To what extent have you interacted with this document?

A. I've read it thoroughly.
B. I've skimmed it for general information.
C. It's on my bookshelf.
D. Huh?

http://www.nap.edu/catalog.php?record_id=13165

How about this one?

A. I've read it thoroughly.
B. I've skimmed it for general information.
C. It's on my bookshelf.
D. No clue
**Or this one?**

A. I’ve read it thoroughly.
B. I’ve skimmed it for general information.
C. It’s on my bookshelf.
D. It’s the first time I’ve seen it.

http://www.nap.edu/catalog.php?record_id=18409

**Why, What, Who, When & Where**

- Explain the reasons for building new science standards.
- Describe the process and timeline for constructing the Framework and the NGSS.
- Describe the structure of a standard within NGSS.
- Discuss the implications of the “shifts” in NGSS for teaching and learning.
- Examine instructional strategies that reflect the intent of NGSS.

**Why were the NGSS developed?**

**Goal**

For all students to:
- Have appreciation for the beauty and wonder of science
- Have sufficient knowledge of science and engineering to engage in public discussions
- Be careful consumers of scientific information relevant to their daily lives
- Continue to learn about science outside school
- Have the skills to enter careers of their choice, including (but not limited to) science, engineering and technology.
The National Assessment of Educational Progress (NAEP)

- NAEP is the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas.

2009 NAEP Science Results

Grade 4
34% of students perform at or above Proficient

Grade 8
30% of students perform at or above Proficient

Grade 12
21% of students perform at or above Proficient
PISA is an international assessment that measures 15-year-old students’ reading, mathematics, and science literacy. PISA also includes measures of general or cross-curricular competencies, such as problem solving. PISA emphasizes functional skills that students have acquired as they near the end of compulsory schooling.

29% of students scored at or above level 4—the level at which students can complete higher order tasks.

TIMSS provides reliable and timely data on the mathematics and science achievement of U.S. students compared to that of students in other countries.
## TIMSS Performance

### United States v Singapore Benchmark Achievement

<table>
<thead>
<tr>
<th>Grade</th>
<th>3 Advanced</th>
<th>2 High</th>
<th>1 Intermediate</th>
<th>0 Low</th>
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<td>19</td>
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<td>42</td>
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<td>10</td>
<td>32</td>
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<td>61</td>
</tr>
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<tr>
<td>1999</td>
<td>12</td>
<td>29</td>
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<td>60</td>
</tr>
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<td>1995</td>
<td>11</td>
<td>29</td>
<td>38</td>
<td>64</td>
</tr>
</tbody>
</table>

* Rank = 1; ** Rank = 5; ***Rank = 9

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Where do you start when developing new standards?
A New Vision of Science Learning that Leads to a New Vision of Teaching

“The framework is designed to help realize a vision for education in the sciences and engineering in which (all) students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.”

A Framework for K-12 Science Education pp. 8-9
The framework is built on the notion of learning as a developmental progression.

It is designed to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works.

Who developed the NGSS?
What does a standard look like in the NGSS?

K Forces and Interactions: Pushes and Pulls

Find and Interactions: Pushes and Pulls

Science and Engineering Practices

Analyzing and Interpreting Data

Analyzing and Interpreting Data

Analyzing and Interpreting Data

Analyzing and Interpreting Data

Analyzing and Interpreting Data

YIKES!!
What’s Inside the Standards Box?

Exploring the Standards Box

- Read the explanation for each heading
- Write a heading in the box that best explains each section of the Standards Box.

Title and Performance Expectations

4-PS3 Energy

What is Assessed
A set of performance expectations describing what students should know and be able to do to master 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.

4-PS3 Energy

A Closer Look at a Performance Expectation

K-LS1 From Molecules to Organisms: Structures and Processes

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

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.
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 are important throughout science.

Connection Box:
Other standards in the Next Generation Science Standards or in the Common Core State Standards that are related to this standard.

