles of Water in Earth's Surface Processes
ESS2.D: Weather and Climate
ESS2.E: Biogeology

ESS3: Earth and Human Activity
ESS3.A: Natural Resources
ESS3.B: Natural Hazards
ESS3.C: Human Impacts on Earth Systems
ESS3.D: Global Climate Change

Disciplinary Core Ideas in Engineering, Technology, and the Application of Science

ETS1: Engineering Design
ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution

ETS2: Links Among Engineering, Technology, Science, and Society
ETS2.A: Interdependence of Science, Engineering, and Technology
ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

LS4.B: Natural Selection
LS4.C: Adaptation
LS4.D: Biodiversity and Humans

Crosscutting Concepts

Patterns

Cause and Effect: Mechanism and Explanation

Scale, Proportion, and Quantity

Systems and System Models

Energy and Matter: Flows, Cycles, and Conservation

Structure and Function

Stability and Change

Scientific and Engineering Practices

NGSS@NSTA STEM STARTS HERE

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

Crosscutting Concepts

NGSS@NSTA STEM STARTS HERE

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

Disciplinary Core Ideas

NGSS@NSTA STEM STARTS HERE

Life Science	Physical Science
LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity and Diversity	PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer
Earth & Space Science	**Engineering & Technology**
ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	ETS1: Engineering Design ETS2: Links Among Engineering, Technology, Science, and Society

Core and Component Ideas

NGSS@NSTA
STEM STARTS HERE

Life Science

LS1: From Molecules to Organisms: Structures and Processes
- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms
- LS1.C: Organization for Matter and Energy Flow in Organisms
- LS1.D: Information Processing

LS2: Ecosystems: Interactions, Energy, and Dynamics
- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS2.D: Social Interactions and Group Behavior

LS3: Heredity: Inheritance and Variation of Traits
- LS3.A: Inheritance of Traits
- LS3.B: Variation of Traits

LS4: Biological Evolution: Unity and Diversity
- LS4.A: Evidence of Common Ancestry and Diversity
- LS4.B: Natural Selection
- LS4.C: Adaptation
- LS4.D: Biodiversity and Humans

Earth & Space Science

ESS1: Earth's Place in the Universe
- ESS1.A: The Universe and Its Stars
- ESS1.B: Earth and the Solar System
- ESS1.C: The History of Planet Earth

ESS2: Earth's Systems
- ESS2.A: Earth Materials and Systems
- ESS2.B: Plate Tectonics and Large-Scale System Interactions
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and Climate
- ESS2.E: Biogeology

ESS3: Earth and Human Activity
- ESS3.A: Natural Resources
- ESS3.B: Natural Hazards
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

Physical Science

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

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

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

PS4: Waves and Their Applications in Technologies for Information Transfer
- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

Engineering & Technology

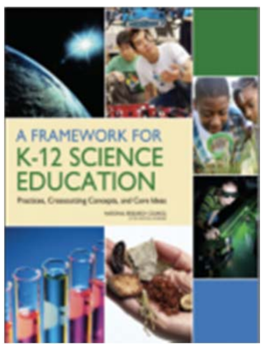
ETS1: Engineering Design
- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

ETS2: Links Among Engineering, Technology, Science, and Society
- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

***Note**: In NGSS, the core ideas for Engineering, Technology, and the Application of Science are integrated with the Life Science, Earth & Space Science, and Physical Science core ideas*

Developing the Standards

NGSS@NSTA
STEM STARTS HERE



THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

July 2011

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

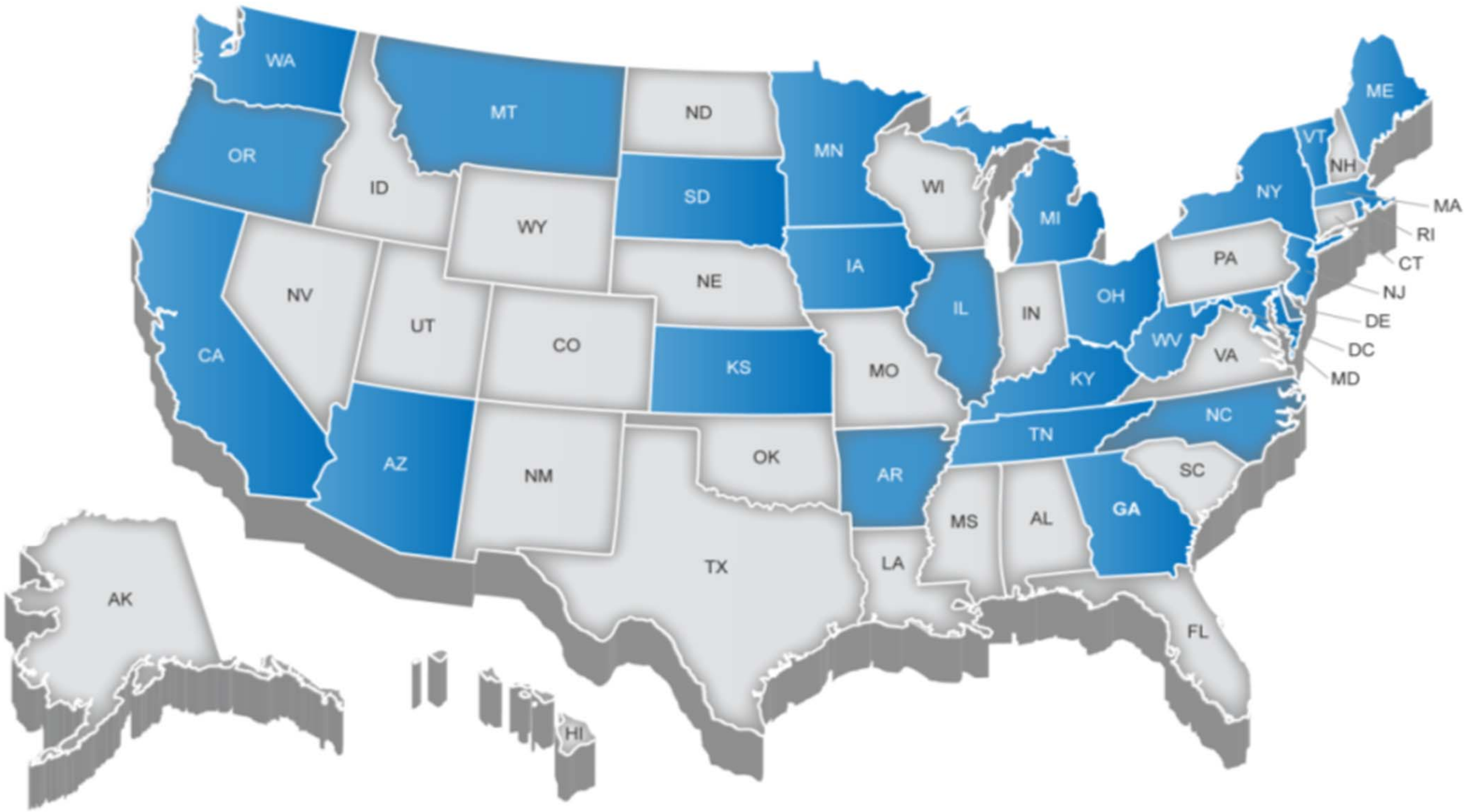
- Assessments
- Curricula
- Instruction
- Teacher Development

Developing the Standards

NGSS@NSTA
STEM STARTS HERE

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

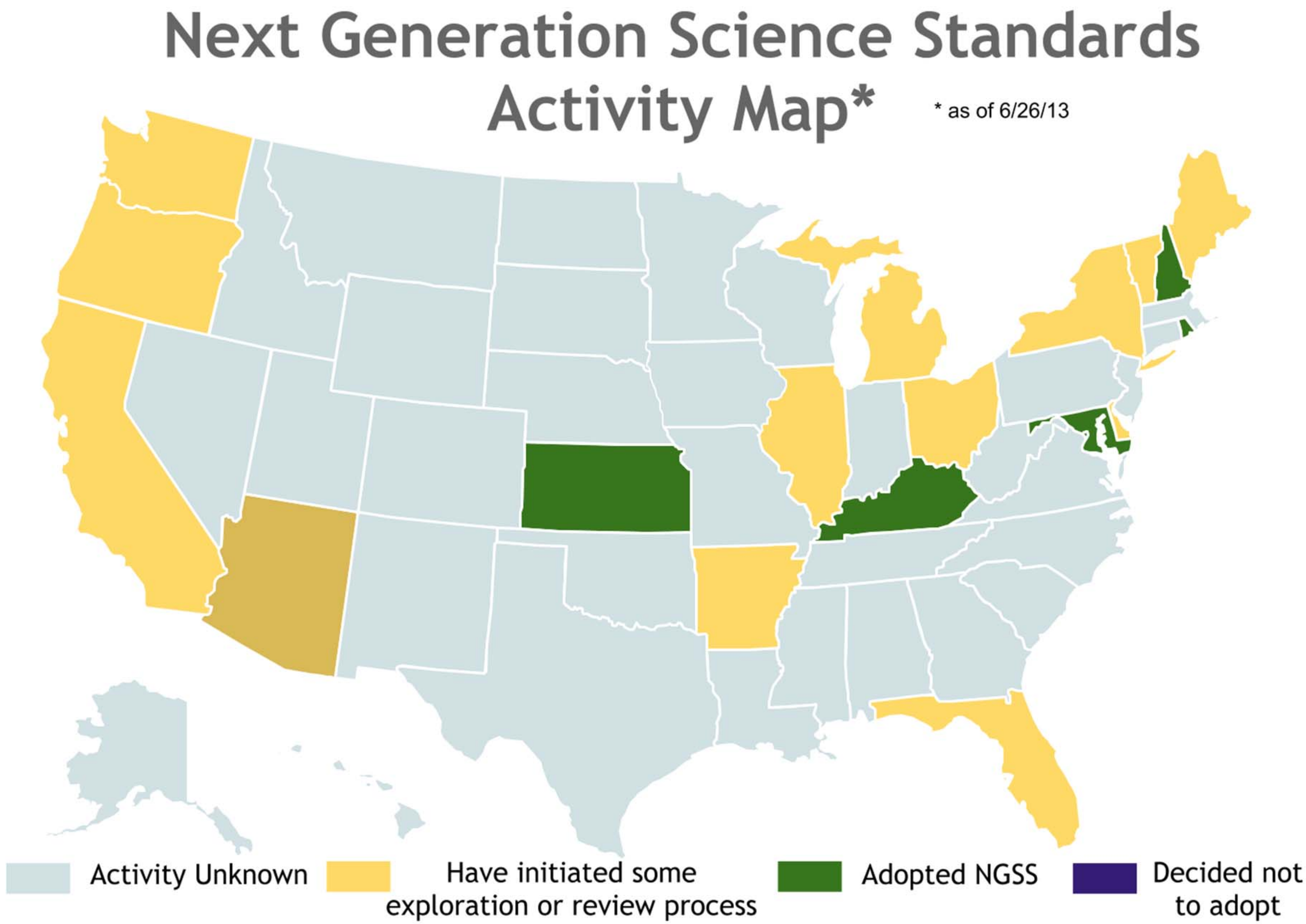
NGSS Lead State Partners



NGSS Writers

State Activity (according to NASBE)

NGSS@NSTA
STEM STARTS HERE



Conceptual Shifts in NGSS

1. K-12 Science Education Should Reflect the Interconnected Nature of Science as it is Practiced and Experienced in the Real World.
2. The Next Generation Science Standards are student performance expectations – NOT curriculum.
3. The science concepts in the NGSS build coherently from K-12.
4. The NGSS Focus on Deeper Understanding of Content as well as Application of Content.
5. Science and Engineering are Integrated in the NGSS from K–12.
6. The NGSS are designed to prepare students for college, career, and citizenship.
7. The NGSS and Common Core State Standards (Mathematics and English Language Arts) are Aligned.

