Introduction


**Interactive Science** is a middle school science program composed of twelve student modules spanning life, earth, physical, and nature topics that makes learning personal, engaging, and relevant for today’s student. **Interactive Science** features an innovative Write-in Student Edition that enables students to become active participants in their learning and truly connect the Big Ideas of science to their world.

Online **Quests** and **STEMQuests** are problem-based learning activities designed to support all three parts of the NGSS framework (Disciplinary Core Ideas, Cross-Cutting Concepts, and Science and Engineering Practices) by diving deep into real world topics at each grade level. A focus on the Science and Engineering Practices ensure your students can apply what they have learned to new situations and new content.

Online **Performance Expectation Activities** are designed to meet specific NGSS Performance Expectations and support the associated DCI, CCC, and SEPs.

<table>
<thead>
<tr>
<th>Interactive Science Modules</th>
<th>Quest and STEMQuest Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science and Technology</td>
<td>Testing, Testing...1, 2, 3</td>
</tr>
<tr>
<td>Earth’s Structure</td>
<td>To Hike or Not to Hike</td>
</tr>
<tr>
<td>Earth’s Surface</td>
<td>The Big Fossil Hunt</td>
</tr>
<tr>
<td>Water and the Atmosphere</td>
<td>Shrinking Your Carbon Footprint</td>
</tr>
<tr>
<td>Astronomy and Space Science</td>
<td>Searching for a Star</td>
</tr>
<tr>
<td>Ecology and the Environment</td>
<td>To Cross or Not to Cross</td>
</tr>
<tr>
<td>Cells and Heredity</td>
<td>Funky Fruit</td>
</tr>
<tr>
<td>The Diversity of Life</td>
<td>Construction without Destruction</td>
</tr>
<tr>
<td>Human Body Systems</td>
<td>Peak Performance Plan</td>
</tr>
<tr>
<td>Introduction to Chemistry</td>
<td>Hot and Cool Chemistry</td>
</tr>
<tr>
<td>Forces and Energy</td>
<td>Keep Hot Liquids Hot</td>
</tr>
<tr>
<td>Sound and Light</td>
<td>Design to Stop a Thief</td>
</tr>
</tbody>
</table>
A Correlation of
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment
to the Next Generation Science Standards for Middle School

Table of Contents

Physical Science ................................................................. 4
Life Science ........................................................................ 44
Earth and Space Science .................................................... 77
Engineering, Technology, and Applications of Science ............... 121

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**MS. Structure and Properties of Matter**  
**MS-PS1-1**

Students who demonstrate understanding can:

**Develop models to describe the atomic composition of simple molecules and extended structures.**

[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]

**INTERACTIVE SCIENCE:** In the *Introduction to Chemistry* module, the online Performance Expectation Activity "Structure and Properties of Matter (MS-PS1-1)" addresses this performance expectation.

Diagrams describing the atomic composition of methane molecules, oxygen molecules, carbon dioxide molecules, and water molecules are shown in "Figure 5: Conservation of Mass" on SE/TE page 25 of the *Introduction to Chemistry* module. An overview of the concepts of atoms and molecules is included on page 10 in Chapter 1, Lesson 2, "Classifying Matter." Models showing the atomic structure of water molecules in different phases are shown in "Figure 1: Melting" on SE/TE page 49. The use of chemical symbols and chemical formulas as a way to model compounds is described in the section "How Are the Formulas and Names of Ionic Compounds Written?" on SE/TE pages 134–135. Models describing the atomic composition of water and sodium chloride are included in "Figure 6: A Sea of Bonding" on SE/TE pages 144–145.

A model describing the extended atomic structure of DNA is shown in "Figure 1: DNA” on SE/TE page 97 of the *Introduction to Chemistry* module. The structure of DNA is also described in Chapter 4, Lesson 1, "The Genetic Code" on SE/TE pages 108–113 of the *Cells and Heredity* module. Models of DNA, mRNA, and proteins are described in “Figure 2: Protein Synthesis” on SE/TE pages 116–117.

Students interpret diagrams showing the atomic composition of simple molecules in “Figure 1: Atoms and Molecules” on SE/TE page 10 of the *Introduction to Chemistry* module. Students make models to illustrate chemical reactions involving simple molecules in “Differentiated Instruction: Jellybean Reaction” on TE page 25. Students use chemical formulas to develop models of simple molecules in the Apply It! on SE/TE page 135. Students use stick-and-ball building kits to develop models of simple molecules in “Differentiated Instruction: Visualizing Molecules” on TE page 145. Students develop models of simple molecules when they draw nitrogen molecules and hydrogen molecules in the Apply It! on SE/TE pages 172–173. Students use models that describe the atomic composition of DNA in “Figure 4: DNA Replication” on SE/TE pages 112–113 of the *Cells and Heredity* module. Students use models describing protein synthesis on SE/TE pages 116–117. Students use models to describe the atomic structure of a water molecule in "Modeling Atoms and Molecules" on page 13 of the TLR *Introduction to Chemistry*. They use models to describe the atomic composition of DNA in "Modeling the Genetic Code” on page 102 of the TLR *Cells and Heredity*. They model DNA and RNA in "What Is RNA” on TLR page 103. They develop models of compounds in "Models of Compounds” on pages 346–350 of the Chapter Activities and Projects book.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.</td>
<td>- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</td>
</tr>
<tr>
<td>- Develop a model to predict and/or describe phenomena.</td>
<td><strong>Introduction to Chemistry</strong>&lt;br&gt;SE/TE: 8–13, Classifying Matter</td>
<td><strong>Introduction to Chemistry</strong>&lt;br&gt;SE/TE: 49, Figure 1 – Melting&lt;br&gt;127, Apply It!</td>
</tr>
</tbody>
</table>
A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

<table>
<thead>
<tr>
<th>Introduction to Chemistry</th>
<th>Introduction to Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>10, Figure 1 – Atoms and Molecules</td>
<td>80–87, Organizing the Elements</td>
</tr>
<tr>
<td>135, Apply It!</td>
<td>84–85, Figure 4: The Periodic Table</td>
</tr>
<tr>
<td>173, Apply It!</td>
<td>92–95, How Are Metals Classified?</td>
</tr>
<tr>
<td>176–177, Balancing Chemical Equations</td>
<td>99–103, What Are the Families Containing Nonmetals?</td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>25, Differentiated Instruction – L1 Jellybean Reaction</td>
<td>125–129, Atoms, Bonding, and the Periodic Table</td>
</tr>
<tr>
<td>145, Differentiated Instruction – L1 Visualizing Molecules</td>
<td>130–137, Ionic Bonds</td>
</tr>
<tr>
<td>173, Differentiated Instruction – Jellybean Equation</td>
<td>132, Figure 3 – Formation of an Ionic Bond</td>
</tr>
<tr>
<td>181E, Describing Chemical Reactions</td>
<td>138–145, Covalent Bonds</td>
</tr>
<tr>
<td>181F, Describing Chemical Reactions</td>
<td>140, Figure 2 – Covalent Bonds</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>13, Modeling Atoms and Molecules</td>
<td>144–145, Figure 6 – A Sea of Bonding</td>
</tr>
<tr>
<td>148, Did You Lose Anything?</td>
<td>146–151, Bonding in Metals</td>
</tr>
<tr>
<td>149, Information in a Chemical Equation</td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>150, Is Matter Conserved?</td>
<td>9, Build Inquiry – Elements Everywhere</td>
</tr>
<tr>
<td><strong>Cells and Heredity</strong></td>
<td><strong>Cells and Heredity</strong></td>
</tr>
<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>112–113, Figure 4: DNA Replication</td>
<td>10, 21st Century Learning</td>
</tr>
<tr>
<td>116–117, Figure 2: Protein Synthesis</td>
<td>13, Differentiated Instruction – L3 All About Matter</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>102, Modeling the Genetic Code</td>
<td>13, Build Inquiry – Getting the Iron Out</td>
</tr>
<tr>
<td>103, What Is RNA?</td>
<td>92, Teacher Demo – Differentiate Alkali Metals</td>
</tr>
<tr>
<td>104, Modeling Protein Synthesis</td>
<td>95, Differentiated Instruction – L3 Alloys</td>
</tr>
<tr>
<td>105, Oops!</td>
<td>103, Differentiated Instruction – L3 Computer Chips</td>
</tr>
<tr>
<td><strong>Chapter Activities and Projects</strong></td>
<td>137, Enrich – Ionic Crystals</td>
</tr>
<tr>
<td>346–350, Models of Compounds</td>
<td>145, Differentiated Instruction – L3 Carbon Chains</td>
</tr>
<tr>
<td>145F, Enrich – Covalent Bonds</td>
<td>145F, Enrich – Covalent Bonds</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>108, Element Chemistry</td>
<td>108, Element Chemistry</td>
</tr>
</tbody>
</table>

- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals)

**Introduction to Chemistry**

| **SE/TE:**                        | **SE/TE:**                        |
| 41–42, How Do You Describe a Solid? | 136, Ionic Crystals |
| 42, Figure 2 – Types of Solids    | 147, What Is the Crystal Structure of a Metal? |
| 137F, Enrich – Pulling Away Electrons | **TE Only:** |
| 139, Figure 1 – Electron Sharing | 41, Build Inquiry–Observe Crystals |
| 140, Figure 2 – Covalent Bonds   | 42, Teacher Demo–Classify Solids |
| 144 Figure 5 – Nonpolar and Polar Molecules | **TLR:** |
| 145–146, Figure 6 – A Sea of Bonding | 40, Modeling Particles |
| 147, Figure 1 – Metallic Bonding  | **TLR:** |
| 173, Apply It!                    | 40, Modeling Particles |
| 137, Enrich – Ionic Crystals      | 109, How Do Ions Form? |
| 145, Differentiated Instruction – L1 Alloys | 122, Sharing Electrons |
| 145D, Review and Reinforce – Bonding in Metals | **TLR:** |
| 151, Differentiated Instruction – L1 Alloys | 40, Modeling Particles |
| 151D, Review and Reinforce – Bonding in Metals | 109, How Do Ions Form? |

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
MS. Structure and Properties of Matter

MS-PS1-3

Students who demonstrate understanding can:

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]

INTERACTIVE SCIENCE: In the Introduction to Chemistry module, the online Performance Expectation Activity "Structure and Properties of Matter (MS-PS1-3)" addresses this performance expectation.