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 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.
How is content articulated in the NGSS?

Review and discuss the progression of energy standards with a partner or your team.

Kindergarten Grade 4 Middle School High School

Partner/Group Review and Discussion

Discuss and Record your observations:
- How do the standards build coherently K-HS?
- How do core ideas progress K-12?
- How does the cognitive rigor progress K-HS?
- What are the opportunities for integration with ELA, Math, and STEM?
What are the three dimensions of learning in the NGSS?

Three Dimensions Intertwined

- The NGSS are written as Performance Expectations
- NGSS will require contextual application of the three dimensions by students.

http://www.nextgenscience.org/3d2-ecosystems-interactions-energy-dynamics

Dimension 1
Science and Engineering Practices

- Behaviors that scientists engage in as they investigate, build models, analyze data and communicate information
- “Practices” rather than “skills” since knowledge and skills are required that are specific to each practice.
- Engineering involves solving a problem through design.
- Engineering practices make STEM relevant to students.

Framework, pp. 41-82
Asking Questions...

Why are there seasons?
Why did the structure collapse?
How is electric power generated?
What do plants need to survive?

... Defining Problems

Developing and Using Models
Planning and Carrying Out Investigations

Analyzing and Interpreting Data

Using Mathematics and Computational Thinking
Obtaining, Evaluating, and Communicating Information

- Have application across all domains of science
- Provide an organizational schema for interrelating knowledge from various science fields

- Include:
  1. Patterns, similarity, and diversity;
  2. Cause and effect;
  3. Scale, proportion and quantity;
  4. Systems and system models;
  5. Energy and matter;
  6. Structure and function;
  7. Stability and change

Dimension 2
Crosscutting Concepts
**Dimension 3**
**Disciplinary Core Ideas**

- Focus K–12 science curriculum, instruction and assessments on the most important aspects of science
- Broad importance or key organizing principle
- Key tool for understanding complex ideas
- Connected to personal or societal concerns
- Teachable and learnable at multiple grades

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**Disciplinary Core Ideas**

<table>
<thead>
<tr>
<th>Physical Science</th>
<th>Life Science</th>
<th>Earth &amp; Space Science</th>
<th>Engineering Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1: Matter &amp; Interactions</td>
<td>LS1: From Molecules to Organisms</td>
<td>ESS1: Earth’s Place in the Universe</td>
<td>ETS1: Engineering Design</td>
</tr>
<tr>
<td>PS3: Energy</td>
<td>LS3: Heredity: Inheritance and Variation of Traits</td>
<td>ESS3: Earth &amp; Human Activity</td>
<td></td>
</tr>
<tr>
<td>PS4: Waves and Their Applications in Technologies for Information Transfer</td>
<td>LS4: Biological Evolution: Unity &amp; Diversity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Current State Science Standard Sample**

**Inquiry Standards**

Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities utilizing safe laboratory procedures.

Students will use the ideas of system, model, change, and scale in exploring scientific and technological matters.

**Content Standards**

Distinguish between atoms and molecules.

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

Identify and demonstrate the Law of Conservation of Matter.
Three Dimensions Intertwined

- The NGSS are written as Performance Expectations
- NGSS will require contextual application of the three dimensions by students.

The 5E Instructional Model

- Appropriate for lessons or units
- Activates prior knowledge
- Student-centered
- Multiple opportunities to explore
- Connects to real world scenarios
- Assessment opportunities in each E

Elementary School

- **Engage**: Students are given an example of a plant or animal and tell where it lives.
- **Explore**: Teams of two students visit the school yard to answer: “How many different plants and animals can you observe?”
- **Explain**: Students present their findings from the trip
- **Elaborate**: Students are asked to collect pictures of three different organisms, display the pictures and describe their habitats
- **Evaluate**: Students are given pictures of plants and animals in different habitats; describe the plants and animals and describe how their actions are like scientists.
Performance Expectation?