Appendices

NGSS@NSTA STEM STARTS HERE

A Conceptual Shifts

B Responses to May Public Feedback

C College and Career Readiness

D All Standards, All Students

E Disciplinary Core Idea Progressions in the NGSS

F Science and Engineering Practices in the NGSS

G Crosscutting Concepts in the NGSS

H Nature of Science in the NGSS

I Engineering Design in the NGSS

J Science, Technology, Society, and the Environment

K Model Course Mapping in Middle and High School

L Connections to Common Core State Standards in Mathematics

M Connections to Common Core State Standards in English Language Arts

Inside the Box

Inside the NGSS Box

3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion. [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships. [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.* [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

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

- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

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

- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.

- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems

- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

Cause and Effect

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

Stability and Change

- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Based on the January 2013 Draft of NGSS

Inside the NGSS Box

What is Assessed

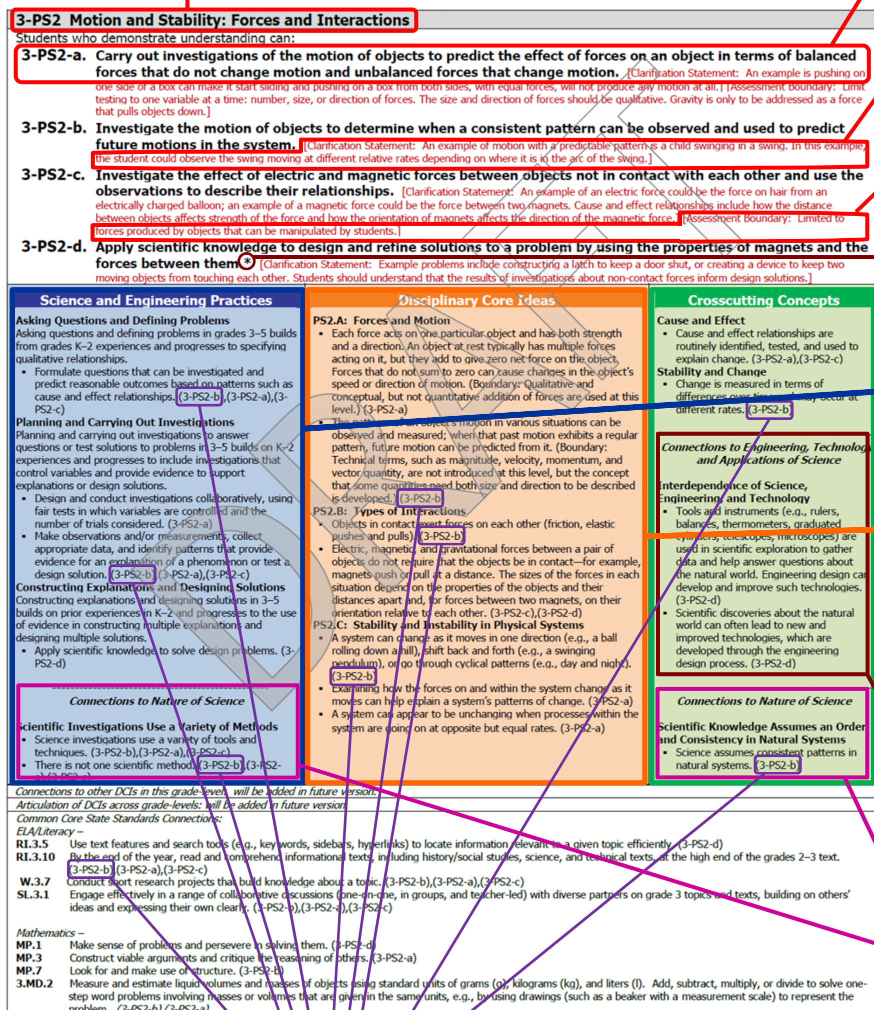
A collection of several performance expectations describing what students should be able to do to master this standard

Foundation Box

The practices, core disciplinary ideas, and crosscutting concepts from the *Framework for K-12 Science Education* that were used to form the performance expectations

Connection Box

Other standards in the *Next Generation Science Standards* or in the *Common Core State Standards* that are related to this standard



3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion. [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships. [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.* [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems
- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

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

Stability and Change
- Change is measured in terms of differences over time, and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Title and Code

The titles of standard pages are not necessarily unique and may be reused at several different grade levels . The code, however, is a unique identifier for each set based on the grade level, content area, and topic it addresses.

Performance Expectations

A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned.

Clarification Statement

A statement that supplies examples or additional clarification to the performance expectation.

Assessment Boundary

A statement that provides guidance about the scope of the performance expectation at a particular grade level.

Engineering Connection (*)

An asterisk indicates an engineering connection in the practice, core idea or crosscutting concept that supports the performance expectation.

Scientific & Engineering Practices

Activities that scientists and engineers engage in to either understand the world or solve a problem

Disciplinary Core Ideas

Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people's lives.

Crosscutting Concepts

Ideas, such as *Patterns* and *Cause and Effect*, which are not specific to any one discipline but cut across them all.

Connections to Engineering, Technology and Applications of Science

These connections are drawn from the disciplinary core ideas for engineering, technology, and applications of science in the *Framework*.

Connections to Nature of Science

Connections are listed in either the practices or the crosscutting connections section of the foundation box.

Codes for Performance Expectations

Codes designate the relevant performance expectation for an item in the foundation box and connection box. In the connections to common core, italics indicate a potential connection rather than a required prerequisite connection.

Based on the January 2013 Draft of NGSS

NSTA

Inside the NGSS Box

Title and Code

The titles of standard pages are not necessarily unique and may be reused at several different grade levels . The code, however, is a unique identifier for each set based on the grade level, content area, and topic it addresses.

What is Assessed

A collection of several performance expectations describing what students should be able to do to master this standard

3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. **Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion.** [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. **Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system.** [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. **Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships.** [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. **Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.*** [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Foundation Box

The practices, core disciplinary ideas, and crosscutting concepts from the *Framework for K-12 Science Education* that were used to form the performance expectations

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems
- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

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

Stability and Change
- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connection Box

Other standards in the *Next Generation Science Standards* or in the *Common Core State Standards* that are related to this standard

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Based on the January 2013 Draft of NGSS

Inside the NGSS Box

What is Assessed

A collection of several performance expectations describing what students should be able to do to master this standard

3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion. [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships. [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.* [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

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

- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

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

- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.

- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems

- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

Cause and Effect

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

Stability and Change

- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:
ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)
RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)
W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)
SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)
MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)
MP.7 Look for and make use of structure. (3-PS2-b)
3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Performance Expectations

A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned.

Clarification Statement

A statement that supplies examples or additional clarification to the performance expectation.

Assessment Boundary

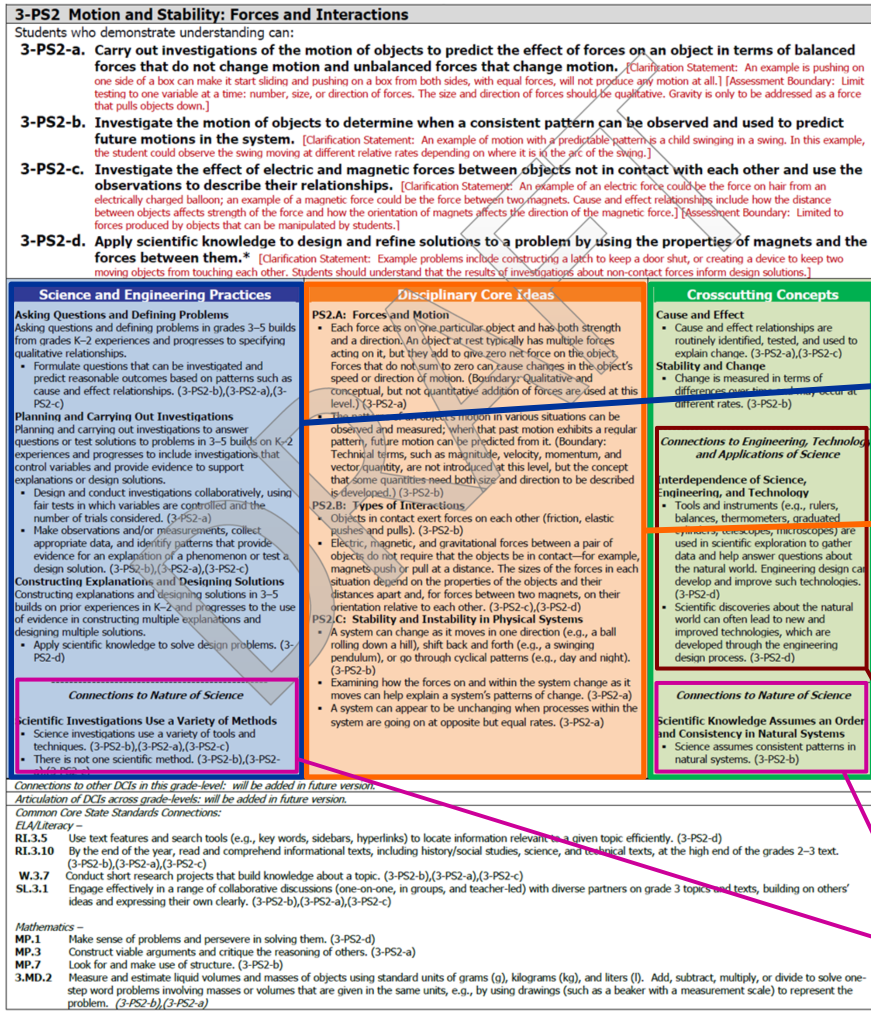
A statement that provides guidance about the scope of the performance expectation at a particular grade level.

Engineering Connection (*)

An asterisk indicates an engineering connection in the practice, core idea or crosscutting concept that supports the performance expectation.

Based on the January 2013 Draft of NGSS

Inside the NGSS Box



3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. **Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion.** [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. **Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system.** [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. **Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships.** [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. **Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.*** [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems
- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

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

Stability and Change
- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Foundation Box

The practices, core disciplinary ideas, and crosscutting concepts from the *Framework for K-12 Science Education* that were used to form the performance expectations

Scientific & Engineering Practices

Activities that scientists and engineers engage in to either understand the world or solve a problem

Disciplinary Core Ideas

Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people's lives.

Crosscutting Concepts

Ideas, such as *Patterns* and *Cause and Effect*, which are not specific to any one discipline but cut across them all.

Connections to Engineering, Technology and Applications of Science

These connections are drawn from the disciplinary core ideas for engineering, technology, and applications of science in the *Framework*.

Connections to Nature of Science

Connections are listed in either the practices or the crosscutting connections section of the foundation box.

Based on the January 2013 Draft of NGSS

Inside the NGSS Box

3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. **Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion.** [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. **Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system.** [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. **Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships.** [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. **Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.*** [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems
- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

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

Stability and Change
- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Foundation Box

The practices, core disciplinary ideas, and crosscutting concepts from the *Framework for K-12 Science Education* that were used to form the performance expectations

Scientific & Engineering Practices

Activities that scientists and engineers engage in to either understand the world or solve a problem

Disciplinary Core Ideas

Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people's lives.

Crosscutting Concepts

Ideas, such as *Patterns* and *Cause and Effect*, which are not specific to any one discipline but cut across them all.