Students make sense of information to describe how some detergents have a beneficial impact on society in “Enrich: Oil Spills” on TE page 145F of the Introduction to Chemistry module. Students research synthetic glassy metals and evaluate the impact on society of these materials in "Sci-Fi Metal" on SE/TE page 157. Students make sense of information about fuel cells when they answer the questions in “Figure 6: How Can Chemical Reactions Generate Speed?” on SE/TE pages 178–179. Students learn that many detergents use a nonrenewable natural resource (petroleum) as a basis in "Can You Be Clean and Green?" on SE/TE page 193. Students research surfactants to gather and make sense of information related to the claims of detergent manufacturers in "Think Like a Scientist" on TE page 193.

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

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.

• Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.

Introduction to Chemistry

SE/TE:
5–7, What Properties Describe Matter?
9, Elements
19, Figure 4 – Using Density
80–87, Organizing the Elements
88–95, Metals
93, Do the Math!
96–103, Nonmetals and Metalloids
118, Discovery of the Elements
124–129, Atoms, Bonding, and the Periodic Table

TE Only:
87F, Enrich – Properties of a “Missing” Element
92, Teacher Demo – Differentiating Alkali Metals
95E, Enrich – More Properties of Metals
137, Differentiated Instruction – L3 Melting Points

TLR:
79–87, Copper or Carbon? That Is the Question

Disciplinary Core Ideas

• Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)

Introduction to Chemistry

SE/TE:
146, My Planet Diary – Superconductors
148–149, Figure 2: Properties of Metals
150, Apply It!
151, Alloys
157, Sci-Fi Metal
182, My Planet Diary – Up in Flames

TE Only:
157, Technology and Society

Forces and Energy

SE/TE:
152, Aerogel Windows
153, Thermal Expansion

TE Only:
147E, Enrich – Thermostats
152, Frontiers and Technology
153, Everyday Science

Sound and Light

SE/TE:
16, My Planet Diary – The Fall of Galloping Gertie

Crosscutting Concepts

Structure and Function
• Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Introduction to Chemistry

SE/TE:
146, My Planet Diary – Superconductors
148–149, Figure 2: Properties of Metals
150, Apply It!
151, Alloys
157, Sci-Fi Metal
182, My Planet Diary – Up in Flames

TE Only:
157, Technology and Society

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
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. (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-5.)

Introduction to Chemistry
SE/TE:
165, Bonding and Chemical Change
165, Figure 3: Breaking and Making Bonds
173, Apply It!
174–177, How Is Mass Conserved During a Chemical Reaction?
180–181, What Are the Three Types of Chemical Reactions?
180, Apply It!
213–214, What Are the Properties of Acids?
215–217, What Are the Properties of Bases?
222–223, What Are the Products of Neutralization?
229, Limestone and Acid Drainage

TE Only:
168, Teacher Demo – A Toaster Reaction
181, Build Inquiry – The Disappearing Penny
187E, Enrich – Flameless Ration Heaters

TLR:
137, What Happens When Chemicals React?
138, Observing Change
148, Did You Lose Anything?
180, Properties of Acids
181, Properties of Bases
182, What Can Cabbage Juice Tell You?

Connections to Engineering, Technology, and Applications of Science

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

Introduction to Chemistry
SE/TE:
146, My Planet Diary – Superconductors
157, Sci-Fi Metal
178–179, Figure 6 – How Can Chemical Reactions Generate Speed?

Forces and Energy
TE Only:
147E, Enrich – Thermostats

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

Introduction to Chemistry
TE Only:
145F, Enrich – Oil Spills
179, Differentiated Instruction – L3 Fuel Cells: Present and Future

Forces
SE/TE:
130, Charge It!
TE Only:
130, Museum of Science
Students who demonstrate understanding can:

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

INTERACTIVE SCIENCE: In the Introduction to Chemistry module, the online Performance Expectation Activity “Structure and Properties of Matter (MS-PS1-4)” addresses this performance expectation.

Background on the states of matter is presented in the Introduction to Chemistry module, Chapter 2, “Solids, Liquids, and Gases.” In Lesson 1, SE/TE pages 40-47, solid, liquid, and gas are defined and discussed. The arrangement of particles in solids is discussed in “How Do You Describe a Solid” on SE/TE page 41. The arrangement of particles in liquids is discussed in “How Do You Describe a Liquid” on SE/TE page 43. The arrangement of particles in gases is discussed in “How Do You Describe a Gas?” on SE/TE page 45. On SE/TE page 47, the effect of temperature upon a gas is discussed. In Lesson 2, SE/TE pages 48-55, changes of state and the relationship to change in temperature and particle motion is presented. In Lesson 3, SE/TE pages 56-59, the effect on pressure and volume in gases as temperature changes is presented.

Students use models of particles in melting ice cubes in “Figure 1: Melting” on SE/TE page 49. Students develop models to describe changes in particle motion as particles move from one state to another in “Differentiated Instruction: Diagram Changes” on TE page 53. Students use models of gas particles at low and temperatures in “Figure 1: Temperatures and Gas Pressures” on SE/TE page 57 and “Figure 3: Charles’s Law” on SE/TE page 58. Students explain how a change in thermal energy relates to the motion of particles during a change of state in “Figure 5: The Changing States of Water” on SE/TE pages 54–55. Students form a hypothesis about change in state in “What Happens When You Breathe on a Mirror?” on TLR page 43. In “Melting Ice” on TLR pages 44–52, students form a hypothesis about the source of thermal energy that causes ice to melt. In “Keeping Cool,” on TLR page 53, students observe the effect on the temperature of a liquid as it evaporates. In “Observing Sublimation,” on TLR page 54, students observe the effect on the temperature of the surrounding liquid as dry ice sublimes. In “How Are Pressure and Temperature Related?,” TLR page 56, and in “Hot and Cold Balloons,” on TLR page 57, students indirectly observe the relationship between temperature and the speed of molecules in a gas.

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

### Science and Engineering Practices

**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.

### Disciplinary Core Ideas

**PS1.A: Structure and Properties of Matter**
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.

### Introduction to Chemistry

**SE/TE Only:**
- 40-47, States of Matter
- 48-55, Changes of State
- 56-59, Gas Behavior

**TE Only:**
- 53, Differentiated Instruction – Diagram Changes
- 55, Differentiated Instruction – Diagram Changes in State

### Crosscutting Concepts

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**Introduction to Chemistry**

**SE/TE Only:**
- 49–50, What Happens to the Particles of a Solid as It Melts?
- 51–52, What Happens to the Particles of a Liquid When It Vaporizes?
- 53, What Happens to the Particles of a Solid as It Sublimes?
- 54–55, Figure 5: The Changing States of Water
In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.

The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

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The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.
PS3.A: Definitions of Energy
- The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (Secondary to MS-PS1-4)

Introduction to Chemistry
SE/TE:
26, Temperature, Thermal Energy
27, Thermal Energy and Changes in Matter
47, Temperature
149, Thermal Conductivity
TE Only:
27, Differentiated Instruction
47, 21st Century Learning

Forces and Energy
SE/TE:
139, Heat
139, Vocabulary Skill
139, Figure 2 – Heat
140–143, The Transfer of Heat
141, Figure 1 – Heat Transfer
TE Only:
138, Teacher to Teacher

- The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material.
Temperature is not a direct measure of a system’s total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)

Introduction to Chemistry
SE/TE:
26, Temperature and Thermal Energy
47, Temperature
49–51, What Happens to the Particles of a Solid as It Melts?
50, Apply It!
51–52, What Happens to Particles of a Liquid as It Vaporizes?
TE Only:
47, Differentiated Instruction – L1 Temperature and Movement of Particles
TLR:
53, Keeping Cool
<table>
<thead>
<tr>
<th><strong>Forces and Energy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>118, Thermal Energy</td>
</tr>
<tr>
<td>136–139, Temperature, Thermal Energy, and Heat</td>
</tr>
<tr>
<td>138, Apply It!</td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>138, Teach Key Concepts</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>Temperature and Thermal Energy</td>
</tr>
</tbody>
</table>
MS.Chemical Reactions

**MS-PS1-2**

Students who demonstrate understanding can:

- Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with HCl.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

**INTERACTIVE SCIENCE:** In the *Introduction to Chemistry* module, the online Performance Expectation Activity “Structure and Properties of Matter (MS-PS1-2)” addresses this performance expectation.

Change in physical and chemical properties is discussed in the *Introduction to Chemistry* module in Chapter 5, Lesson 1, “Observing Chemical Change,” on SE/TE pages 163-167. On page 163, students **learn** about the chemical changes to a copper penny that becomes tarnished. On page 165, students **contrast** the properties of the reactants oxygen and magnesium with the properties of the product magnesium oxide. Students **explain** why the formation of table salt from sodium and chlorine is a chemical reaction in “Differentiated Instruction: Table Salt” on TE page 165. Students **research** the chemical reaction that happens when fruits ripen in “Differentiated Instruction: Ripening” on TE page 165. Students **interact** data on the chemical reaction that occurs when vinegar is added to baking soda in “Teacher Demo: Hopping Corn” on TE page 167. They **interpret data** on the chemical reaction that occurs when bread is toasted in “Teacher Demo: A Toaster Reaction” on TE page 168.

