Chemistry & The Next Generation Science Standards

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Goals of this session

1. Describe the Next Generation Science Standards
2. Highlight Chemistry Practices in light of Next Generation Standards
3. Share Practical Teaching Strategies Used in 1st year Chemistry across ability levels
Next Generation Standards

- Project 2061: American Association for the Advancement of Science
- National Research Council
- States
- Public (Open Review)
Building on the Past: Preparing for the Future

1/2010 - 7/2011

1990s-2009

1990s

Phase I

Phase II

7/2011 – March 2013

1/2010 - 7/2011
Three Dimensions Intertwined

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

- Appendices have been added to support the NGSS and in response to feedback
- Appendix A – Conceptual Shifts
- Appendix B – Responses to May Public Feedback
- Appendix C – College and Career Readiness
- Appendix D – All Standards, All Students
- Appendix E – Disciplinary Core Idea Progressions in the NGSS
- Appendix F – Science and Engineering Practices in the NGSS
- Appendix G – Crosscutting Concepts in the NGSS
- Appendix H – Nature of Science
- Appendix I – Engineering Design, Technology, and the Applications of Science in the NGSS
- Appendix J – Model Course Mapping in Middle and High School
- Appendix K – Connections to Common Core State Standards in Mathematics
3. Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms

**3.LS4-d.** Analyze and interpret data about changes in the environment of different areas and describe how the changes may affect the organisms that live in the areas. [Clarification Statement: Environmental changes should include changes to landforms, distribution of water, temperature, or availability of resources. The system is a particular area, its components, and how they interact.] [Assessment Boundary: Data may be provided for students.]

**3.LS4-e.** Use evidence about organisms in their natural habitats to design an artificial habitat in which the organisms can survive well.* [Clarification Statement: Evidence to include needs and characteristics of the organisms. The organisms and their habitat make up a system in which the parts depend on each other.]

**3.LS4-a.** Analyze and interpret data from fossils to describe the types of organisms that lived long ago and the environments in which they lived and compare them with organisms and environments today. [Clarification Statement: Students can observe fossils, images of fossils, and/or other data.]

**3.LS2-a.** Use multiple sources to generate and communicate information about the size, stability, and specialization of groups animals may form, and how different types of groups may help the members survive in their natural habitats. [Clarification Statement: Systems are groups of animals.] [Assessment Boundary: Knowledge of specific groups of animals is not required.]

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

**Analyzing and Interpreting Data**
- Analyzing data in 3–5 builds on K–2 and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations.
  - Display data in tables and graphs, using digital tools when feasible, to reveal patterns that indicate relationships. (3.LS4-d, 3.LS4-a)
  - Use data to evaluate claims about cause and effect. (3.LS4-d)

**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.
  - Use evidence (e.g., measurements, observations, patterns) to construct a scientific explanation or design a solution to a problem. (3.LS4-e)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 3–5 builds on K–2 and progresses to evaluating the merit and accuracy of ideas and methods.
  - Compare and/or combine across complex texts and/or other reliable media to acquire appropriate scientific and/or technical information. (3.LS2-a)

### Disciplinary Core Ideas

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
- When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce; others move to new locations, yet others move into the transformed environment, and some die. (3.LS4-d)

**LS2.D: Social Interactions and Group Behavior**
- Groups can be collections of equal individuals, hierarchies with dominant members, small families, groups of single or mixed gender, or groups composed of individuals similar in age. Some groups are stable over long periods of time; others are fluid with members moving in and out. Some groups assign specialized tasks to each member; in others, all members perform the same or a similar range of functions. (3.LS4-a)

**LS4.A: Evidence of Common Ancestry and Diversity**
- Some kinds of plants and animals that once lived on Earth (e.g., dinosaurs) are no longer found anywhere, although others now living (e.g., lizards) resemble them in some ways. (Moved from K-2)

**LS4.C: Adaptation**
- Changes in an organism’s habitat are sometimes beneficial to it

### Crosscutting Concepts

**Systems and System Models**
- A system can be described in terms of its components and their interactions. (3.LS4-d, 3.LS4-e)