Based on the January 2013 Draft of NGSS

Inside the NGSS Box

3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion. [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships. [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.* [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Foundation Box

The practices, core disciplinary ideas, and crosscutting concepts from the *Framework for K-12 Science Education* that were used to form the performance expectations

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems
- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

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

Stability and Change
- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Connections to Engineering, Technology and Applications of Science

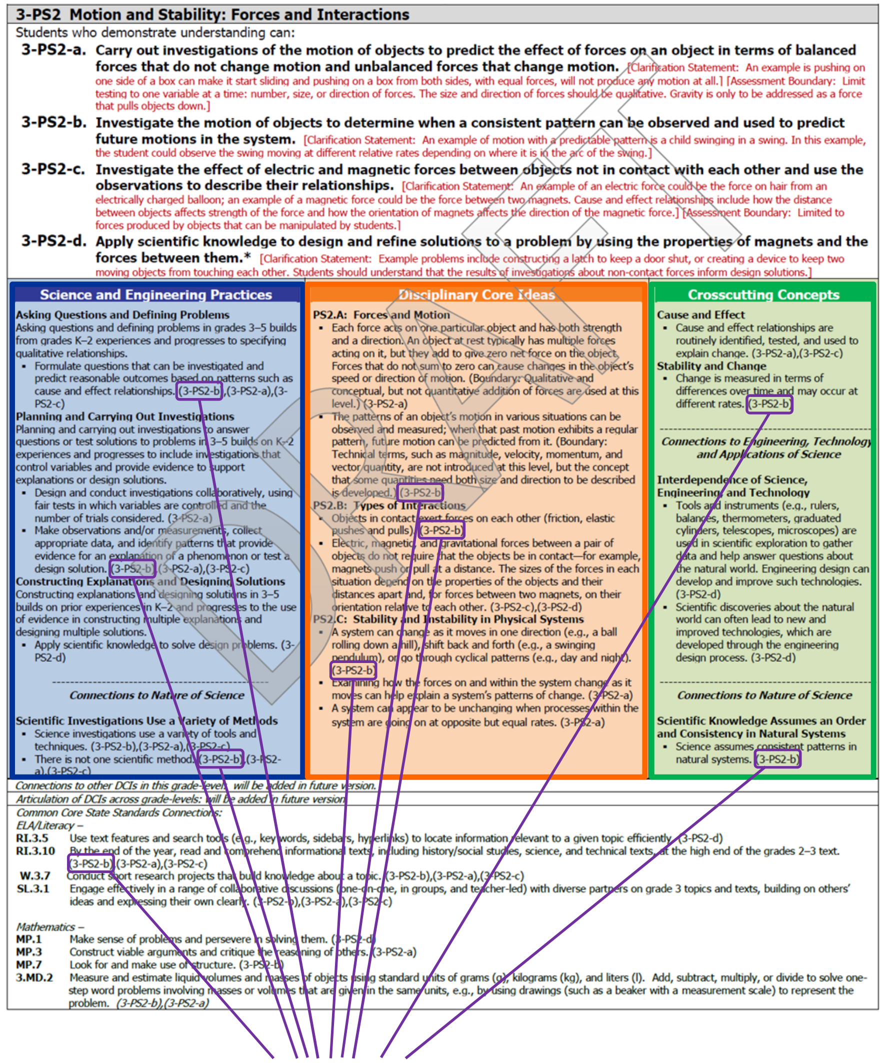
These connections are drawn from the disciplinary core ideas for engineering, technology, and applications of science in the *Framework*.

Connections to Nature of Science

Connections are listed in either the practices or the crosscutting connections section of the foundation box.

Based on the January 2013 Draft of NGSS

Inside the NGSS Box



3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-a. Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion. [Clarification Statement: An example is pushing on one side of a box can make it start sliding and pushing on a box from both sides, with equal forces, will not produce any motion at all.] [Assessment Boundary: Limit testing to one variable at a time: number, size, or direction of forces. The size and direction of forces should be qualitative. Gravity is only to be addressed as a force that pulls objects down.]

3-PS2-b. Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. [Clarification Statement: An example of motion with a predictable pattern is a child swinging in a swing. In this example, the student could observe the swing moving at different relative rates depending on where it is in the arc of the swing.]

3-PS2-c. Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships. [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated by students.]

3-PS2-d. Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them.* [Clarification Statement: Example problems include constructing a latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other (friction, elastic pushes and pulls). (3-PS2-b)
- Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-c),(3-PS2-d)

PS2.C: Stability and Instability in Physical Systems
- A system can change as it moves in one direction (e.g., a ball rolling down a hill), shift back and forth (e.g., a swinging pendulum), or go through cyclical patterns (e.g., day and night). (3-PS2-b)
- Examining how the forces on and within the system change as it moves can help explain a system's patterns of change. (3-PS2-a)
- A system can appear to be unchanging when processes within the system are going on at opposite but equal rates. (3-PS2-a)

Crosscutting Concepts

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

Stability and Change
- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-b),(3-PS2-a)*

Codes for Performance Expectations

Codes designate the relevant performance expectation for an item in the foundation box and connection box. In the connections to common core, italics indicate a potential connection rather than a required prerequisite connection.

Based on the January 2013 Draft of NGSS

Inside the NGSS Box

What is Assessed

A collection of several performance expectations describing what students should be able to do to master this standard

Foundation Box

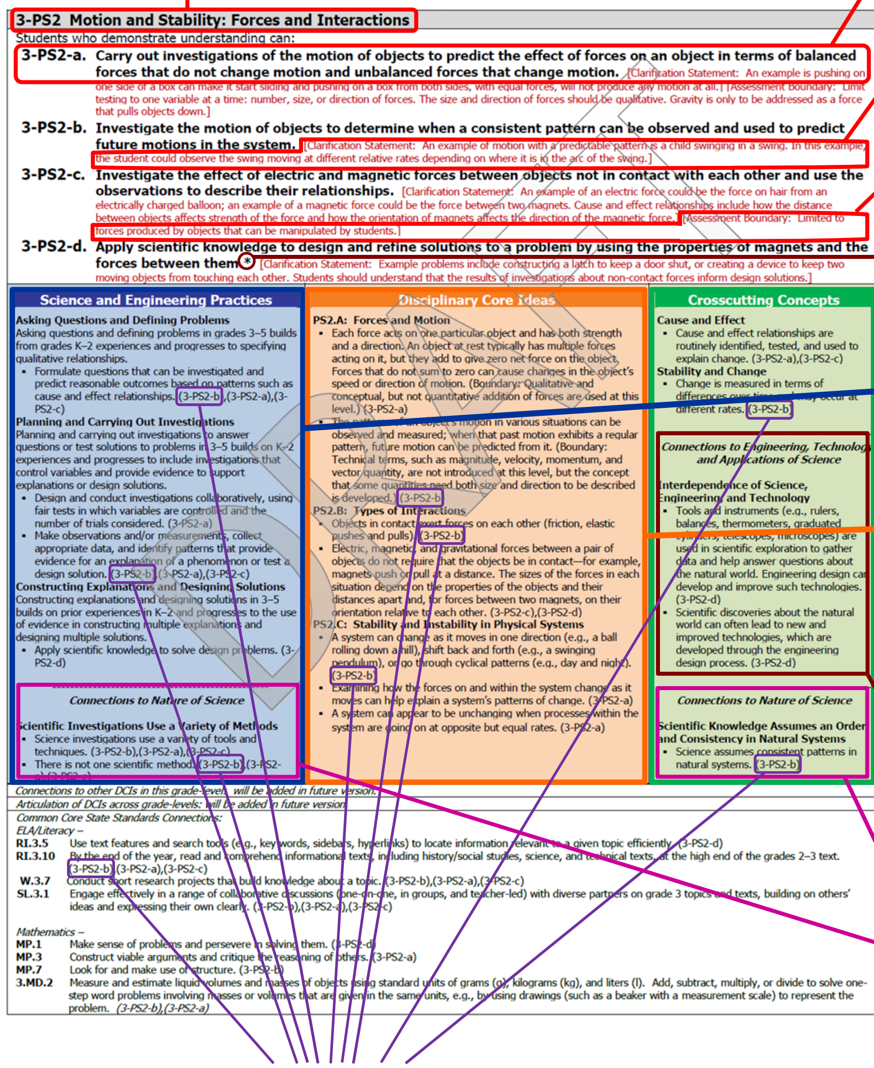
The practices, core disciplinary ideas, and crosscutting concepts from the *Framework for K-12 Science Education* that were used to form the performance expectations

Connection Box

Other standards in the *Next Generation Science Standards* or in the *Common Core State Standards* that are related to this standard

Title and Code

The titles of standard pages are not necessarily unique and may be reused at several different grade levels . The code, however, is a unique identifier for each set based on the grade level, content area, and topic it addresses.



Performance Expectations

A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned.

Clarification Statement

A statement that supplies examples or additional clarification to the performance expectation.

Assessment Boundary

A statement that provides guidance about the scope of the performance expectation at a particular grade level.

Engineering Connection (*)

An asterisk indicates an engineering connection in the practice, core idea or crosscutting concept that supports the performance expectation.

Scientific & Engineering Practices

Activities that scientists and engineers engage in to either understand the world or solve a problem

Disciplinary Core Ideas

Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people's lives.

Crosscutting Concepts

Ideas, such as *Patterns* and *Cause and Effect*, which are not specific to any one discipline but cut across them all.

Connections to Engineering, Technology and Applications of Science

These connections are drawn from the disciplinary core ideas for engineering, technology, and applications of science in the *Framework*.

Connections to Nature of Science

Connections are listed in either the practices or the crosscutting connections section of the foundation box.

Codes for Performance Expectations

Codes designate the relevant performance expectation for an item in the foundation box and connection box. In the connections to common core, italics indicate a potential connection rather than a required prerequisite connection.

Based on the January 2013 Draft of NGSS

Closer Look at NGSS

Closer Look at a NGSS (Grade 2)

NGSS@NSTA STEM STARTS HERE

2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

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

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)	**PS1.A: Structure and Properties of Matter** • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	**Patterns** • Patterns in the natural and human designed world can be observed. (2-PS1-1)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: 5.PS1.A

Connections to Common Core State Standards in ELA/Literacy:

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1)

Connections to Common Core State Standards in Mathematics:

MP.4 Model with mathematics. (2-PS1-1)

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1

Closer Look at a NGSS (Grade 2)

NGSS@NSTA STEM STARTS HERE

2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

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

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)	**PS1.A: Structure and Properties of Matter** • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	**Patterns** • Patterns in the natural and human designed world can be observed. (2-PS1-1)

Note: Performance expectations combine practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***.

They are not instructional strategies or objectives for a lesson.

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: 5.PS1.A

Connections to Common Core State Standards in ELA/Literacy:

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1)

Connections to Common Core State Standards in Mathematics:

MP.4 Model with mathematics. (2-PS1-1)

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1

Closer Look at a NGSS (Grade 2)

NGSS@NSTA STEM STARTS HERE

2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

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

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)	**PS1.A: Structure and Properties of Matter** • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	**Patterns** • Patterns in the natural and human designed world can be observed. (2-PS1-1)

Note: Performance expectations combine practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***.

They are not instructional strategies or objectives for a lesson.