Students **use data** to **explain** chemical reactions and **compare** properties in “What Happens When Chemicals React?” on TLR page 137 and in “Observing Change” on TLR page 138. In “Where’s the Evidence?” on TLR pages 139-147, students **observe** three different chemical reactions and **record** their observations of changes in properties from reactants to products.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>PS1.A: Structure and Properties of Matter</strong></td>
<td></td>
</tr>
<tr>
<td>Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
<td></td>
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</tr>
<tr>
<td>• Analyze and interpret data to determine similarities and differences in findings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Introduction to Chemistry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE/TE:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>184, Figure 2 – Graphs of Exothermic and Endothermic Reactions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>187, Figure 5 – Catalysts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE Only:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>187, Build Inquiry – Comparing Reaction Rates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>187D, Review and Reinforce – Controlling Chemical Reactions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLR:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>139–147, Where’s the Evidence?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>152, Can You Speed Up or Slow Down a Reaction?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>153, Modeling Activation Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>154, Effect of Temperature on</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Introduction to Chemistry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE/TE:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–7, What Properties Describe Matter?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9, Elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19, Figure 4 – Using Density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80–87, Organizing the Elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>88–95, Metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>93, Do the Math!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>96–103, Nonmetals and Metalloids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>118, Discovery of the Elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>124–129, Atoms, Bonding, and the Periodic Table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE Only:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>87F, Enrich – Properties of a “Missing” Element</td>
<td></td>
<td></td>
</tr>
<tr>
<td>92, Teacher Demo – Differentiating Alkali Metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95E, Enrich – More Properties of</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Patterns**
- Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

**Introduction to Chemistry**

**SE/TE:**
- 80–87, Organizing the Elements
- 92–95, How Are Metals Classified?
- 96–105, Nonmetals and Metalloids
- 136–137, What Are Properties of Ionic Compounds?
- 141–142, What Are Properties of Molecular Compounds?
- 148–149, What Are Properties of Metals?
- 148–149, Figure 2: Properties of Metals
- 163–167, Observing Chemical Change

**TE Only:**
- 87F, Enrich – Properties of a “Missing” Element
- 95E, Enrich – Metals
- 137F, Enrich – Pulling Away
<table>
<thead>
<tr>
<th>STEMQuest: Hot and Cool Chemistry</th>
<th>Metals</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Salts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Connections to Nature of Science

- **Scientific Knowledge is Based on Empirical Evidence**
  - Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)

### Introduction to Chemistry

#### SE/TE:
- 166-169, How Do You Identify a Chemical Reaction?
- 165, Bonding and Chemical Change

#### TE Only:
- 168, Teacher Demo – A Toaster Reaction
- 181, Build Inquiry – The Disappearing Penny
- 187E, Enrich – Flameless Ration Heaters

#### TLR:
- 137, What Happens When Chemicals React?
- 138, Observing Change
- 148, Did You Lose Anything?

---

### STEMQuest: Hot and Cool Chemistry

- Energy Salts

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### Metals

- 137, Differentiated Instruction – L3 Melting Points
- **TLR:**
  - 79–87, Copper or Carbon? That Is the Question
  - 90, Carbon—A Nonmetal
  - 108, Element Chemistry
  - 112–120, Shedding Light on Ions
  - 123, Properties of Molecular Compounds
  - 126, Metal Crystals
  - 127, What Do Metals Do?
  - 176, Does It Dissolve?
  - 183, pHone Home

- **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. (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)

---

### Electrons

- 165, Differentiated Instruction – L1 Table Salt
- 167, 21st Century Learning
- 77, Expanding the Periodic Table
- 92, How Much Goes Away
- 107, What Are the Trends in the Periodic Table?
- 122, Sharing Electrons
- 123, Properties of Molecular Compounds
- 137, What Happens When Chemicals React?
- 138, Observing Change
- 139-147, Where’s the Evidence?
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**MS.Chemical Reactions**

**MS-PS1-5**

Students who demonstrate understanding can:

Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter, and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]

**INTERACTIVE SCIENCE:** In the *Introduction to Chemistry* module, the online Performance Expectation Activity “Structure and Properties of Matter (MS-PS1-5)” addresses this performance expectation.


In “Figure 5: Conservation of Mass” on SE/TE page 25, students use models of molecules to show how mass is conserved when methane and oxygen react to produce carbon dioxide and water. Students develop and use a model in “Differentiated Instruction: Visualizing Conservation of Mass” on TE Page 25. Students use models to describe the conservation of mass in “Differentiated Instruction: Jellybean Reaction” on TE page 25. On SE/TE page 177, students use models of molecules to balance a chemical equation for hydrogen and oxygen forming and demonstrate conservation of mass. Students model conservation of mass using coins in “Did You Lose Anything?” on TLR page 148 and using bolts and nuts in “Is Matter Conserved?” on TLR page 150.

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

### Disciplinary Core Ideas

- **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. (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)

### Crosscutting Concepts

- **Energy and Matter**
  - Matter is conserved because atoms are conserved in physical and chemical processes.

### Introduction to Chemistry

**SE/TE:**
25, Figure 5 – Conservation of Mass
174–177, How Is Mass Conserved During a Chemical Reaction?

**TE Only:**
25, Teacher Demo – Conservation of Mass
175, Differentiated Instruction – L3 Conservation of Matter
175, Differentiated Instruction – L3 Lavoisier’s Experiment
175, Build Inquiry – Still There
177, Differentiated Instruction
177, Build Inquiry – A Balancing Act

**TLR:**
148, Did You Lose Anything?
150, Is Matter Conserved?

### Science and Engineering Practices

- **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 describe unobservable mechanisms.

### Introduction to Chemistry

**SE/TE:**
25, Figure 5 – Conservation of Mass
177, Balancing Chemical Equations

**TE Only:**
25, Differentiated Instruction – L1 Visualizing Conservation of Mass
25, Differentiated Instruction – L1 Jellybean Reaction
175, Build Inquiry – Still There
177, Build Inquiry – A Balancing Act

**TLR:**
148, Did You Lose Anything?
150, Is Matter Conserved?
**Connections to Nature of Science**

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Laws are regularities or mathematical descriptions of natural phenomena.

**Introduction to Chemistry**

**SE/TE:**
- 24, Conservation of Mass
- 24, Figure 5: Conservation of Mass
- 174–177, How Is Mass Conserved During a Chemical Reaction?
- 178–179, Figure 6 – How Can Chemical Reactions Generate Speed?

**TE Only:**
- 25, Teacher Demo – Conservation of Mass
- 175, Differentiated Instruction – L1 Conservation of Mass
- 175, Differentiated Instruction – L3 Lavoisier’s Experiment
- 175, Build Inquiry – Still There

**TLR:**
- 148, Did You Lose Anything?
- 150, Is Matter Conserved?

- The total number of each type of atom is conserved, and thus the mass does not change.

**Introduction to Chemistry**

**SE/TE:**
- 25, Figure 5 – Conservation of Mass
- 174–177, How Is Mass Conserved During a Chemical Reaction?

**TE Only:**
- 25, Teacher Demo – Conservation of Mass
- 175, Differentiated Instruction
- 175, Build Inquiry – Still There
- 177, Differentiated Instruction
- 177, Build Inquiry – A Balancing Act

**TLR:**
- 148, Did You Lose Anything?
- 150, Is Matter Conserved?
- 174, How is Mass Conserved During a Chemical Reaction?
- 176–177, Balancing Chemical Equations
Students who demonstrate understanding can:

**Undertake a design process to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.**

[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.]

[Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

**INTERACTIVE SCIENCE:** In the *Introduction to Chemistry* module, the online Performance Expectation Activity "Structure and Properties of Matter (MS-PS1-6)" addresses this performance expectation.

Endothermic and exothermic reactions are explored in the *Introduction to Chemistry* module in Chapter 5, Lesson 1, "Observing Chemical Change," in "Changes in Energy," on pages SE/TE 168-169. In the Do the Math! feature on SE/TE page 169, students **graph** and **interpret** data to determine if a reaction was exothermic or endothermic. In "Figure 6: How Can Chemical Reactions Generate Speed?", students **explain** the chemical reactions that release energy in a fuel cell.

In the *Cells and Heredity* module, Chapter 2, "Cell Processes and Energy," students **obtain information** about the chemical reactions for photosynthesis on SE/TE page 49, and cellular respiration on SE/TE page 52. These are described in terms of releasing energy when complex molecules are broken down and absorbing energy when simple molecules are combined.

Students **design, construct, test, and modify** a closed reaction chamber that absorbs thermal energy in "Design and Build a Closed Reaction Chamber" on pages 353–357 of the *Chapter Activities and Projects* book. Students **explore** the chemical reactions and thermal consequences when natural gas burns in "The Pipeline Is Burning" on pages 152–153 of the *Scenario-Based Investigations* book.

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

### Science and Engineering Practices

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

### Disciplinary Core Ideas

**PS1.B: Chemical Reactions**

- Some chemical reactions release energy, others store energy.

**Cells and Heredity**

**SE/TE:**

- 49, The Photosynthesis Equation
- 52, The Cellular Respiration Equation

**Introduction to Chemistry**

**SE/TE:**

- 168–169, Changes in Energy
- 169, Do the Math!
- 178–179, Figure 6: How Can Chemical Reactions Generate Speed?

**STEMQuest:**

- Hot and Cool Chemistry
- Energy Salts
- Design Your Pack
- Pack Building
- Heat It Up or Ice It Down
- Reflect on Your Pack

**Crosscutting Concepts**

**Energy and Matter**

- The transfer of energy can be tracked as energy flows through a designed or natural system.