<table>
<thead>
<tr>
<th>5E</th>
<th>Practices</th>
<th>DCIs</th>
<th>Crosscutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage</td>
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<td></td>
</tr>
<tr>
<td>Evaluate</td>
<td></td>
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</tbody>
</table>

Three dimensions (ES)

Middle School

- **Engage**: describe characteristics of two fossil brachiopods to see if changes occurred; supply evidence to support claim
- **Explore**: measure and graph characteristics of two populations; propose explanations for variations
- **Explain**: present explanations and evidence
- **Elaborate**: Students review images of embryological development for similarities; research the similarities of related organisms and how they evolved
- **Evaluate**: students answer questions about variation in a population of cheetahs and describe how variation results in some individuals surviving and reproducing
High School

- **Engage:** view images of the “arms” of organisms, and attempt to identify their habitat; discuss adaptations.
- **Explore:** review slides of the Galapagos Islands and examine data on beak depth and tarsal length in finches. How could variation in beak depth help or harm finches?
- **Explain:** read and discuss Darwin’s description of natural selection.
- **Elaborate:** examine morphological features of apes and humans. Students build models to compare DNA codes for proteins to determine relatedness of organisms.
- **Evaluate:** use graphical evidence for natural selection to construct an explanation for adaptation of populations.

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What shifts are necessary for teaching and learning in the NGSS?

**NEXT GENERATION SCIENCE STANDARDS**
For States, By States

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Conceptual Shifts in the 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 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. NGSS content is focused on preparing students for college, careers, and citizenship.
7. The NGSS and Common Core State Standards (English Language Arts and Mathematics) are **Aligned.**
Maryland and the NGSS: Where are We Going?

**Phase I: Spring 2013-2014**

**Exploration**

**Awareness**

State capacity-building
- Teachers
- LEA Science Supervisors
- State Science Leadership Team
- MSDE staff
Phase 2: 2014-2015

Classroom transitions, K-12
- Map scope and sequence
- Incorporate Engineering Practices
Shifts in instruction
- Integrate the three Dimensions
- Focus on teaching through the Science and Engineering Practices
- Incorporate formative assessment tasks
- Continue to evaluate instructional resources using the EQuIP rubric
Identify possible policy changes to implement NGSS

Phase 3: 2015-2016

Classroom transitions, K-12
- Refine scope and sequence
- Articulate Performance Expectations among grades and courses
- Refine formative assessment tasks
- Continue to evaluate, incorporate and refine instructional resources using the EQuIP rubric
Provide professional learning opportunities for teachers and administrators

Phase 4: 2016-2017

Ongoing support of leadership network
- Professional learning
- Assessment development
- Multistate consortium with NGSS states
- State-level assessment system
- Data collection: courses, student achievement
Policy changes
- Course credit requirements
- Teacher evaluation
Phase 5: 2017-2018

- Full PreK-12 implementation
- Scope and sequence appropriate for all LEAs
- High school credit requirements in place
- Assessment system in place
- Instructional resources and strategies aligned with NGSS
- Professional learning for pre-service and new teachers
- Data reporting, storage and retrieval system in place

Outcomes

- Explained the reasons for building new science standards.
- Described the process and timeline for constructing the Framework and the NGSS.
- Described the structure of a standard within NGSS.
- Discussed the implications of the “shifts” in NGSS for teaching and learning.
- Examined instructional strategies that reflect the intent of NGSS.

Exit Slip

- Write a message that describe the implications of the NGSS for teaching and learning in YOUR classroom.
- Tweet
- Message
- Facebook
Resources

http://www.nap.edu/catalog.php?record_id=13165#

Developing Assessments for the Next Generation Science Standards
http://www.nap.edu/download.php?record_id=18409

NSTA
http://ngss.nsta.org/access-standards/

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Next Generation Science Standards
www.nextgenscience.org

National Academy of Sciences
http://sites.nationalacademies.org/dbasse/bose/framework_k12_science/index.htm