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: 5.PS1.A

Connections to Common Core State Standards in ELA/Literacy:

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1)

Connections to Common Core State Standards in Mathematics:

MP.4 Model with mathematics. (2-PS1-1)

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1

Closer Look at a NGSS (Grade 2)

2.PS1 Matter and Its Interactions		
Students who demonstrate understanding can: **2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)	**PS1.A: Structure and Properties of Matter** • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	**Patterns** • Patterns in the natural and human designed world can be observed. (2-PS1-1)
Connections to other DCIs in second grade: N/A		
Articulation of DCIs across grade-levels: 5.PS1.A		
Connections to Common Core State Standards in ELA/Literacy: **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1) **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1) **Connections to Common Core State Standards in Mathematics:** **MP.4** Model with mathematics. (2-PS1-1) **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1		

Note: Performance expectations combine practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***.

They are not instructional strategies or objectives for a lesson.

Closer Look at a NGSS (Grade 2)

2.PS1 Matter and Its Interactions		
Students who demonstrate understanding can: **2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)	**PS1.A: Structure and Properties of Matter** • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	**Patterns** • Patterns in the natural and human designed world can be observed. (2-PS1-1)
Connections to other DCIs in second grade: N/A		
Articulation of DCIs across grade-levels: 5.PS1.A		
Connections to Common Core State Standards in ELA/Literacy: **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1) **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1) **Connections to Common Core State Standards in Mathematics:** **MP.4** Model with mathematics. (2-PS1-1) **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1		

Note: Performance expectations combine practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***.

They are not instructional strategies or objectives for a lesson.

An Analogy

An Analogy between NGSS and a Cake

NGSS@NSTA
STEM STARTS HERE

Baking a Cake
(Performance Expectation)

Baking Tools & Techniques
(Practices)

Cake
(Core Ideas)

Frosting
(Crosscutting Concepts)

An Analogy between NGSS and Cooking

NGSS@NSTA
STEM STARTS HERE

Preparing a Meal
(Performance Expectation)

Kitchen Tools & Techniques
(Practices)

Basic Ingredients
(Core Ideas)

Herbs, Spices, & Seasonings
(Crosscutting Concepts)

An Analogy between NGSS and Cooking

NGSS@NSTA STEM STARTS HERE

Life Science (Vegetables)

Physical Science (Meats)

Earth & Space Science (Grains)

Engineering & Technology (Dairy)

Writing a Performance Expectation

Writing a Performance Expectation

Directions:

1. Select a core idea from the *Sample Disciplinary Core Ideas* handout
2. Review the *Three Dimensions of NGSS* handout and select a practice and a crosscutting concept that go well with the disciplinary core idea
3. Write an example of a performance expectation

When finished, discuss the following questions:

- How did you go about selecting a practice and crosscutting concept?
- What challenges did you encounter?
- What are the advantages of incorporating all of the dimensions into a performance expectation?

Sample Disciplinary Core Ideas

NGSS@NSTA
STEM STARTS HERE

	Life Science	Earth and Space Science	Physics	Chemistry	Engineering Design
K-2	**LS1.C: Organization for Matter and Energy Flow in Organisms** All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	**ESS1.B: Earth and the Solar System** Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	**PS2.A: Forces and Motion** Pushes and pulls can have different strengths and directions.	**PS1.A: Structure and Properties of Matter** Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.	**ETS1.A: Defining and Delimiting Engineering Problems** Before beginning to design a solution, it is important to clearly understand the problem.
3-5	**LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	**PS2.B: Types of Interactions** Objects in contact exert forces on each other.	**PS1.B: Chemical Reactions** When two or more different substances are mixed, a new substance with different properties may be formed.	**ETS1.C: Optimizing the Design Solution** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.
6-8	**LS2.A: Interdependent Relationships in Ecosystems** In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.	**ESS1.A: The Universe and Its Stars** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.	**PS3.A: Definitions of Energy** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	**PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
9-12	**LS4.B: Natural Selection** The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.	**ESS3.A: Natural Resources** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.	**PS4.A: Wave Properties** The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.	**PS1.A: Structure and Properties of Matter** The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.	**ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

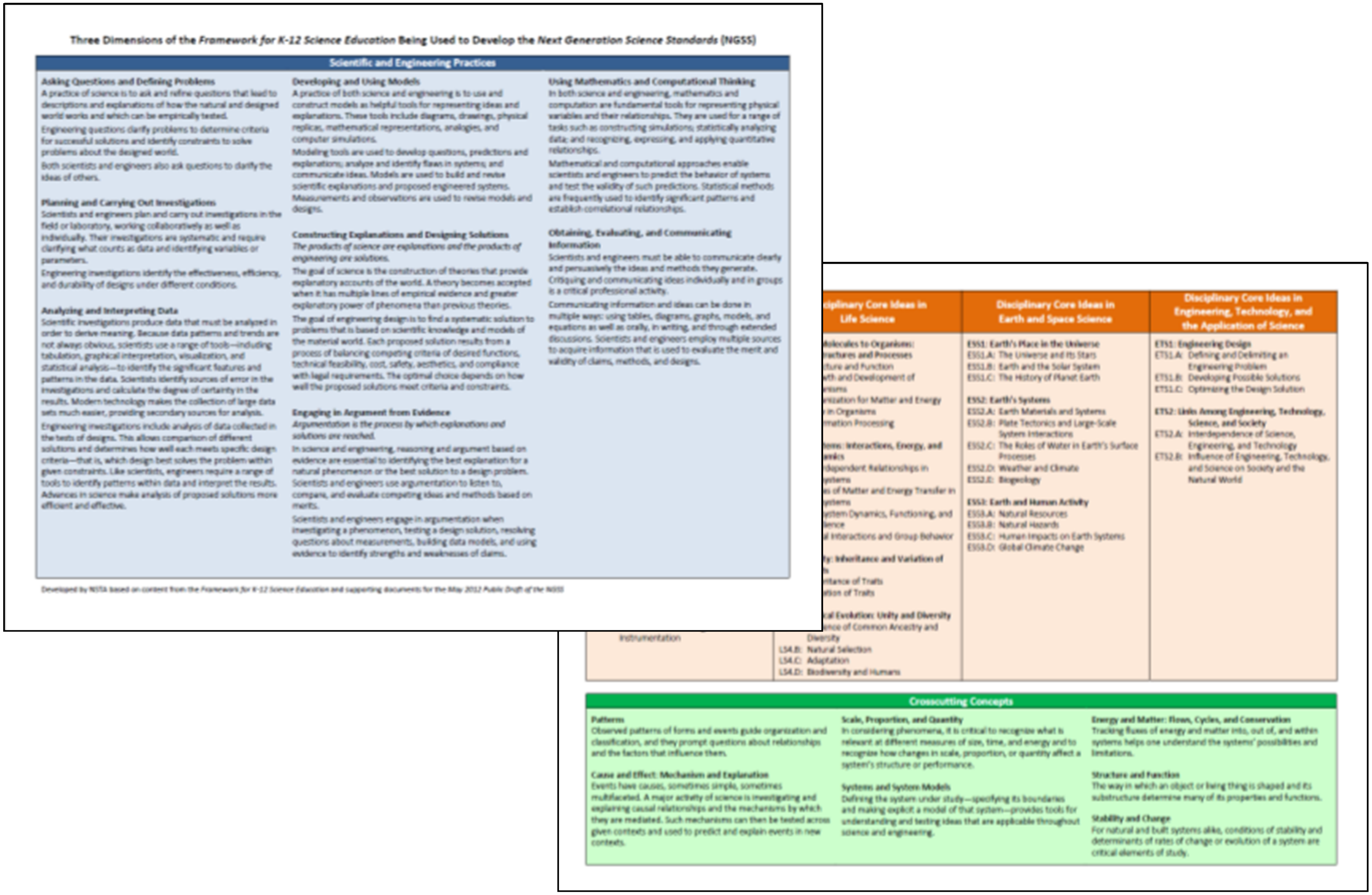
Sample Disciplinary Core Ideas

NGSS@NSTA
STEM STARTS HERE

	Life Science	Earth and Space Science	Physics	Chemistry	Engineering Design
K-2	**LS1.C: Organization for Matter and Energy Flow in Organisms** All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	**ESS1.B: Earth and the Solar System** Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	**PS2.A: Forces and Motion** Pushes and pulls can have different strengths and directions.	**PS1.A: Structure and Properties of Matter** Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.	**ETS1.A: Defining and Delimiting Engineering Problems** Before beginning to design a solution, it is important to clearly understand the problem.
3-5	**LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	**PS2.B: Types of Interactions** Objects in contact exert forces on each other.	**PS1.B: Chemical Reactions** When two or more different substances are mixed, a new substance with different properties may be formed.	**ETS1.C: Optimizing the Design Solution** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.
6-8	**LS2.A: Interdependent Relationships in Ecosystems** In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.	**ESS1.A: The Universe and Its Stars** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.	**PS3.A: Definitions of Energy** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	**PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
9-12	**LS4.B: Natural Selection** The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.	**ESS3.A: Natural Resources** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.	**PS4.A: Wave Properties** The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.	**PS1.A: Structure and Properties of Matter** The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.	**ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

Handout about the Three Dimensions

NGSS@NSTA
STEM STARTS HERE



Exploring at the Practices

Exploring the Practices

NGSS@NSTA STEM STARTS HERE

Review the following information about one practice:

A. Section from Chapter 3 of the *Framework*
B. Matrix for the practices from Appendix F of the NGSS
C. Example performance expectations that use the practice

Use these discussion questions:

1. What are the key elements of this practice?
2. How will engaging in this practice support the learning of a disciplinary core idea?
3. To what extent do you currently provide opportunities for students to engage in this practice during instruction?

Prepare a poster and be prepared to make a 2 minute presentation about your practice to the whole group

Handouts

NGSS@NSTA
STEM STARTS HERE

Practice 1 Asking Questions and Defining Problems

Questions are the engine that drive science and engineering.
Science asks

- What exists and what happens?
- Why does it happen?
- How does one know?

Engineering asks

- What can be done to address a particular human need or want?
- How can the need be better specified?
- What tools and technologies are available, or could be developed, for addressing this need?

Both science and engineering ask

- How does one communicate about phenomena, evidence, explanations, and design solutions?

Asking questions is essential to developing scientific habits of mind. Even for individu scientists or engineers, the ability to ask well defined questions is an important compo helping to make them critical consumers of scientific knowledge.

Scientific questions arise in a variety of ways. They can be driven by curiosity about th the sky blue?). They can be inspired by a model's or theory's predictions or by attempt model or theory (e.g., How does the particle model of matter explain the incompressibi can result from the need to provide better solutions to a problem. For example, the que impossible to siphon water above a height of 32 feet led Evangelista Torricelli (17th-c barometer) to his discoveries about the atmosphere and the identification of a vacuum.

Questions are also important in engineering. Engineers must be able to ask probing qu an engineering problem. For example, they may ask: What is the need or desire that un What are the criteria (specifications) for a successful solution? What are the constraint when generating possible solutions: Will this solution meet the design criteria? Can tw combined to produce a better solution? What are the possible trade-offs? And more qu testing solutions: Which ideas should be tested? What evidence is needed to show whi the given constraints?

The experience of learning science and engineering should therefore develop students' indeed, encourage them to ask—well-formulated questions that can be investigated em need to recognize the distinction between questions that can be answered empirically a answerable only in other domains of knowledge or human experience.

GOALS

By grade 12, students should be able to

- Ask questions about the natural and human-built worlds—for example: Why a do bees do? Why did that structure collapse? How is electric power generated
- Distinguish a scientific question (e.g., Why do helium balloons rise?) from a n (Which of these colored balloons is the prettiest?).
- Formulate and refine questions that can be answered empirically in a science c to design an inquiry or construct a pragmatic solution.
- Ask probing questions that seek to identify the premises of an argument, requ refine a research question or engineering problem, or challenge the interpretati example: How do you know? What evidence supports that argument?
- Note features, patterns, or contradictions in observations and ask questions ab
- For engineering, ask questions about the need or desire to be met in order to d specifications for a solution.