**Cells and Heredity**

**SE/TE:**

- 49, The Photosynthesis Equation
- 52, The Cellular Respiration Equation

**STEMQuest:**

- Hot and Cool Chemistry
- Energy Salts
- Design Your Pack

---

**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
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. (secondary to MS-PS1-6)

Introduction to Chemistry
STEMQuest: Hot and Cool Chemistry
Design Your Pack
Pack Building
Heat It Up or Ice It Down
Reflect on Your Pack

Chapter Activities and Projects
353–357, Design and Build a Closed Reaction Chamber

Scenario-Based Investigations
152–153, The Pipeline Is Burning

ETS1.C: Optimizing the Design Solution
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)

Introduction to Chemistry
STEMQuest: Hot and Cool Chemistry
Pack Building
Reflect on Your Pack

Chapter Activities and Projects
353–357, Design and Build a Closed Reaction Chamber

- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6)

Introduction to Chemistry
STEMQuest: Hot and Cool Chemistry
Pack Building

Chapter Activities and Projects
353–357, Design and Build a Closed Reaction Chamber

Forces and Energy
STEMQuest: Keep Hot Liquids Hot
Contain the Heat

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

<table>
<thead>
<tr>
<th>MS.Forces and Interactions</th>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MS-PS2-1</strong></td>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>PS2.A: Forces and Motion</strong></td>
<td><strong>Systems and System Models</strong></td>
</tr>
<tr>
<td>Students who demonstrate understanding can:</td>
<td>Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>• For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law).</td>
<td>• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.</td>
</tr>
<tr>
<td><strong>Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.</strong></td>
<td><strong>Forces and Energy</strong></td>
<td><strong>Forces and Energy</strong></td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td>(Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.)</td>
<td>SE/TE: 48-49, What is Newton’s Third Law of Motion? 48, Figure 3 – Action-Reaction Pairs 49, Did You Know?, Figure 4 – Action-Reaction Forces 50-51, What Makes a Bug Go Splat?</td>
<td>49, Figure 4 – Action-Reaction Forces 55, Inquiry Warm-Up - How Pushy Is a Straw?</td>
<td><strong>Influence of Science, Engineering, and Technology on Society and the Natural World</strong></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td><strong>TE Only:</strong></td>
<td><strong>TE Only:</strong></td>
<td>• The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.</td>
</tr>
<tr>
<td></td>
<td>54, Interpreting Illustrations</td>
<td>55, How Pushy Is a Straw?</td>
<td>170–171, Please Drop In</td>
</tr>
</tbody>
</table>

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource

18
Students who demonstrate understanding can:

**Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton’s First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton’s Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame, and to change in one variable at a time. Assessment does not include the use of trigonometry.]

INTERACTIVE SCIENCE: In the *Forces and Energy* module, the online Performance Expectation Activity “Forces and Interactions (MS-PS2-2)” addresses this performance expectation.

Units of measurement and reference points for making observations are discussed in the *Forces and Energy* module, Chapter 1, Lesson 1, “Describing Motion.” On SE/TE pages 4-6, reference points and relative motion are presented. In the Art in Motion feature on SE/TE page 5, students write about reference points. In the 21st Century Learning feature on TE page 5, pairs of student simulate the motion of Earth around the sun and describe the motion from the reference point of the sun and Earth. In the Apply It! feature on SE/TE page 6, students write about relative position. On TE page 6, students identify different reference points to observe Earth’s motion. Different units of distance in the SI system of measurements are described on SE/TE page 7. In Figure 2, Measuring Distance, on SE/TE page 7, students convert units of distance among various different units. In the Build Inquiry feature on TE page 7, students identify appropriate units of measurement to use in measuring classroom objects. Students describe motion from multiple reference points in enrichment activity on TE page 7E. Students observe motion from multiple reference points in “What Is Motion” on TLR page 9 and “Identifying Motion” on TLR page 10.

Force and its effect on motion are explored in Chapter 2, Lesson 1, “Nature of Force” on SE/TE pages 32-35. In “Figure 2: Net Force” on SE/TE pages 34-35, illustrations are used to demonstrate that a change in motion is caused by the net force acting on an object. Students calculate the net force in three different situations: when forces cause motion because they are added together and they have the same direction, when forces cause motion because they have opposite direction but are unbalanced, and when forces do not cause motion because they are in opposite directions but are balanced. In the Apply It! feature on SE/TE page 35, students draw a diagram to illustrate two forces and the resulting net force. The effects of friction and the force of gravity are described. On TE page 35E, students graph the relationship between mass and force at a constant speed and interpret the graph. Students observe how equal and unequal forces affect the motion of an object in “Is the Force With You?” on TLR page 37. Students measure forces in “What Is Force?” on TLR page 38. They model unbalanced forces in a game of tug-of-war during the Quick Lab “Modeling Unbalanced Forces” on TLR page 39.

Newton’s first, second, and third law of motion are detailed in Chapter 2, Lesson 3, “Newton’s Laws of Motion” on SE/TE pages 44–51. Students use Newton’s first law of motion to explain the motions of a roller coaster in “Figure 1: Inertia” on SE/TE page 45. They illustrate Newton’s second law of motion in “Figure 2: Newton’s Second Law” on SE/TE page 46. They investigate motion and forces in “What Changes Motion?” on TLR page 51. They investigate Newton’s first law in “Around and Around on TLR page 52. They investigate mass and acceleration in “Newton’s Second Law” on TLR page 53.
• Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

### Forces and Energy

**TLR:**
- 39, Modeling Unbalanced Forces
- 40, Observing Friction
- 41-49, Sticky Sneakers
- 51, What Changes Motion?
- 52, Around and Around

**Connections to Nature of Science**

**Scientific Knowledge is Based on Empirical Evidence**
- Science knowledge is based upon logical and conceptual connections between evidence and explanations

### Forces and Energy

**SE/TE:**
- 44-45, What Is Newton’s First Law of Motion?

**TLR:**
- 39, Modeling Unbalanced Forces
- 40, Observing Friction
- 41-49, Sticky Sneakers
- 51, What Changes Motion?
- 52, Around and Around

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**PS2.A: Forces and Motion**

- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

### Forces and Energy

**SE/TE:**
- 4-6, Describing Motion
- 7, Measuring Distance

**TE Only:**
- 5, 21st Century Learning
- 6, 21st Century Learning
- 7, Differentiated Instruction – L3
- 7I Units
- 7, Build Inquiry – Describe Distance
- 7E, Enrichment – Exploring Reference Points

**TLR:**
- 9, What is Motion?
- 10, Identifying Motion
Students who demonstrate understanding can:

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

**INTERACTIVE SCIENCE:** In the **Forces and Energy** module, the online Performance Expectation Activity "Forces and Interactions (MS-PS2-3)" addresses this performance expectation.

Electric fields are discussed in Chapter 6, Lesson 1, "Electric Charge and Static Electricity" on SE/TE pages 158–163 of the **Forces and Energy** module. The factors affecting the strength of electrical forces are explored in “How Does Charge Build Up?" on SE/TE pages 161-163. A discussion of magnetic force is included in “How Do Magnetic Poles Interact?" on SE/TE pages 198–199. Students learn about factors that affect magnetic force in "Enrich: William Gilbert and the Science of Magnetism" on TE page 199. Students obtain information about factors that affect the strength of magnetic forces in Chapter 7, Lesson 2, “Magnetic Fields" on SE/TE pages 200–205; in Chapter 7, Lesson 3, in “What Is a Magnetic Field Produced by a Current Like?” on SE/TE page 209; and in “What Are the Characteristics of Solenoids and Electromagnets?” on SE/TE pages 210-211. In the Enrich activity "A Turn for the Better" on TE page 211F, students learn about the relationship between current turns of wire around a core and electromagnetic strength.

Students observe the effects of increased electric charge in "Drawing Conclusions: Electricity” on TLR page 149. In this lab, they observe the effect of electric charge before and after causing a charge in a comb. Students investigate the relationship between an electric current and the magnetic field it creates in “Can a Magnet Move a Wire?” on TLR page 201. Students use magnets of various sizes and strengths to build a piece of artwork in "Magnetic Art” on pages 402–406 of the **Chapter Activities and Projects** book.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asking Questions and Defining Problems</strong></td>
<td>PS2.B: Types of Interactions</td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Asking questions and defining problems in grades 6-8 builds from grades K-5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. * 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.</td>
<td>• Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.</td>
<td>• Cause and effect relationships may be used to predict phenomena in natural or designed systems.</td>
</tr>
<tr>
<td><strong>Forces and Energy</strong></td>
<td><strong>Forces and Energy</strong></td>
<td><strong>Forces and Energy</strong></td>
</tr>
<tr>
<td><strong>SE/TE:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>203, Apply It!</td>
<td>SE/TE: 161-163, How Does Charge Build Up?</td>
<td></td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td>207, Targeted Reading Skill – Relate Cause and Effect</td>
<td></td>
</tr>
<tr>
<td>193, Predict the Field</td>
<td>209, What Is a Magnetic Field Produced by a Current Like?</td>
<td></td>
</tr>
<tr>
<td>199, Electromagnet</td>
<td>210-211, What Are the Characteristics of Solenoids and Electromagnets?</td>
<td></td>
</tr>
<tr>
<td>211, Apply It!</td>
<td>193, Predict the Field</td>
<td></td>
</tr>
<tr>
<td>199, Electromagnet</td>
<td>193, Predict the Field</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>TE Only:</th>
</tr>
</thead>
<tbody>
<tr>
<td>160, Teacher Demo: Electric Field Exerts a Force</td>
</tr>
<tr>
<td>161, Differentiated Instruction – Model How Objects Are Charged</td>
</tr>
<tr>
<td>163, 21st Century Learning – Differentiated Instruction</td>
</tr>
<tr>
<td>165E, Enrich – St. Elmo’s Fire</td>
</tr>
<tr>
<td>199E, Enrich – William Gilbert and the Science of Magnetism</td>
</tr>
<tr>
<td>211E, Review and Reinforce – Electromagnetic Force</td>
</tr>
<tr>
<td>211F, Enrich – A turn for the Better</td>
</tr>
<tr>
<td>TLR:</td>
</tr>
<tr>
<td>148, Can You Move a Can Without Touching It?</td>
</tr>
<tr>
<td>149, Drawing Conclusions: Electricity</td>
</tr>
<tr>
<td>183–191, Detecting Fake Coins</td>
</tr>
<tr>
<td>193, Predict the Field</td>
</tr>
<tr>
<td>198, Magnetic Fields From Electric Current</td>
</tr>
<tr>
<td>201, Can a Magnet Move a Wire?</td>
</tr>
</tbody>
</table>

**Chapter Activities and Projects**
402–406, Magnetic Art
### MS. Forces and Interactions
#### MS-PS2-4

Students who demonstrate understanding can:

**Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.** [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

**INTERACTIVE SCIENCE:** In the *Forces and Energy* module, the online Performance Expectation Activity "Forces and Interactions (MS-PS2-4)" addresses this performance expectation.