**Stability and Change**
- Some systems appear stable, but over long periods of time will eventually change. (3.LS4-a, 3.LS2-a)

**Connections to Engineering, Technology, and Applications of Science**
- Interdependence of Science, Engineering, and Technology
  - Knowledge of relevant scientific concepts and research findings is important in engineering. (3.LS4-e)
## A Word about Common Core

- **Reading: Literature**
- **Reading: Informational Text**
- **Reading: Foundational Skills**
- **Writing**
- **Speaking & Listening**
- **Language**
- **Range, Complexity and Quality**

### Common Core State Standards Connections:

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<thead>
<tr>
<th>ELA/Literacy -</th>
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<tr>
<td>RST.6-8.3</td>
<td>Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. <em>(MS-PS1-b)</em></td>
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<td>RST.6-8.7</td>
<td>Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). <em>(MS-PS1-c), (MS-PS1-d), (MS-PS1-g)</em></td>
</tr>
<tr>
<td>RI.8.3</td>
<td>Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories). <em>(MS-PS1-g)</em></td>
</tr>
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<td>WHST.6-8.7</td>
<td>Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. <em>(MS-PS1-b)</em></td>
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<tr>
<td>SL.8.1</td>
<td>Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly. <em>(MS-PS1-c)</em></td>
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<tr>
<td>SL.7.5</td>
<td>Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. <em>(MS-PS1-a)</em></td>
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<tr>
<th>Mathematics -</th>
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<tr>
<td>MP.2</td>
<td>Reason abstractly and quantitatively. <em>(MS-PS1-e), (MS-PS1-g)</em></td>
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<td>MP.5</td>
<td>Use appropriate tools strategically. <em>(MS-PS1-g)</em></td>
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<td>MP.9</td>
<td>Look for and express regularity in repeated reasoning. <em>(MS-PS1-d)</em></td>
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<tr>
<td>6.EE</td>
<td>Represent and analyze quantitative relationships between dependent and independent variables. <em>(MS-PS1-b), (MS-PS1-e)</em></td>
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<tr>
<td>6.SP</td>
<td>Develop understandings of statistical variability. <em>(MS-PS1-b), (MS-PS1-e)</em></td>
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...In the Details

GROUP STUDY TOPICS...
- Curriculum Design
- Development Process
- Content Valuation
- Common Core
- College and Career Readiness
Science & Engineering Practices

- The Real World:
  - Ask Questions
  - Observe
  - Experiment
  - Measure
  - Collect Data
  - Test Solutions
  - Investigating

- Argue, Critique, Analyze

- Theories and Models:
  - Imagine
  - Reason
  - Calculate
  - Predict
  - Formulate Hypotheses
  - Propose Solutions
  - Developing Explanations and Solutions

*FIGURE 3-1* The three spheres of activity for scientists and engineers.
### Practices for K-12 Science Classrooms

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
Cross-cutting Concepts

- Patterns
- Cause and effect
- Scale, proportion and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change
Disciplinary Core Ideas: Content

**Physical Science**
- Matter and its interactions
- Motion and Stability
- Energy
- Waves and their applications in Technologies for Information Transfer

**Life Science**
- Molecules to Organisms: Structure and Processes
- Ecosystem: Interactions, Energy and Dynamics
- Heredity: Inheritance and Variation of Traits
- Biological Evolution: Unity and Diversity

**Engineering, Technology & Applications of Science**
- Engineering Design
  - Defining and Delimiting Problems
  - Developing Possible Solutions
- STE(M) in a 21st c. Society

**Earth & Space Sciences**
- Earth's Place in the Universe
- Earth's Systems
- Earth and Human Activity
Context, Chemistry

- Matter and its interactions
  - Structure and Properties of Matter
  - Chemical Reactions
  - Nuclear Processes
- Motion and Stability
  - Forces and Motions
  - Types of Interactions
  - Stability and Instability in Physical Systems
- Energy
  - Definition of Energy
  - Conservation of Energy and Energy Transfer
  - Relationship between Energy and Forces
  - Energy in Chemical Processes and Everyday life
- Waves and their applications in Technologies for Information Transfer
  - Wave properties
  - Electromagnetic radiation
  - Information technologies and instrumentation
What we use to teach.
Guiding Theoretical Frameworks