NGSS Science and Engineering Practices* (March 2013 Draft)

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Asking Questions and Defining Problems A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.	Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.	Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, clarify arguments and models.	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
	• Ask questions based on observations to find more information about the natural and/or designed world(s).	• Ask questions about what would happen if a variable is changed.	• Ask questions ◦ that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. ◦ to identify and/or clarify evidence and/or the premise(s) of an argument. ◦ to determine relationships between independent and dependent variables and relationships in models.. ◦ to clarify and/or refine a model, an explanation, or an engineering problem.	• Ask questions ◦ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. ◦ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. ◦ to determine relationships, including quantitative relationships, between independent and dependent variables. ◦ to clarify and refine a model, an explanation, or an engineering problem.
	• Ask and/or identify questions that can be answered by an investigation.	• Identify scientific (testable) and non-scientific (non-testable) questions. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	• Ask questions that require sufficient and appropriate empirical evidence to answer. • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	• Evaluate a question to determine if it is testable and relevant. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
			• Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.	• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of

Exploring the Crosscutting Concepts

Exploring the Crosscutting Concepts

NGSS@NSTA STEM STARTS HERE

Review the following about one Crosscutting Concept:

A. Section from Chapter 4 of the *Framework*
B. Matrix for the practices from Appendix G of the NGSS
C. Example performance expectations that use this crosscutting concept

Use these discussion questions:

1. What are the key elements of this crosscutting concept?
2. What are some science concepts and contexts that would provide good opportunities for students to explore this crosscutting concept?
3. In what ways could you change your current methods of instruction to include more opportunities for students to improve their understanding of this crosscutting concept?

Prepare a poster and be prepared to make a 2 minute presentation about your practice to the whole group

Handouts

NGSS@NSTA STEM STARTS HERE

Crosscutting Concept 1: Patterns

Patterns exist everywhere—in regularly occurring shapes or structures and in repeating events and relationships. For example, patterns are discernible in the symmetry of flowers and snowflakes, the cycling of the seasons, and the repeated base pairs of DNA. Noticing patterns is often a first step to organizing and asking scientific questions about why and how the patterns occur.

One major use of pattern recognition is in classification, which depends on careful observation of similarities and differences; objects can be classified into groups on the basis of similarities of visible or microscopic features or on the basis of similarities of function. Such classification is useful in codifying relationships and organizing a multitude of objects or processes into a limited number of groups. Patterns of similarity and difference and the resulting classifications may change, depending on the scale at which a phenomenon is being observed. For example, isotopes of a given element are different—they contain differen
neutrons—but from the perspective of chemistry they can be classified as equ
they have identical patterns of chemical interaction. Once patterns and variati
noted, they lead to questions; scientists seek explanations for observed patter
similarity and diversity within them. Engineers often look for and analyze pa
example, they may diagnose patterns of failure of a designed system under te
improve the design, or they may analyze patterns of daily and seasonal use of
system that can meet the fluctuating needs.

The ways in which data are represented can facilitate pattern recogniti
development of a mathematical representation, which can then be used as a to
underlying explanation for what causes the pattern to occur. For example, bio
changes in population abundance of several different species in an ecosystem
correlations between increases and decreases for different species by plotting
same graph and can eventually find a mathematical expression of the interdep
foodweb relationships that cause these patterns.

Progression

Human beings are good at recognizing patterns; indeed, young children begin
patterns in their own lives well before coming to school. They observe, for ex
and the moon follow different patterns of appearance in the sky. Once they ar
important for them to develop ways to recognize, classify, and record patterns
they observe. For example, elementary students can describe and predict the p
seasons of the year; they can observe and record patterns in the similarities an
between parents and their offspring. Similarly, they can investigate the charac
classification of animal types (e.g., mammals, fish, insects), of plants (e.g., tr
grasses), or of materials (e.g., wood, rock, metal, plastic).

These classifications will become more detailed and closer to scientifi
the upper elementary grades, when students should also begin to analyze patt
change—for example, the growth rates of plants under different conditions. B
students can begin to relate patterns to the nature of microscopic and atomic-l
example, they may note that chemical molecules contain particular ratios of d
high school, students should recognize that different patterns may be observe
scales at which a system is studied. Thus classifications used at one scale may
revision when information from smaller or larger scales is introduced (e.g., cl
on DNA comparisons versus those based on visible characteristics).

from *The Framework for K-12 Science Education*, National Research Cou

Matrix of Crosscutting Concepts in NGSS

NGSS@NSTA STEM STARTS HERE

K-2	3-5	6-8	9-12
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.	• 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 an explanation.	• 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.	• 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.			
• Events have causes that generate observable patterns. • Simple tests can be designed to gather evidence to support or refute student ideas about causes.	• 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.	• 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.	• 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.			
• 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.	• 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.	• 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).

Developed by NSTA using information from Appendix G of the *Next Generation Science Standards* © 2011, 2012, 2013 Achieve, Inc.

Adapted from: National Research Council (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academy Press. Chapter 4: Crosscutting Concepts.

Connections to Common Core and STEM

Connections to Common Core & STEM

NGSS@NSTA STEM STARTS HERE

Choose a topic and join a group focusing on that Topic:

1. Mathematics
2. English Language Arts (ELA)
3. Engineering

Review the Sample Standards Page for your Topic

Use these discussion questions:

1. What connections are there between science and your topic (Math, ELA, or Engineering)?
2. How do the standards show connections between science and your topic?
3. How could you make those connections explicit to students during instruction?

Handouts

NGSS@NSTA
STEM STARTS HERE

Sample Performance Expectations (to study the connections to **Common Core Math**)

MS-PS1-1 Matter and Its Interactions

Develop models to describe the atomic composition of simple mole
[Clarification Statement: Emphasis is on developing models of molecules that vary i
ammonia and methanol. Examples of extended structures could include sodium chl
include drawings, 3D ball and stick structures, or computer representations showin
[Assessment Boundary: Assessment does not include valence electrons and bonding
structures, or a complete description of all individual atoms in a complex molecule

Science and Engineering Practices	Disciplinary Core I
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to predict and/or describe phenomena.	**PS1.A: Structure and Properties o** • Substances are made from diffe atoms, which combine with on various ways. Atoms form mole in size from two to thousands • Solids may be formed from mo may be extended structures wi subunits (e.g., crystals).

Connections to other DCIs in this grade-band: MS.ESS2.C

Articulation of DCIs across grade-bands: 5.PS1.A ; HS.PS1.A ; HS.ESS1.A

Connections to Common Core State Standards in ELA/Literacy:
RST.6-8.7 Integrate quantitative or technical information expressed in words in a in a flowchart, diagram, model, graph, or table). (MS-PS1-1)

Connections to Common Core State Standards in Mathematics:
MP.2 Reason abstractly and quantitatively. (MS-PS1-1)
MP.4 Model with mathematics. (MS-PS1-1)
6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical prob
8.EE.A.3 Use numbers expressed in the form of a single digit times an integer po to express how many times as much one is than the other. (MS-PS1-1)

5-ESS1-2 Earth's Place in the Universe

Represent data in graphical displays to reveal patterns of daily chang night, and the seasonal appearance of some stars in the night sky.
[Clarification Statement: Examples of patterns could include the position and motio visible only in particular months.] [Assessment Boundary: Assessment does not incl

Science and Engineering Practices	Disciplinary C
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.	**ESS1.B: Earth and the Solar S** • The orbits of Earth around moon around Earth, toget Earth about an axis betwe poles, cause observable pa day and night; daily chang direction of shadows; and the sun, moon, and stars a day, month, and year.

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

Articulation of DCIs across grade-bands: 1.ESS1.A ; 1.ESS1.B ; 3.PS2.A ; MS.ESS1.A ;

Connections to Common Core State Standards in ELA/Literacy:
SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displ development of main ideas or themes. (5-ESS1-2)

Connections to Common Core State Standards in Mathematics:
MP.2 Reason abstractly and quantitatively. (5-ESS1-2)
MP.4 Model with mathematics. (5-ESS1-2)
5.G.A.2 Represent real world and mathematical problems by graphing points in coordinate values of points in the context of the situation. (5-ESS1-2)

Sample Performance Expectations (to study the connections to **Common Core ELA**)

5-ESS3-1 Earth and Human Activity

Obtain and combine information about ways individual communities us and environment.

Science and Engineering Practices	Disciplinary Core Ideas
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.	**ESS3.C: Human Impacts on Earth Systems** • Human activities in agriculture, industry, and everyday life have ha major effects on the land, vegetati streams, ocean, air, and even oute space. But individuals and communities are doing things to he protect Earth's resources and environments.

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

Articulation of DCIs across grade-bands: MS.ESS3.A ; MS.ESS3.C ; MS.ESS3.D

Connections to Common Core State Standards in ELA/Literacy:
RI.5.1 Quote accurately from a text when explaining what the text says explicitly
RI.5.7 Draw on information from multiple print or digital sources, demonstrating solve a problem efficiently. (5-ESS3-1)
RI.5.9 Integrate information from several texts on the same topic in order to writ
W.5.8 Recall relevant information from experiences or gather relevant informatic information in notes and finished work, and provide a list of sources. (5-ES
W.5.9 Draw evidence from literary or informational texts to support analysis, refl

Connections to Common Core State Standards in Mathematics:
MP.2 Reason abstractly and quantitatively. (5-ESS3-1)
MP.4 Model with mathematics. (5-ESS3-1)

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Construct an argument supported by empirical evidence that changes ecosystem affect populations. [Clarification Statement: Emphasis is on recogni about changes in populations, and on evaluating empirical evidence supporting argume

Science and Engineering Practices	Dis
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. - **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science disciplines share common rules of obtaining and evaluating empirical evidence.	**LS2.C: Eco Functionin** • Ecosyst their ch time. Di biologic ecosyst populat

Connections to other DCIs in this grade-band: MS.LS4.C ; MS.LS4.D ; MS.ESS2.A ; MS.E

Articulation of DCIs across grade-bands: 3.LS2.C ; 3.LS4.D ; HS.LS2.C ; HS.LS4.C ; HS.LS4

Connections to Common Core State Standards in ELA/Literacy:
RST.6-8.1 Cite specific textual evidence to support analysis of science and technica
RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing relevant and sufficient to support the claims. (MS-LS2-4)
WHST.6-8.1 Write arguments to support claims with clear reasons and relevant evide
WHST.6-8.9 Draw evidence from literary or informational texts to support analysis, r

Sample Performance Expectations (to study how **Engineering** is integrated into NGSS)

HS-PS4-5 Waves and their Applications in Technologies for Information Transfer

Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**PS3.D: Energy in Chemical Processes** • Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary) **PS4.A: Wave Properties** • Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. **PS4.B: Electromagnetic Radiation** • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. **PS4.C: Information Technologies and Instrumentation** • Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.	**Cause and Effect** • Systems can be designed to cause a desired effect. - **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). **Influence of Engineering, Technology, and Science on Society and the Natural World** • Modern civilization depends on major technological systems.