Gravitational force is introduced in the *Forces and Energy* module in Chapter 2, Lesson 2, “What Factors Affect Gravity?” on SE/TE pages 41–43. Students use a model of a hypothetical planetary system to describe the relationship among gravity, mass, and distance in “Figure 3 - Gravitational Attraction,” on page SE/TE page 42.

The relationship between gravity, mass, and weight is also discussed in Chapter 1, Lesson 3, “Gravity and Motion,” on SE/TE pages 18–21 of the *Astronomy and Space Science* module. Students interpret a graph to draw conclusions about how distance affects the force of gravity in “Do the Math!” on SE/TE page 21. Students use magnets to model the force of gravity and then use evidence obtained from their models in “What’s Doing the Pulling?” on TLR page 28.

The effect of the sun and the moon’s force of gravity on tides is discussed in Chapter 1, Lesson 5, “Tides,” on pages 28–31 of the *Astronomy and Space Science* module. Students use evidence to support the claim that gravitational interactions are attractive in “Differentiated Instruction: Track the Tides” on TE page 31.

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

#### Science and Engineering Practices
- Engaging in Argument from Evidence
  - Engaging in argument from evidence in 6–8 builds from 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.
  - Construct and present oral and written arguments 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.

#### Disciplinary Core Ideas
- **PS2.B: Types of Interactions**
  - Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.

#### Astronomy and Space Science
- **SE/TE:** 18–21, Gravity and Motion
- **TE Only:** 21E, Enrich – Your Weight in the Solar System
  - 31, Differentiated Instruction – L3 Track the Tides
  - 31E, Enrich – What Affects the Heights of Tides?
- **TLR:** 28, What’s Doing the Pulling?

#### Forces and Energy
- **SE/TE:** 41–43, What Factors Affect Gravity?
- 42, Figure 3: Gravitational Attraction

#### Crosscutting Concepts
- **Systems and System Models**
  - Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.

- **Astronomy and Space Science**
  - **SE/TE:** 19, Figure 1 – Gravity, Mass, and Distance
  - 20, Figure 2 – Orbital Motion
  - 29, Figure 1: Tides
  - 30, The Sun’s Role
  - **TLR:** 34, Modeling the Moon’s Pull of Gravity

- **Forces and Energy**
  - **SE/TE:** 42, Figure 3 – Gravitational Attraction
### Connections to Nature of Science

**Scientific Knowledge is Based on Empirical Evidence**
- Science knowledge is based upon logical and conceptual connections between evidence and explanations.

### Astronomy and Space Science

**SE/TE:**
- 29, Figure 1: Tides
- 30, The Sun’s Role

**TE Only:**
- 31, Differentiated Instruction – Le Track the Tides
- 31E, Enrich – What Affects the Heights of Tides?

**TE Only:**
- 43, Plant Response to Gravity
Students who demonstrate understanding can:

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged plastic balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields. Assessment is limited to qualitative evidence for the existence of fields.]

INTERACTIVE SCIENCE: In the Forces and Energy module, the online Performance Expectation Activity “Forces and Interactions (MS-PS2-5)” addresses this performance expectation.


Students observe how the electric force of a charged balloon affects a stream of water in “Teacher Demo: Electric Field Exerts a Force” on TE page 160. Students demonstrate the forces acting at a distance from magnetic fields in the Apply it! feature on SE/TE page 203. They demonstrate that an electrical field can act at a distance to move an aluminum can in “Can You Move a Can Without Touching It?” on TLR page 148. Students conduct an investigation and evaluate the experimental design to show a magnetic field acts at a distance when they use a magnet to detect fake coins in “Detecting Fake Coins” on TLR pages 188–191. Students conduct an investigation to show how iron filings in a Petri dish align if a magnet is placed beneath the Petri dish in “Predict the Field” on TLR page 193. Students conduct an investigation using iron filings and a magnet to model the effect of Earth’s magnetic field in “Earth’s Magnetic Field” on TLR page 195. Students conduct an investigation to show the effect of electric fields acting at a distance on a compass in “Magnetic Fields From Electric Current” on TLR page 198. Students conduct an investigation to show how an electromagnetic field can produce mechanical motion in “Can a Magnet Move a Wire?” on TLR page 201.

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

Science and Engineering Practices
Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
• Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.

Forces and Energy
SE/TE:
203, Apply It!
TLR:
182–190, Detecting Fake Coins
193, Predict the Field
198, Magnetic Fields From Electric Currents
201, Can a Magnet Move a Wire?

 Disciplinary Core Ideas
PS2.B: Types of Interactions
• Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).

Astronomy and Space Science
SE/TE:
18-21, Gravity and Motion
21, Do the Math!
29, Figure 1 – Tides
30, The Sun’s Role

TE Only:
18A, Content Refresher
21E, Enrich – Your Weight in the Solar System
31E, Enrich – What Affects the Heights of Tides?

TLR:
27, What Factors Affect Gravity?

Crosscutting Concepts
Cause and Effect
• Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Forces and Energy
SE/TE:
159, Figure 1 – Repel or Attract?
161, Figure 3 – Charge Buildup
203, Apply It!
211, Apply It!

TE Only:
200A – Content Refresher
165E, Enrich – St. Elmo’s Fire
204, Teacher Demo – Earth’s Magnetic Field
205, Differentiated Instruction – Multimedia Presentation

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
## Forces and Energy

**SE/TE:**
- 41–43, What Factors Affect Gravity?
- 159–160, How Do Charges Interact?
- 159, Figure 1 – Repel or Attract
- 160, Figure 2 – Electric Fields
- 161, Figure 3 – Charge Buildup
- 201–203, What Is a Magnetic Field’s Shape?
- 201, Figure 1 – Magnetic Field Lines
- 202, Figure 2 – Magnetic Fields
- 204, Figure 3 – Earth’s Magnetic Field
- 209–211, Electromagnetic Force
- 209, Figure 2 – Change Magnetic Field Characteristics
- 210, Figure 3 – A Solenoid and an Electromagnet

**TE Only:**
- 43, Teacher Demo
- 160, Teacher Demo – Electric Field Exerts a Force
- 202, Address Misconceptions – Contact Forces and Field Forces
- 210, Build Inquiry – Modeling a Solenoid’s Magnetic Field

**TLR:**
- 148, Can You Move a Can Without Touching It?
- 149, Drawing Conclusions
- 182–190, Detecting Fake Coins
- 193, Predict the Field
- 194, Spinning in Circles
- 195, Earth’s Magnetic Field
- 196, Electromagnetism
- 197, Magnetic Fields From Electric Current
- 201, Can a Magnet Move a Wire?
## MS.Energy
### MS-PS3-1

Students who demonstrate understanding can:

**Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.** [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]

**INTERACTIVE SCIENCE:** In the *Forces and Energy* module, the online Performance Expectation Activity “Forces and Interactions (MS-PS3-1)” addresses this performance expectation.

The relationship between the kinetic energy of an object and the mass and speed of that object is discussed in the *Forces and Energy* module, Chapter 4, Lesson 1, “Kinetic Energy,” on SE/TE pages 108–113. In “Figure 2: Kinetic Energy” on SE/TE page 110, students rank objects by amount of kinetic energy. In the Do the Math! feature on SE/TE page 111, students draw conclusions about the relative amount of kinetic energy of a running person and a running dog. Students investigate the relationship between kinetic energy and speed by dropping a tennis ball and measuring the height of the bounce in "How High Does a Ball Bounce?" on TLR page 99. Students investigate the effects of increasing the mass of a moving skateboard and kinetic energy's relationship with mass and speed in "Mass, Velocity, and Kinetic Energy" on TLR page 109. Students construct graphical displays showing the relative amounts of kinetic and potential energy of a roller coaster as it progresses up and down ramps in "Figure 4: Conserving Energy While You Ride" on SE/TE page 124–125.

The performance expectation above was 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 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - Construct and interpret graphical displays of data to identify linear and nonlinear relationships.

### Disciplinary Core Ideas
- **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.

### Forces and Energy
- **SE/TE:**
  - 110-111, Kinetic Energy
  - 110, Figure 2 – Kinetic Energy
  - 111, Relate Cause and Effect
  - 111, Do the Math!

### Crosscutting Concepts
- **Scale, Proportion, and Quantity**
  - 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.

### Forces and Energy
- **SE/TE:**
  - 111, Calculating Kinetic Energy
  - 111, Do the Math!
  - 124–125, Figure 4 – Conserving Energy While You Ride
Students who demonstrate understanding can:

**Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.** [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate’s hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

**INTERACTIVE SCIENCE:** In the *Forces and Energy* module, the online Performance Expectation Activity "Forces and Interactions (MS-PS3-2)" addresses this performance expectation.

Students obtain information about potential energy in a gravitational field in the *Forces and Energy* module in Chapter 4, Lesson 1, "Potential Energy," on SE/TE page 112. Students calculate the gravitational potential energy of three rock climbers and rank the climbers according to the amount of potential energy. Students use models of arrangements of objects when they interpret diagrams of a person jumping on a trampoline in "Figure 4: Elastic Potential Energy" on SE/TE page 113. Students use models of a roller coaster to construct bar graphs showing the relative amounts of potential and kinetic energy as the roller coaster moves up and down the tracks in "Figure 4: Conserving Energy While You Ride" on SE/TE pages 124–125. In Lesson 2, SE/TE page 115, students draw conclusions about the change in the potential energy of a basketball as its position changes. In "Determining Mechanical Energy" on TLR page 111, students drop a ball from four different heights onto clay to observe the difference in the effect and explain these differences in terms of increased potential energy due to position. In "Design and Build a Roller Coaster" on *Chapter Activities and Projects* pages 386–392, students build a roller coaster and change variables to determine how potential energy is stored in the system.