1. Marzano's Level of Understanding
2. Danielson's Framework for Teaching
Levels of **Introductory Chemistry** Instruction in our High School

**Characterized by... Uncertainty**

1. **Conceptual (Practical)**
   a. BIG IDEAS
   b. REAL WORLD UTILITY
   c. MAINLY QUALITATIVE REPRESENTATIONS OF QUANTITATIVE DATA

2. **College preparatory (General)**
   a. BIG IDEAS
   b. REAL WORLD UTILITY
   c. BALANCE BETWEEN QUALITATIVE AND QUANTITATIVE REPRESENTATIONS OF INFORMATION

3. **Accelerated (Honor's)**
   a. BIG IDEAS
   b. REAL WORLD UTILITY
   c. MAINLY QUANTITATIVE REPRESENTATIONS OF DATA
Conceptual

Scope and Sequence - "Chemistry in Context"

Introduction to Chemistry – Inquiry, Lab Safety, Scientific Argumentation
Unit 1: Water: Exploring Solutions
Unit 2: Materials: Structures and Uses
Unit 3: Petroleum: Breaking and Making Bonds
Unit 4: Air: Chemistry and the Atmosphere
Unit 5: Atoms: Nuclear Interactions
Conceptual

Chemsketch Modeling
1. Building structures
2. Naming compounds
3. Identifying isomers
4. Emphasizing structure-function relationships

Science meets Engineering Practice
Scope and Sequence - "Chemistry 1"

Unit 1: Classification and Properties of Matter and Energy – Chapter 3
Unit 2: Scientific Experimentation – Chapters 1 and 2
Unit 3: Atomic Structure and Nuclear Chemistry - Chapters 4 and 17
Unit 4: Electrons in Atoms and the Periodic Table – Chapters 4 and 9
Unit 5: Chemical Bonding– Chapter 10
Unit 6: Chemical Nomenclature and Chemical Reactions – Chapters 5 and 7
Unit 7: The Mole and Chemical Composition – Chapter 6
Unit 8: Stoichiometry– Chapter 8
Unit 9: Properties of Gases – Chapter 11
Unit 10: Properties of Solutions – Chapter 13
College Preparatory

Videos
- World of Chemistry (online) at http://learner.org
- Popular movies
- PBS videos

Simulations
- Explorelearning.com
- pHET
Accelerated

Scope and Sequence - "Accelerated Chemistry 1"

- Unit 1: Scientific Experimentation (Chapters 1 and 3)
- Unit 2: Classification of Matter and Energy (Chapter 2)
- Unit 3: Atomic Structure/ Nuclear Chemistry (Chapters 4 and 25)
- Unit 4: Electrons in Atoms and Periodic Trends (Chapters 5 and 6)
- Unit 5: Chemical Bonding and Intermolecular Forces (Chapters 7, 8, and 22)
- Unit 6: Chemical Nomenclature, Types of Reactions (Chapters 9 and 11)
- Unit 7: The Mole and Stoichiometry (Chapters 10 and 12)
- Unit 8: Properties of Gases (Chapter 14)
- Unit 9: Solutions Chemistry (Chapters 13 and 16)
- Unit 10: Reaction Rates and Equilibrium (Chapter 18)
- Unit 11: Acid/Base Chemistry (Chapter 19)
- Unit 12: Redox Chemistry and Electrochemistry (Chapters 20 and 21)
Accelerated

Construction of Knowledge in Collaboration with Peers

- POGIL Activities/ PhET Simulations
- Google Docs for peer writing and editing for presentation and discussion of data

Interaction with non-fiction text

- Current event articles from Scientific American or NY Times
- Non-fiction scientific novels such as "Napoleon's Buttons" or "The Disappearing Spoon"
Further Reading/Additional Resources

5. Chemsketch (Freeware; registration required) [http://www.acdlabs.com/resources/freeware/chemsketch/](http://www.acdlabs.com/resources/freeware/chemsketch/)
6. Alien Periodic Table [Modified] [http://21cstememc2.weebly.com](http://21cstememc2.weebly.com)