Connections to other DCIs in this grade-band: HS.PS3.A

Articulation of DCIs across grade-bands: MS.PS4.A ; MS.PS4.B ; MS.PS4.C

Connections to Common Core State Standards in ELA/Literacy:
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5)

MS-ETS1-1 Engineering Design

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.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	**ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include: Physical Science: MS-PS3-3

Articulation of DCIs across grade-bands: 3-5.ETS1.A ; 3-5.ETS1.C ; HS.ETS1.A ; HS.ETS1.B

Connections to Common Core State Standards in ELA/Literacy:
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1)
WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ETS1-1)

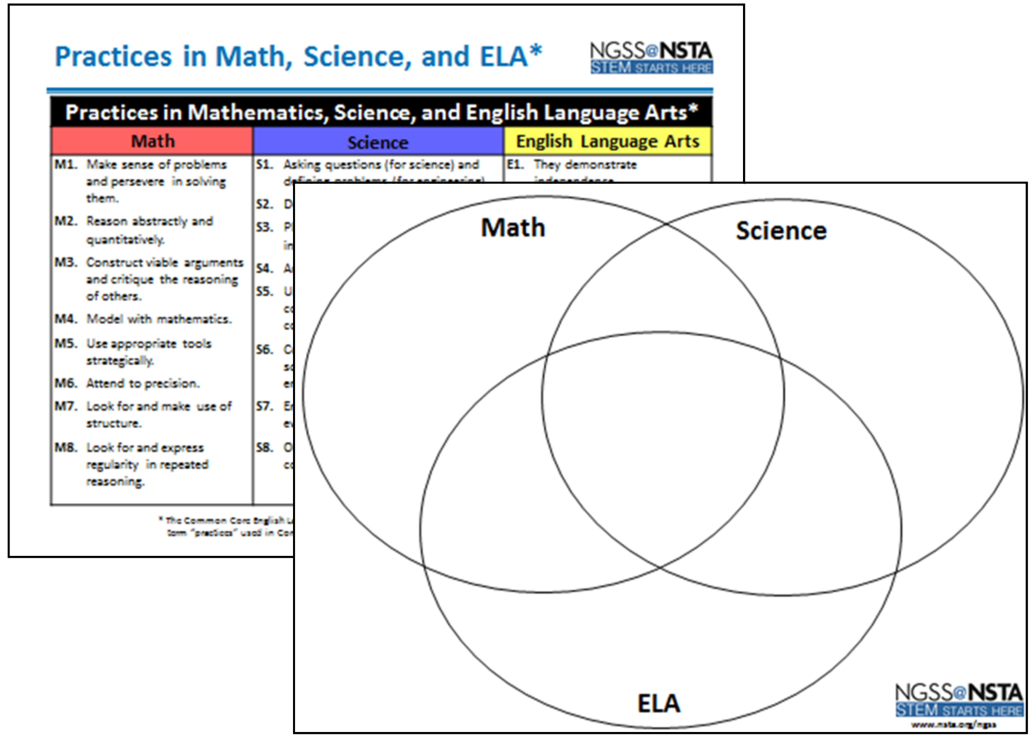
Connections to Common Core State Standards in Mathematics:
MP.2 Reason abstractly and quantitatively. (MS-ETS1-1)
7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1)

Practices in Science, Mathematics, and English Language Arts (ELA)

Venn Diagram Activity

NGSS@NSTA STEM STARTS HERE

- Have participants review the list of practices in Science, Mathematics, and English Language Arts
- Give them a blank Venn diagram and ask them to fill it out.



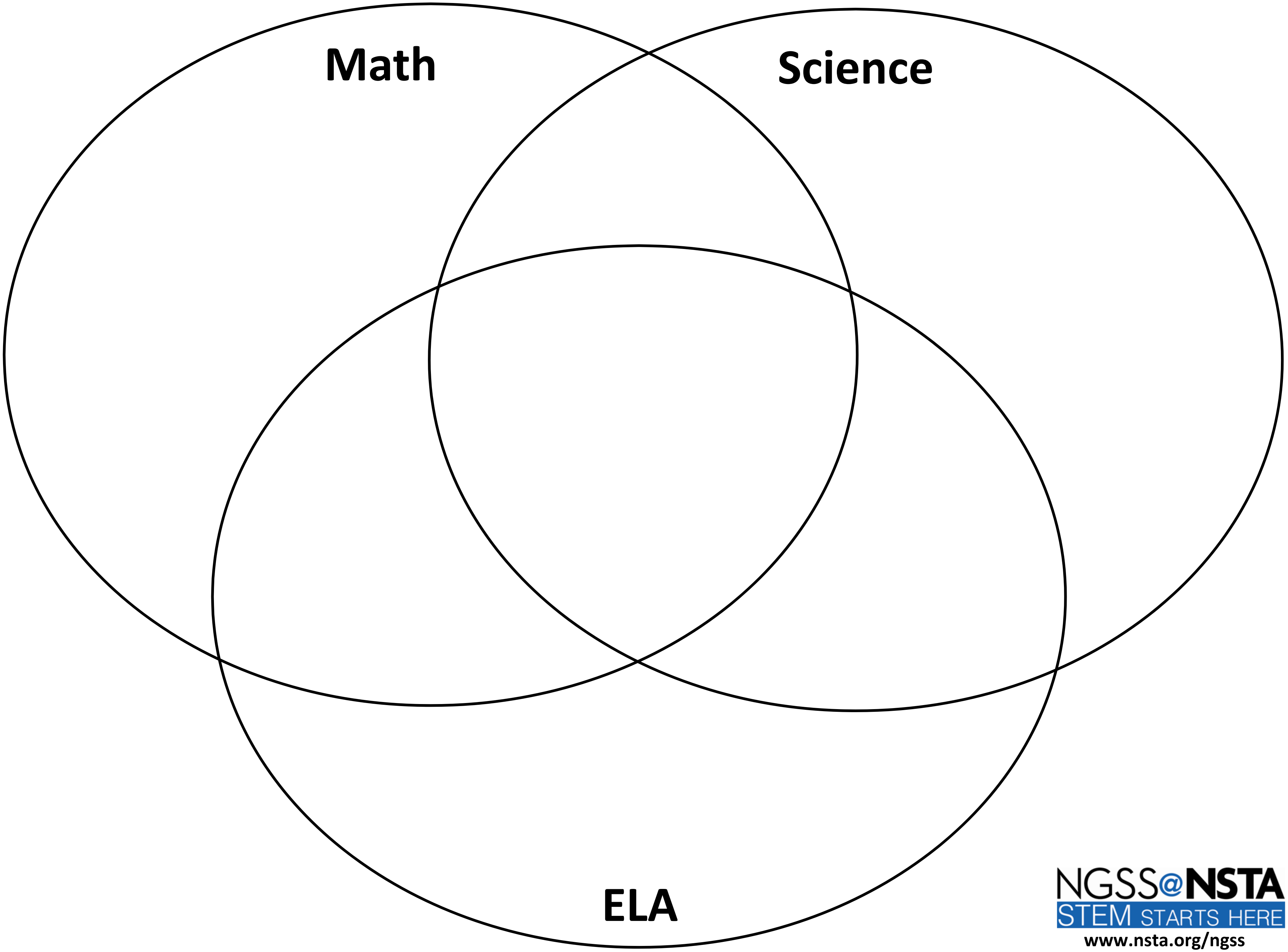
- If you wish, you can have them compare it to the one prepared by the English Language Learners group at Stanford University. Note that there is no one right answer. The goal is to stimulate discussion.