Students obtain information about the interaction of electrical charges and the force between charged objects in Chapter 6, Lesson 1, "Electric Charge and Static Electricity," on SE/TE pages 158–161 of the *Forces and Energy* module. Students label drawings to develop models that describe how the position of charged spheres relative to each other changes when the charges on the spheres change (thus changing the amount of potential energy) in "Figure 1: Repel or Attract?" on SE/TE page 159. Students label photographs to develop models describing that as the distance between a charged balloon and a student’s hair decreases, the student’s hair becomes attracted to the balloon (thus changing the amount of potential energy stored in the student–balloon "system") in "Figure 3: Charge Buildup" on SE/TE page 161. Students investigate how the interaction of a charged balloon and an aluminum can changes as the balloon is brought closer to the can in "Can You Move a Can Without Touching It?" on TLR page 148.

Students obtain information about magnets and the interaction of magnetic poles in "How Do Magnetic Poles Interact?" on SE/TE page 198–199 of the *Forces and Energy* module. Students label drawings to develop models describing that when the distance between magnetic poles decreases, the arrangement of the poles relative to each other changes (thus changing the amount of potential energy stored in the magnet–magnet system) in "Figure 2: Attraction and Repulsion" on SE/TE page 198. Students investigate how the interaction of two toy cars changes when a bar magnet is attached to each car and the distance between the cars decreases in "Magnetic Poles" on TLR page 192.

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

**Science and Engineering Practices**
- 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.

**Disciplinary Core Ideas**
- PS3.A: Definitions of Energy
  - A system of objects may also contain stored (potential) energy, depending on their relative positions.

**Crosscutting Concepts**
- Systems and System Models
  - Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.
A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

- Develop a model to describe unobservable mechanisms.

**Forces and Energy**  
**SE/TE:**  
112, Potential Energy  
112, Figure 3 – Gravitational Potential Energy  
115, Figure 1, Mechanical Energy  
124–125, Figure 4 – Conserving Energy While You Ride  
158–161, Electric Charge and Static Electricity  
159, Figure 1 – Repel or Attract?  
161, Figure 3 – Charge Buildup  
198–199 How Do Magnetic Poles Interact?  
198, Figure 2 – Attraction and Repulsion  
**TLR:**  
111, Determining Mechanical Energy  
148, Can You Move a Can Without Touching It?  
192, Magnetic Poles

**PS3.C: Relationship Between Energy and Forces**  
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

**Forces and Energy**  
**SE/TE:**  
116, Mechanical Energy and Work  
158–161, Electric Charge and Static Electricity  
159, Figure 1 – Repel or Attract?  
161, Figure 3 – Charge Buildup  
198–199 How Do Magnetic Poles Interact?  
198, Figure 2 – Attraction and Repulsion  
**TLR:**  
111, Determining Mechanical Energy  
148, Can You Move a Can Without Touching It?  
192, Magnetic Poles

**Chapter Activities and Projects**  
386–392, Design and Build a Roller Coaster

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**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
MS.Energy
MS-PS3-3

Students who demonstrate understanding can:

**Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.** [*Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

**INTERACTIVE SCIENCE:** In the *Forces and Energy* module, the online Performance Expectation Activity “Forces and Interactions (MS-PS3-3)” addresses this performance expectation.

Temperature and thermal energy are discussed in Chapter 5, Lesson 1 “Temperature, Thermal Energy, and Heat,” on SE/TE pages 136–139 of the *Forces and Energy* module. Students obtain information about heat transfer in Chapter 5, Lesson 2, “The Transfer of Heat,” on SE/TE pages 140–143. The citations below indicate additional areas in *Interactive Science* where these and related ideas are presented.

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

**Science and Engineering Practices**

*Constructing Explanations and Designing Solutions*
- Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.

**Ecology and the Environment**

TLR: 144-152, Design and Build a Solar Cooker

**Forces and Energy**

SE/TE: 153, Science Matters, Make Way for Heat
TE Only: 142, 21st Century Learning – Creativity
TLR: 125-133, Lab Investigation, Build Your Own Thermometer
STEMQuest: Keep Hot Liquids Hot

**Chapter Activities and Projects:**
414-420, In Hot Water

**Disciplinary Core Ideas**

**PS3.A: Definitions of Energy**
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

**Forces and Energy**

SE/TE: 136-137, What Determines the Temperature of an Object?
138-139, What Is Thermal Energy?

TE Only:
139A, After the Inquiry Warm-Up – How Cold Is the Water?
TLR: 124, How Cold Is the Water?
125-133, Build Your Own Thermometer
134, Temperature and Thermal Energy

**PS3.B: Conservation of Energy and Energy Transfer**
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

**Forces and Energy**

SE/TE: 139, Heat
140-143, The Transfer of Heat

TE Only:
139, Support the Big Q – Where Does Heat Go?

**Crosscutting Concepts**

**Energy and Matter**
- The transfer of energy can be tracked as energy flows through a designed or natural system.

**Forces and Energy**

SE/TE: 120-125, Energy Transformations and Conservation
140-143, The Transfer of Heat

TE Only:
125A, After the Inquiry Warm-Up – What Would Make a Card Jump?
TLR: 113, What Would Make a Card Jump?
136, Visualizing Convection Currents

STEMQuest: Keep Hot Liquids Hot

Contains the Heat

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
<table>
<thead>
<tr>
<th>142, Build Inquiry – Heat Flow From Lamps</th>
</tr>
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<tbody>
<tr>
<td>143, Differentiated Instruction – Observing Conduction</td>
</tr>
<tr>
<td>143A, After the Inquiry Warm-Up - What Does It Mean to Heat Up?</td>
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<tr>
<td>143E, Enrich – Radiating Heat</td>
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<tr>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>135, What Does It Mean to Heat Up?</td>
</tr>
<tr>
<td>136, Visualizing Convection Currents</td>
</tr>
<tr>
<td><strong>STEMQuest:</strong> Keep Hot Liquids Hot Contain the Heat</td>
</tr>
</tbody>
</table>

**ETS1.A: Defining and Delimiting an Engineering Problem**
- 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 is likely to limit possible solutions. *(secondary to MS-PS3-3)*

**Ecology and the Environment**
- **TLR:**
  - 144-152, Design and Build a Solar Cooker

**Forces and Energy**
- **STEMQuest:** Keep Hot Liquids Hot Contain the Heat
- Keep the Heat In
- Keep the Cold Out
- Reflect on Your Insulating Container

**Chapter Activities and Projects**
- 414-420, In Hot Water

**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. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(secondary to MS-PS3-3)*

**Ecology and the Environment**
- **TLR:**
  - 144-152, Design and Build a Solar Cooker
**Forces and Energy**

**STEMQuest:** Keep Hot Liquids
- Hot
- Keep the Cold Out
- Reflect on Your Insulating Container

**Chapter Activities and Projects**
- 414-420, In Hot Water

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SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
Students who demonstrate understanding can:

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

INTERACTIVE SCIENCE: In the Forces and Energy module, the online Performance Expectation Activity “Forces and Interactions (MS-PS3-4)” addresses this performance expectation.

Temperature and thermal energy are discussed in Chapter 5, Lesson 1 “Temperature, Thermal Energy, and Heat,” on SE/TE pages 136–139 of the Forces and Energy module. The citations below indicate additional areas in Interactive Science where these and related ideas are presented.

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

### Science and Engineering Practices

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

**Chapter Activities and Projects**
- 414-420, In Hot Water

**Connections to Nature of Science**

- **Scientific Knowledge is Based on Empirical Evidence**
  - Science knowledge is based upon logical and conceptual connections between evidence and explanations

- **Forces and Energy**
  - TLR: 124, How Cold Is the Water?
  - 125-133, Build Your Own Thermometer
  - 134, Temperature and Thermal Energy

### Disciplinary Core Ideas

**PS3.A: Definitions of Energy**
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

**Forces and Energy**

**SE/TE:**
- 136-137, What Determines the Temperature of an Object?
- 138-139, What Is Thermal Energy?

**TE Only:**
- 139A, After the Inquiry
  - Warm-Up – How Cold Is the Water?

**TLR:**
- 124, How Cold Is the Water?
- 125-133, Build Your Own Thermometer
- 134, Temperature and Thermal Energy

**PS3.B: Conservation of Energy and Energy Transfer**
- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.

**Forces and Energy**

**SE/TE:**
- 138-139, What Is Thermal Energy?
- 138, Apply It!
- 138, Identify Supporting Evidence

### Crosscutting Concepts

**Scale, Proportion, and Quantity**
- 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.

**Forces and Energy**

**TLR:**
- 134, Temperature and Thermal Energy
- 137, Thermal Properties
- 138, Frosty Balloons
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<tr>
<th>TE Only:</th>
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<tbody>
<tr>
<td>138, Make Analogies</td>
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<td>138, Apply It!</td>
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<tr>
<td>TLR:</td>
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<tr>
<td>134, Temperature and Thermal Energy</td>
</tr>
</tbody>
</table>

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
Students who demonstrate understanding can:

**Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.** [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

**INTERACTIVE SCIENCE:** In the *Forces and Energy* module, the online Performance Expectation Activity “Forces and Interactions (MS-PS3-5)” addresses this performance expectation.

Energy transformations are discussed in Chapter 4, Lesson 3, “Energy Transformations and Conservation,” on SE/TE pages 120–125 of the *Forces and Energy* module. The citations below indicate additional areas in *Interactive Science* where this idea is presented.

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

### Science and Engineering Practices

**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 worlds.

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.

### Disciplinary Core Ideas

**PS3.B: Conservation of Energy and Energy Transfer**

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

**Forces and Energy**

**SE/TE:**

- 120-123, How Are Different Forms of Energy Related?

