**Science and Engineering Practices**

**Developing and Using Models**
- Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-6)

**Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)

**Engaging in Argument from Evidence**
- Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)

**Disciplinary Core Ideas**

**ESS1.C: The History of Planet Earth**
- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)
- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history. (HS-ESS1-6)

**ESS2.A: Earth Materials and Systems**
- Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1) (Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2.)

**ESS2.B: Plate Tectonics and Large-Scale System Interactions**
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s surface and provides a framework for understanding its geologic history. (ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5), (HS-ESS2-1)
- Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth’s crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1)

**PS1.C: Nuclear Processes**
- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5), (secondary to HS-ESS1-6)

**Crosscutting Concepts**

**Patterns**
- Empirical evidence is needed to identify patterns. (HS-ESS1-5)

**Stability and Change**
- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

**Connections to Nature of Science**

**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**
- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the scientific community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-6)
- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1-6)

**Common Core State Standards Connections:**

**ELA/Literacy**
- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to gaps or inconsistencies in the account. (HS-ESS1-5), (HS-ESS1-6)
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS1-5), (HS-ESS1-6)
- Write arguments focused on discipline-specific content. (HS-ESS1-6)
- Write informative/ explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-5)

**Mathematics**
- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-1)

- Reason abstractly and quantitatively. (HS-ESS1-5), (HS-ESS1-6), (HS-ESS2-1)
- Model with mathematics. (HS-ESS2-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>HSN-Q.A.1</td>
<td>Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)</td>
</tr>
<tr>
<td>HSN-Q.A.2</td>
<td>Define appropriate quantities for the purpose of descriptive modeling (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)</td>
</tr>
<tr>
<td>HSN-Q.A.3</td>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)</td>
</tr>
<tr>
<td>HSF-IF.B.5</td>
<td>Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)</td>
</tr>
<tr>
<td>HSS-ID.B.6</td>
<td>Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. (HS-ESS1-6)</td>
</tr>
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