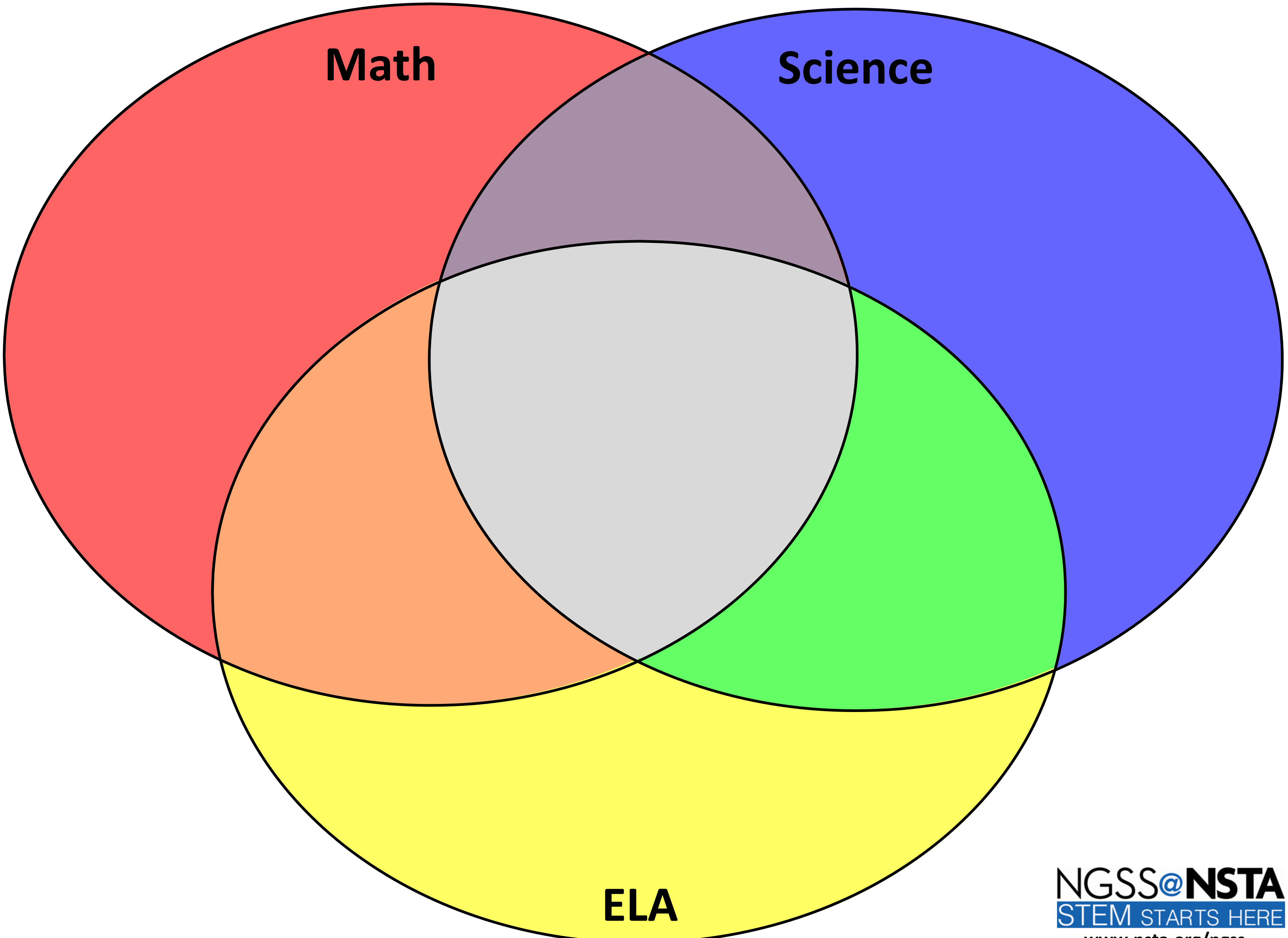
Practices in Math, Science, and ELA*

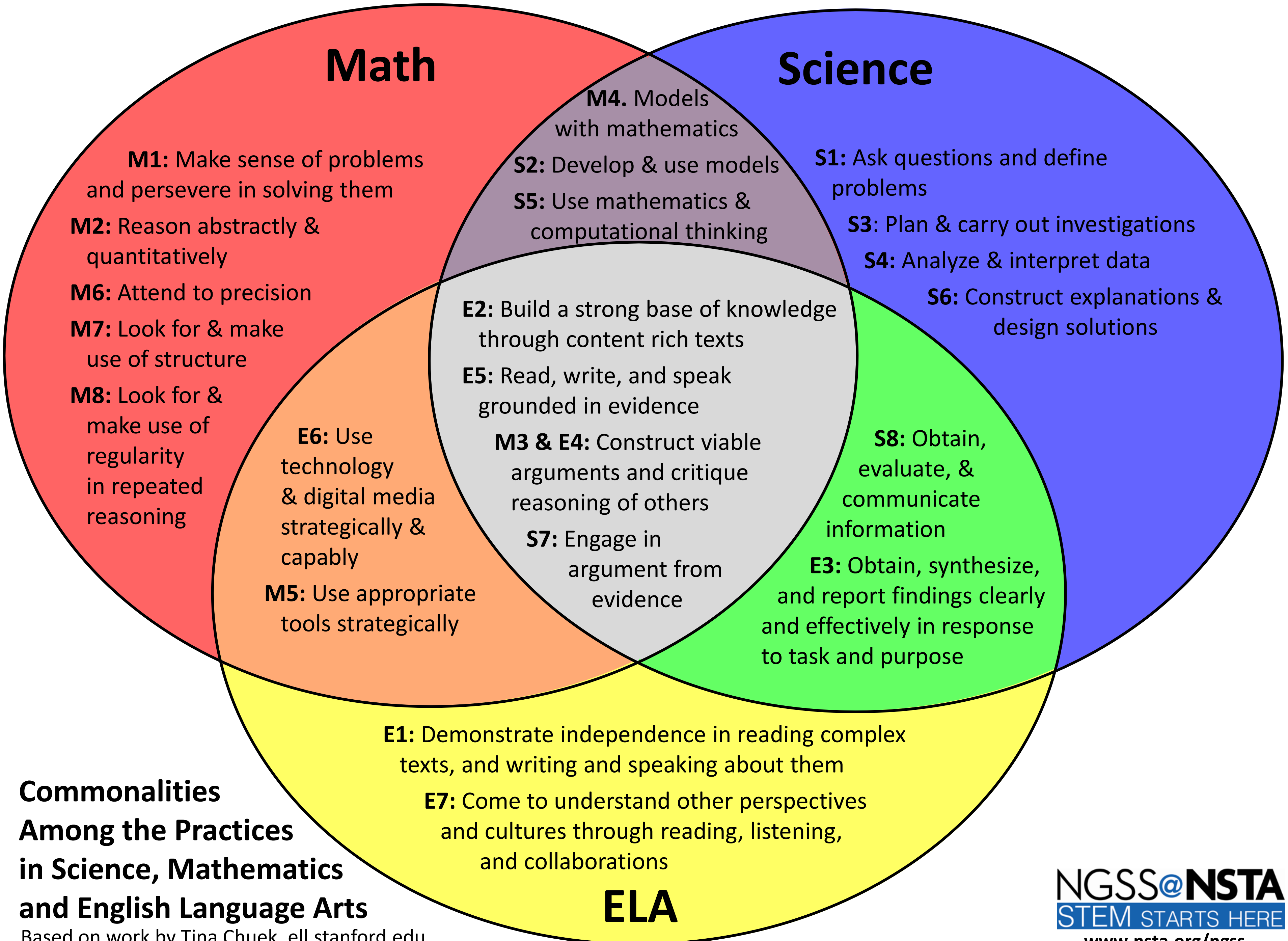
NGSS@NSTA
STEM STARTS HERE

Practices in Mathematics, Science, and English Language Arts*		
Math	**Science**	**English Language Arts**
M1. Make sense of problems and persevere in solving them.	**S1.** Asking questions (for science) and defining problems (for engineering).	**E1.** They demonstrate independence.
M2. Reason abstractly and quantitatively.	**S2.** Developing and using models.	**E2.** They build strong content knowledge.
M3. Construct viable arguments and critique the reasoning of others.	**S3.** Planning and carrying out investigations.	**E3.** They respond to the varying demands of audience, task, purpose, and discipline.
M4. Model with mathematics.	**S4.** Analyzing and interpreting data.	**E4.** They comprehend as well as critique.
M5. Use appropriate tools strategically.	**S5.** Using mathematics, information and computer technology, and computational thinking.	**E5.** They value evidence.
M6. Attend to precision.	**S6.** Constructing explanations (for science) and designing solutions (for engineering).	**E6.** They use technology and digital media strategically and capably.
M7. Look for and make use of structure.	**S7.** Engaging in argument from evidence.	**E7.** They come to understanding other perspectives and cultures.
M8. Look for and express regularity in repeated reasoning.	**S8.** Obtaining, evaluating, and communicating information.	

* The Common Core English Language Arts uses the term "student capacities" rather than the term "practices" used in Common Core Mathematics and the Next Generation Science Standards.


Math
Science
ELA


Math
Science
ELA



Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek, ell.stanford.edu

NGSS@NSTA
STEM STARTS HERE
www.nsta.org/ngss

Reflections

Goals of the Workshop

NGSS@NSTA STEM STARTS HERE

Participants will understand:

- How NGSS was developed
- How the integration of the three dimensions described in the Framework come together in NGSS
- How performance expectations are directives about assessment, but not about instruction
- How the scientific and engineering practices are central to good instruction of NGSS
- How NGSS is related to STEM and the Common Core State Standards

Key Points

NGSS@NSTA STEM STARTS HERE

- This isn't going to be easy
- It's worth doing
- When doing PD on NGSS, start with the *Scientific and Engineering Practices*
- When reading NGSS, start with the *Disciplinary Core Ideas*
- There are still a lot of decisions to make
- It's going to take time

Reflecting on the Process

Reporting Out:

What was a major "Head scratcher"?

OR

What was a major "Ah Ha!" moment?

Looking at the Activities

NGSS@NSTA
STEM STARTS HERE

Reporting Out:

How useful was these activities?

Could you use themwith the educators you work with?