**TE ONLY:**

- 122, 21st Century Learning – Critical Thinking
- 123, Differentiated Instruction – Pole Vault Energy
- 123, Build Inquiry – Model Pole Vaulting
- 125, Differentiated Instruction – Oral Presentation

**TLR:**

- 113, What Would Make a Card Jump?
- 114, Soaring Straws

### Crosscutting Concepts

**Energy and Matter**

- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

**Forces and Energy**

**SE/TE:**

- 110-113, What Are Two Types of Energy?
- 114-116, How Can You Find an Object’s Mechanical Energy?
- 117-119, What Are Other Forms of Energy?

**TLR:**

- 110, What Makes a Flashlight Shine?
- 112, Forms of Energy

### Scenario-Based Investigations

- 166-168, Stuck at the Top

**Connections to Nature of Science**

Scientific Knowledge is Based on Empirical Evidence

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

**Forces and Energy**

**TLR:**

- 112, Forms of Energy
- 113, What Would Make a Card Jump?
- 114, Soaring Straws

**Chapter Activities and Projects**

- 386-392, Design and Build a Roller Coaster

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SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
MS.Waves and Electromagnetic Radiation
MS-PS4-1

Students who demonstrate understanding can:

**Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.** [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]

**INTERACTIVE SCIENCE:** In the *Sound and Light* module, the online Performance Expectation Activity "Waves and Electromagnetic Radiation (MS-PS4-1)" addresses this performance expectation.

The definition, characteristics, and types of mechanical waves are discussed on SE/TE pages 4–9 of Chapter 1, Lesson 1, “What Are Waves?” in the *Sound and Light* module. The relationship between wave amplitude and the energy in waves is described in "Amplitude" on SE/TE page 11.

Students **use models** of waves to identify areas of compression and areas of rarefaction in "Figure 3: Motion in a Longitudinal Wave" on SE/TE page 8 and in the "Apply It!" on this same page. Students **use models** of a transverse wave to measure its amplitude in "Figure 1: Amplitude" on SE/TE page 11. Students **use models** of a transverse wave to identify wavelength and frequency in "Figure 2: Properties of Waves" on SE/TE pages 12–13. Students **use mathematical representations** to describe a simple model for waves when they construct a table by using mathematical formulas to show the relationship between wavelength, frequency, and speed in "Do the Math!" on SE/TE page 14. Students **predict** how the amplitude of the waves in the wave pool at an amusement park will change if the timing and strength (i.e., energy) of the waves changed in "Figure 3: Ride the Waves" on SE/TE page 15. Students **use mathematical representations** when they use a graph to answer questions related to patterns in the orbit of one of Jupiter’s moons in "Enrich: Moon Waves" on TE page 15E. Students **investigate** how amplitude and energy are related in "What Do Waves Look Like?" on TLR page 12.

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

### Science and Engineering Practices

**Using Mathematics and Computational Thinking**

Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to describe and/or support scientific conclusions and design solutions.

### Disciplinary Core Ideas

#### PS4.A: Wave Properties

A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.

### Sound and Light

**SE/TE:**

- 4–9, What Are Waves?
- 9, Figure 4 – Waves Transfer Energy
- 10–15, Properties of Waves
- 11, Figure 1: Amplitude
- 12–13, Figure 2: Properties of Waves
- 14, Do the Math!
- 15, Figure 3 – Ride the Waves
- 28, Wall of Water
- 29, The Operatic Superpower

**TE Only:**

- 7, Teacher Demo – Diagram Transverse Waves
- 9, Differentiated Instruction – L3 Torsional Waves
- 9E, Enrich – Waves in the World Around You

### Crosscutting Concepts

**Patterns**

- Graphs and charts can be used to identify patterns in data.

**Sound and Light**

**SE/TE:**

- 14, Do the Math!
- 37, Figure 3: Speed of Sound in Air
- 38, Do the Math!
- 43, Apply It!
- 74, Figure 2: The Electromagnetic Spectrum

**TE Only:**

- 15E, Enrich – Moon Waves
- 37, Differentiated Instruction – L3 Properties of Sound Waves
- 43, Differentiated Instruction – L3 Research Decibel Levels
- 57E, Enrich – Range of Hearing

*SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource*
<table>
<thead>
<tr>
<th>Sound and Light</th>
<th>13, Teacher Demo – Speed of a Wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE/TE: 6, Waves and Energy</td>
<td>13, Differentiated Instruction – Make a Presentation</td>
</tr>
<tr>
<td>6, Figure 1: Forming a Mechanical Wave</td>
<td>15, Differentiated Instruction – Solve Problems</td>
</tr>
<tr>
<td>TLR: 10, What Causes Mechanical Waves?</td>
<td>15, Differentiated Instruction – Wave Pool</td>
</tr>
<tr>
<td>12, What Do Waves Look Like?</td>
<td>15E, Enrich – Mon Waves</td>
</tr>
<tr>
<td>11, Three Types of Waves</td>
<td></td>
</tr>
<tr>
<td>TLR: 9, What Are Waves?</td>
<td></td>
</tr>
<tr>
<td>10, What Causes Mechanical Waves?</td>
<td></td>
</tr>
<tr>
<td>11, Three Types of Waves</td>
<td></td>
</tr>
<tr>
<td>12, What Do Waves Look Like?</td>
<td></td>
</tr>
<tr>
<td>13, Properties of Waves</td>
<td></td>
</tr>
<tr>
<td>14, What Affects the Speed of a Wave?</td>
<td></td>
</tr>
</tbody>
</table>
Students who demonstrate understanding can:

**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

**INTERACTIVE SCIENCE:** In the *Sound and Light* module, the online Performance Expectation Activity "Waves and Electromagnetic Radiation (MS-PS4-2)" addresses this performance expectation.

The materials that sound waves travel through are explored in Chapter 2, Lesson 1, "The Nature of Sound," on SE/TE pages 34–39 of the *Sound and Light* module. Students use a model of sound waves to identify areas of rarefaction and compression in "Figure 1: Sound Waves" on SE/TE page 35. They use a model of a bird’s anatomy to show how birds produce sound in "Enrich: The Sound of Nature” on SE/TE page 39F. A discussion of pitch, loudness, and the Doppler affect is provided in “Properties of Sound” on SE/TE pages 40–45. Students make models representing different sound frequencies (pitch) in “Figure 1: Pitch” on SE/TE page 41. Students can develop and use a model to represent loudness in "Build Inquiry: Model Sound Intensity" on TE page 42. Students use a model to show how headphones transmit sound waves through air in "Figure 4: How Your Headphones Work” on SE/TE page 45. Echolocation, sonar and ultrasound imaging, which make use of reflected sound waves, are discussed in Lesson 5 on SE/TE pages 55–56. Students use models to describe how echolocation and sonar work in "Figure 1: Echolocation" on SE/TE page 55 and "Apply It!” on SE/TE page 56, respectively. Students investigate reflected sound waves and explain how these waves moved in "Designing Experiments" on TLR page 55.

The properties of electromagnetic waves, which include light waves, are described in Chapter 3, Lesson 1, "The Nature of Electromagnetic Waves," on SE/TE pages 68–71 of the *Sound and Light* module. Students use a model of light in "Figure 2: Light as a Wave” on SE/TE page 70. They write labels to develop and use a model of light waves emitted by a flashlight in "Apply It!” on SE/TE page 71. They develop a model of the electromagnetic spectrum in "Differentiated Instruction: Make a Drawing” on TE page 75. They develop and use a model of the electromagnetic spectrum in "Figure 6: Surfing the Spectrum” on SE/TE page 79.

Light waves are discussed in the *Sound and Light* module in Chapter 4. Absorption of light waves is presented in Lesson 1, "Light and Color,” on SE/TE pages 98-103. Students use a model to show which colors are produced by absorption, transmittal, and reflection of light waves in "Figure 2: Color of an Opaque Object” on SE/TE page 100. They develop and use models to indicate how the colors we see are affected by red, green, and blue filters in "Apply It!” on SE/TE page 101. Students learn about the reflection of light waves in Lesson 2, "Reflection and Mirrors,” on SE/TE pages 104-109. They develop models by adding labels to illustrations showing how light reflects off different materials in "Figure 1: Diffuse and Regular Reflection” on SE/TE page 105. They use models showing how light reflects off of mirrors in "Figure 3: Concave Mirror” on SE/TE page 107, "Figure 4: Convex Mirror” on SE/TE page 108, and "Apply It!” on SE/TE page 109. They use a model showing how light is reflected and refracted by water droplets in "Figure 3: Water + Light = A Rainbow” on SE/TE page 113. They develop a model of reflected light waves in "Differentiated Instruction: Diagramming a Mirage” on TE page 115. They draw and add labels to develop and use models illustrating how light is transmitted and reflected in cameras and telescopes in (respectively) "Apply It!” on SE/TE page 123 and "Figure 1: Reflecting and Refracting Telescopes” on SE/TE page 124. They develop a model of a reflecting telescope in "Seeing Double” on SE/TE page 130. They develop and use a model to show how light reflects off of (and is absorbed and scattered by) a chameleon’s skin in “Hiding in Plain Sight” on SE/TE page 131.

Seismic waves, which are mechanical waves, are explored in the *Earth’s Structure* module, Chapter 4, Lesson 2, "What Are Seismic Waves?” on SE/TE pages 111-113. Students use models of three types of seismic waves in "Figure 2: P, S, and Surface Waves” on SE/TE page 113. Students model seismic waves in "Properties of Seismic Waves” on TLR page 102.

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SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
## 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 and use a model to describe phenomena.