Standards are Only the Start

Standards are Only the Start

NSTA Resources

On the Web

NGSS@NSTA
STEM STARTS HERE

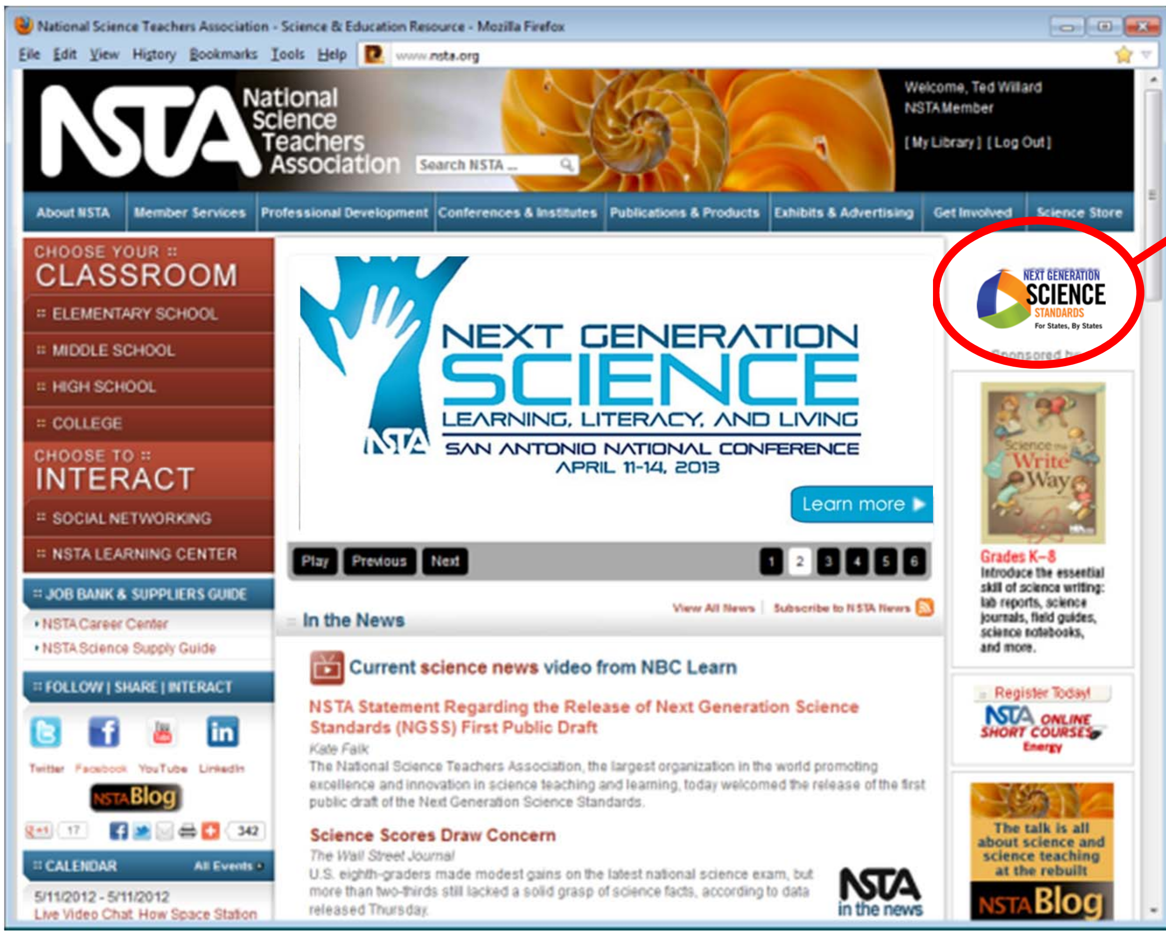
nextgenscience.org

nsta.org/ngss

NSTA Resources on NGSS

NGSS@NSTA
STEM STARTS HERE

www.nsta.org

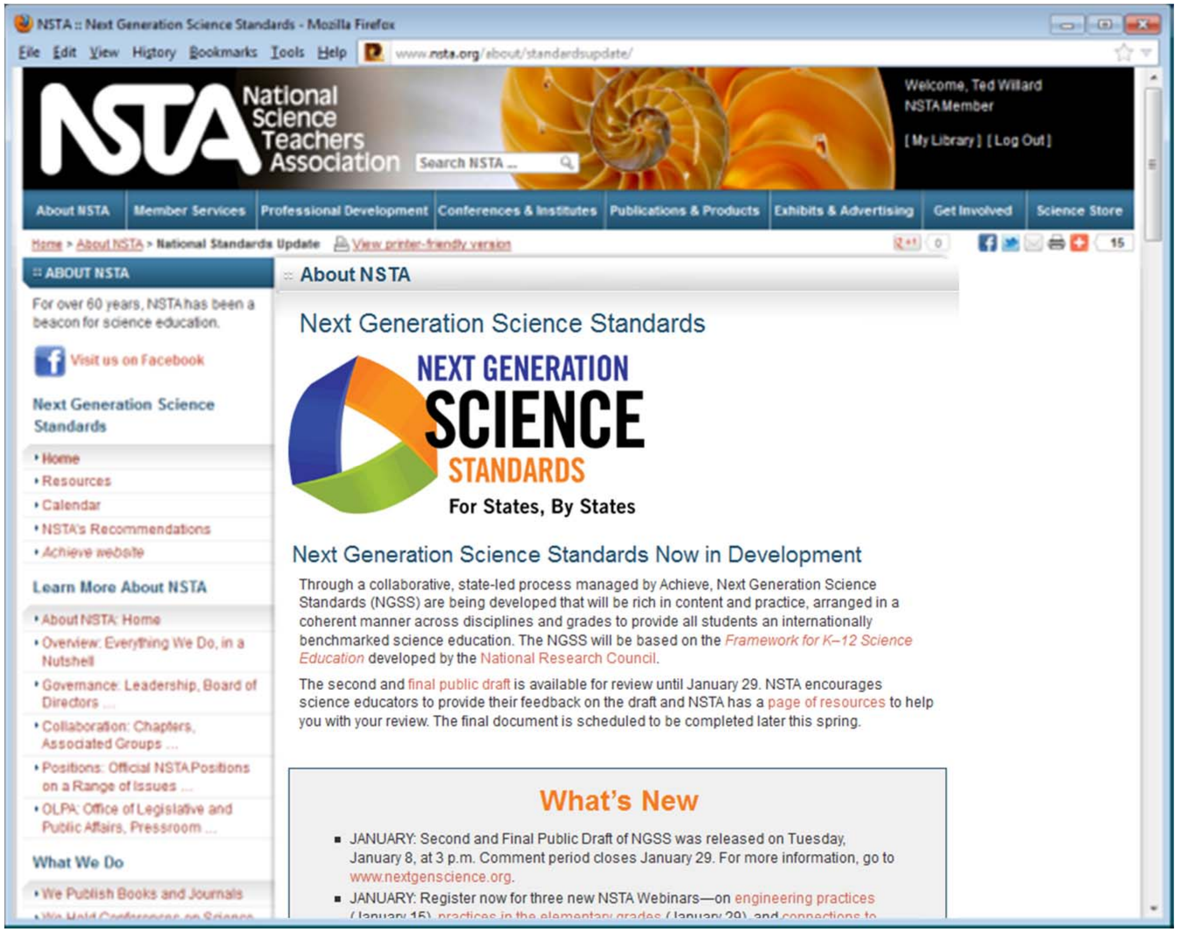


NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

NSTA Resources on NGSS

NGSS@NSTA
STEM STARTS HERE

www.nsta.org/ngss



NSTA Resources on NGSS

NGSS@NSTA
STEM STARTS HERE

NSTA WEB SEMINARS
LIVE INTERACTIVE LEARNING @ YOUR DESKTOP

Web Seminars

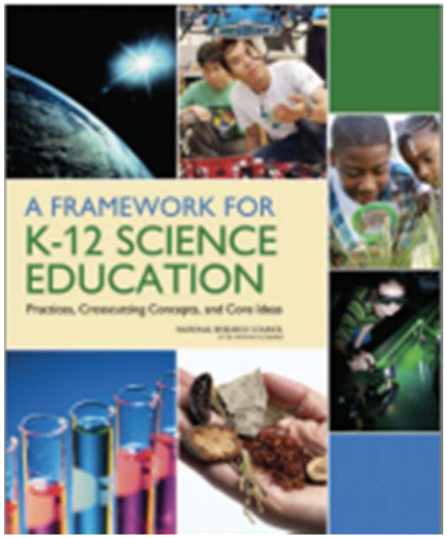
- Practices (Archive from Fall 2012)
- Crosscutting Concepts (Archive from Spring 2013)
- Disciplinary Core Ideas (Coming in the 2013-2014 School Year)

Journal Articles

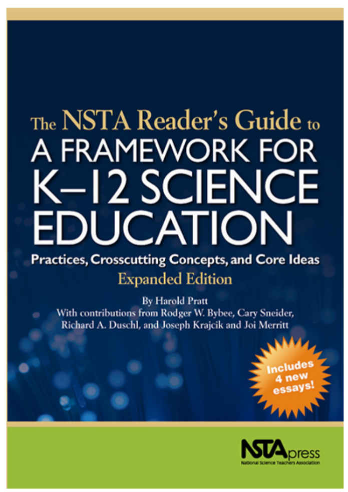
- Science and Children
- Science Scope
- The Science Teacher

From the NSTA Bookstore

NGSS@NSTA
STEM STARTS HERE



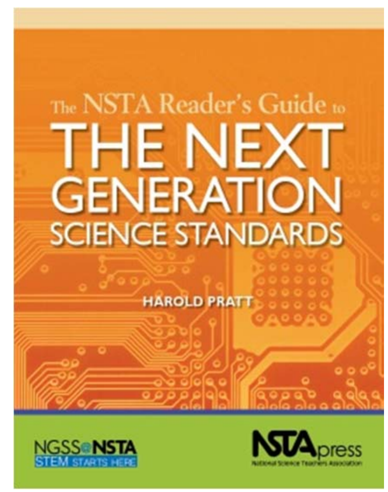
Available Now



Available Now

Available this summer

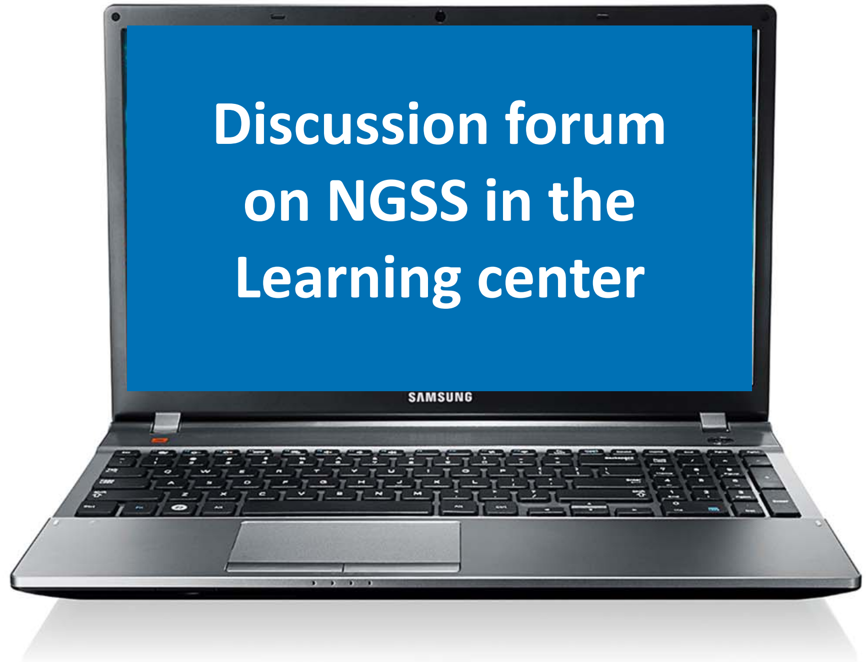
Preorder Now



Available Now

Connect & Collaborate with Colleagues

NGSS@NSTA
STEM STARTS HERE



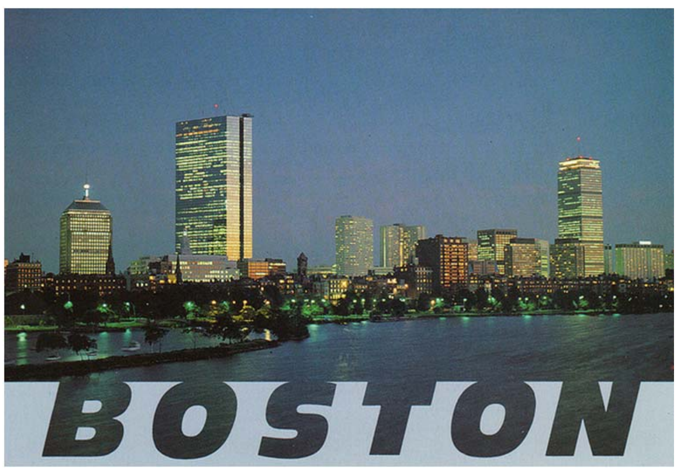
Future Conferences

NGSS@NSTA
STEM STARTS HERE

Portland, OR
October 24–26

Charlotte, NC
November 7–9

Denver, CO
December 12–14



National Conference

Boston – April 3-6, 2014

END

Comparison between NGSS and Traditional Standards

Current State Science Standard Sample

NGSS@NSTA STEM STARTS HERE

Inquiry Standards

a. Students will explore the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.
b. Students will use standard safety practices for all classroom laboratory and field investigations.
c. Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.
d. Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities utilizing safe laboratory procedures.
e. Students will use the ideas of system, model, change, and scale in exploring scientific and technological matters.
f. Students will communicate scientific ideas and activities clearly.
g. Students will question scientific claims and arguments effectively.

Content Standards

a. Distinguish between atoms and molecules.
b. Describe the difference between pure substances (elements and compounds) and mixtures.
c. Describe the movement of particles in solids, liquids, gases, and plasmas states.
d. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
f. Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
g. Identify and demonstrate the Law of Conservation of Matter.

Standards Comparison:

Structure and Properties of Matter

NGSS@NSTA STEM STARTS HERE

Current State Middle School Science Standard

a. Distinguish between atoms and molecules.
b. Describe the difference between pure substances (elements and compounds) and mixtures.
c. Describe the movement of particles in solids, liquids, gases, and plasmas states.
d. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
f. Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
g. Identify and demonstrate the Law of Conservation of Matter.

NGSS Middle School Sample

a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.
b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
c. Use a simulation or mechanical model to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.
d. Construct an argument that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.

Standards Comparison:

Structure and Properties of Matter

Current State Middle School Science Standard

- **a.** **Distinguish** between atoms and molecules.
- **b.** **Describe** the difference between pure substances (elements and compounds) and mixtures.
- **c.** **Describe** the movement of particles in solids, liquids, gases, and plasmas states.
- **d.** **Distinguish** between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
- **e.** **Distinguish** between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
- **f.** **Recognize** that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
- **g.** **Identify and demonstrate** the Law of Conservation of Matter.

NGSS Middle School Sample

- a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.
- b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
- c. Use a simulation or mechanical model to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.
- d. Construct an argument that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.

Standards Comparison:

Structure and Properties of Matter

NGSS@NSTA STEM STARTS HERE

Current State Middle School Science Standard

a. **Distinguish** between atoms and molecules.
b. **Describe** the difference between pure substances (elements and compounds) and mixtures.
c. **Describe** the movement of particles in solids, liquids, gases, and plasmas states.
d. **Distinguish** between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
e. **Distinguish** between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
f. **Recognize** that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
g. **Identify and demonstrate** the Law of Conservation of Matter.

NGSS Middle School Sample

a. **Construct and use models to explain** that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.
b. **Plan investigations to generate evidence** supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
c. **Use a simulation or mechanical model to determine** the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.
d. **Construct an argument that explains** the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.

Standards Comparison:

Structure and Properties of Matter

NGSS@NSTA STEM STARTS HERE

Current State Middle School Science Standard

a. Distinguish **between atoms and molecules**.

b. Describe the difference between **pure substances (elements and compounds) and mixtures**.

c. Describe the **movement of particles in solids, liquids, gases, and plasmas states**.

d. Distinguish between **physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility**).

e. Distinguish between **changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color)**.

f. Recognize that there are more than **100 elements and some have similar properties as shown on the Periodic Table of Elements**.

g. Identify and demonstrate the **Law of Conservation of Matter**.

NGSS Middle School Sample

a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.

b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.

c. Use a simulation or mechanical model to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.

d. Construct an argument that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.

Standards Comparison:

Structure and Properties of Matter

NGSS@NSTA STEM STARTS HERE

Current State Middle School Science Standard

a. Distinguish **between atoms and molecules**.

b. Describe the difference between **pure substances (elements and compounds) and mixtures**.

c. Describe the **movement of particles in solids, liquids, gases, and plasmas states**.

d. Distinguish between **physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility**).

e. Distinguish between **changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color)**.

f. Recognize that there are more than **100 elements and some have similar properties as shown on the Periodic Table of Elements**.

g. Identify and demonstrate the **Law of Conservation of Matter**.

NGSS Middle School Sample

a. Construct and use models to explain that **atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits**.

b. Plan investigations to generate evidence supporting the claim that **one pure substance can be distinguished from another based on characteristic properties**.

c. Use a simulation or mechanical model to determine the effect on the **temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance**.

d. Construct an argument that explains the effect of **adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion**.