## Crosscutting Concepts
### Structure and Function
- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

## Disciplinary Core Ideas
### PS4.A: Wave Properties
- A sound wave needs a medium through which it is transmitted.

#### Sound and Light
**SE/TE:**
- 34-39, The Nature of Sound
- 35, Figure 1: Sound Waves
- 38, Did You Know?
- 40-45, Properties of Sound

**TE Only:**
- 37, Differentiated Instruction – L1
  - Feel Sound Waves
- 38, Teacher Demo – Stiffness and Speed of Sound
- 39, Differentiated Instruction – L3
  - Write a Story
- 39F, The Sound of Nature
- 44, Teacher Demo – Model the Doppler Effect
- 49E, Enrich – Musical Wood

**TLR:**
- 35, What Is Sound?
- 36, Understandings Sound
- 37, Ear to the Sound
- 48, Listen to This
- 51, How Can You Change Pitch?

#### Sound and Light
**SE/TE:**
- 98–101 What Determines Color?
- 100, Figure 2 – Color of an Opaque Object

**TE Only:**
- 100, Teacher Demo – Light Reflected by Opaque Materials
- 104–109, Reflection and Mirrors
- 105, Figure 1 – Diffuse and Regular Reflection
- 107, Figure 3 – Concave Mirror
- 108, Figure 4 – Convex Mirror

**TLR:**
- 110, How Does a Pinhole Camera Work?
- 111, What a View!

**STEMQuest:** Design to Stop a Thief
- Make Light Go Where You Want It
- Optical Demonstration
- An Optimal Optical Solution
- Reflect on Your Demonstration

### PS4.B: Electromagnetic Radiation
- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.

#### Sound and Light
**SE/TE:**
- 98–101 What Determines Color?
- 100, Figure 2 – Color of an Opaque Object

**TE Only:**
- 100, Teacher Demo – Light Reflected by Opaque Materials
- 103E, Enrich – Colors: Reflected, Absorbed, Passed Through

**TLR:**
- 107, Differentiated Instruction – L3 Diagram Reflected Rays

### STEMQuest: Design to Stop a Thief
- Light Behavior

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<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>PS4.A: Wave Properties</strong></td>
<td><strong>Structure and Function</strong></td>
</tr>
<tr>
<td>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.</td>
<td>- A sound wave needs a medium through which it is transmitted.</td>
<td>- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</td>
</tr>
<tr>
<td><strong>Sound and Light</strong></td>
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<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>35, Figure 1 – Sound Waves</td>
<td>34-39, The Nature of Sound</td>
<td>109, Apply It!</td>
</tr>
<tr>
<td>41, Figure 1 – Pitch</td>
<td>35, Figure 1: Sound Waves</td>
<td>122–125, Using Light</td>
</tr>
<tr>
<td>71, Apply It!</td>
<td>38, Did You Know?</td>
<td>123, Apply It!</td>
</tr>
<tr>
<td>73, Figure 1 – Comparing Electromagnetic Waves</td>
<td>40-45, Properties of Sound</td>
<td>124, Figure 1 – Reflecting and Refracting Telescopes</td>
</tr>
<tr>
<td>74, Figure 2 – The Electromagnetic Spectrum</td>
<td><strong>TE Only:</strong></td>
<td>125, Differentiated Instruction – L3 Scanning Electron Microscope (SEM)</td>
</tr>
<tr>
<td>79, Figure 6 – Surfing the Spectrum</td>
<td>79, Figure 1 – Types of Materials</td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>99, Figure 1 – Types of Materials</td>
<td>100, Figure 2 – Color of an Opaque Object</td>
<td>110, How Does a Pinhole Camera Work?</td>
</tr>
<tr>
<td>101, Apply It!</td>
<td>101, Apply It!</td>
<td>111, What a View!</td>
</tr>
<tr>
<td>105, Figure 1 – Diffuse and Regular Reflection</td>
<td><strong>TE Only:</strong></td>
<td><strong>STEMQuest:</strong> Design to Stop a Thief</td>
</tr>
<tr>
<td>108, Figure 4 – Convex Mirror</td>
<td>42, Build Inquiry – Model Sound Intensity</td>
<td>Make Light Go Where You Want It</td>
</tr>
<tr>
<td>115, Figure 5 – Concave Lens</td>
<td>43, Differentiated Instruction – L1</td>
<td>Optical Demonstration</td>
</tr>
<tr>
<td>116, Figure 7 – How a Convex Lens Works</td>
<td>Make a Drawing</td>
<td>An Optimal Optical Solution</td>
</tr>
<tr>
<td>123, Apply It!</td>
<td>124, Apply It!</td>
<td>Reflect on Your Demonstration</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>52, Hearing Sound</td>
<td>104–109, Reflection and Mirrors</td>
<td><strong>STEMQuest:</strong> Design to Stop a Thief</td>
</tr>
<tr>
<td>STEMQuest: Design to Stop a Thief</td>
<td>105, Figure 1 – Diffuse and Regular Reflection</td>
<td>Light Behavior</td>
</tr>
<tr>
<td>Light Behavior</td>
<td>107, Figure 3 – Concave Mirror</td>
<td></td>
</tr>
</tbody>
</table>
### TLR:
- 92, Developing Hypotheses
- 93–101, Changing Colors
- 103, Observing

### STEMQuest: Design to Stop a Thief
- Light Behavior
- Make Light Go Where You Want It
- Optical Demonstration
- An Optimal Optical Solution
- Reflect on Your Demonstration

- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.

### Sound and Light

#### SE/TE:
- 104–109, Reflection and Mirrors
- 106, Figure 2 – Image in a Plane Mirror
- 110–117, Refraction and Lenses
- 113, Figure 3 – Water + Light = A Rainbow
- 116, Figure 7 – How a Convex Lens Works
- 117, Apply It!
- 122–125, Using Light
- 123, Apply It!
- 124, Figure 1: Reflecting and Refracting Telescopes

#### TE Only:
- 71E, Enrich – Measuring the Speed of Light
- 107, Teacher Demo – Model Reflection From a Concave Mirror
- 113, Build Inquiry – Observing Refraction of Light
- 116, Teacher Demo – Focal Point
- 117E, Enrich – Light Benders
- 121E, Enrich – A Better View

#### TLR:
- 102, How Does Your Reflection Wink?
- 104, Mirror Images
- 106, Bent Pencil

### STEMQuest: Design to Stop a Thief
- Light Behavior
- Make Light Go Where You Want It
- Optical Demonstration
- An Optimal Optical Solution
- Reflect on Your Demonstration
• A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.

Sound and Light
SE/TE
68–69, What Makes Up Electromagnetic Waves?
71, Wave Model of Light
71, Figure 2: Light as a Wave
71, Apply It!

TE Only:
70, Build Inquiry – Observe How Filters Polarize Light
71, Differentiated Instruction – L1 Polarized Sunglasses

• However, because light can travel through space, it cannot be a matter wave, like sound or water waves.

Sound and Light
SE/TE
71, Particle Model of Light
71, Figure 3 – The Photoelectric Effect
Students who demonstrate understanding can:

Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in Wi-Fi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

**INTERACTIVE SCIENCE:** In the Sound and Light module, the online Performance Expectation Activity “Waves and Electromagnetic Radiation (MS-PS4-3)” addresses this performance expectation.

Students list the advantages and disadvantages of using voice recognition software to create a word-processing document in “Relate Text and Visuals” on SE/TE page 120 of the Science and Technology module. Students can integrate qualitative scientific and technical information by reading the discussion regarding designing a computer mouse on SE/TE pages 124–131 and then answering the questions in “Enrich – A Redesigned Mouse” on TE page 131E.

A discussion of the use of computers in mapmaking is provided in Chapter 1, Lesson 3, “Mapping Technology,” on SE/TE pages 18–23 in the Earth’s Surface module. Students can integrate technical information from their textbooks to answer questions regarding the advantages of using computers for mapmaking in “Teach Key Concepts” on TE page 19. A discussion of the use of digitized satellite images to make maps is included in “Maps From Satellite Images” on SE/TE page 20.

A discussion of the technologies involved with cell phones, satellite communications, and the global positioning system is included on pages 84–86 of the Sound and Light module.

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

**Science and Engineering Practices**

Obtaining, Evaluating, and Communicating Information

- Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.
- Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.

**Science and Technology**

SE/TE: 120, Relate Text and Visuals

STEMQuest: Testing, Testing...1, 2, 3

Analog and Digital Recordings

Evaluate Recording Technologies

**Disciplinary Core Ideas**

PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

**Science and Technology**

SE/TE:

120, Relate Text and Visuals

122, Apply It!

TE Only:

131E, Enrich – A Redesigned Mouse

STEMQuest: Testing, Testing...1, 2, 3

Analog and Digital Recordings

Evaluate Recording Technologies

**Earth’s Surface**

SE/TE:

20, Maps From Satellite Images

TE Only:

19, Teach Key Concepts

**Crosscutting Concepts**

Structure and Function

- Structures can be designed to serve particular functions.

**Science and Technology**

SE/TE:

122, Apply It!

TE Only:

131E, Enrich – A Redesigned Mouse

STEMQuest: Testing, Testing...1, 2, 3

Constructing a Microphone

Analog and Digital Recordings

Evaluate Recording Technologies

Reflect on Your Recording Method

**Sound and Light**

SE/TE:

84–85, How Does a Cell Phone Work?

86–87, How Does Satellite Communications Work?

123, Apply It!
## Forces and Energy

**SE/TE:** 230, Magnetic Pictures

## Sound and Light

**SE/TE:**
- 84–85, How Does a Cell Phone Work?
- 86–87, How Does Satellite Communications Work?
- 92, Channel Surfin’ on an Infrared Wave
- 123, Cameras

**TE Only:**
- 92, Museum of Science

### Connections to Engineering, Technology, and Applications of Science

- **Influence of Science, Engineering, and Technology on Society and the Natural World**
  - Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.

### Science and Technology

**TLR:**
- 17, Reading Satellite Images

### Forces and Energy

**SE/TE:**
- 230, Magnetic Pictures

### Connections to Nature of Science

- **Science is a Human Endeavor**
  - Advances in technology influence the progress of science and science has influenced advances in technology.

### Science and Technology

**SE/TE:**
- 120, Relate Text and Visuals

### Sound and Light

**SE/TE**
- 84–85, How Does a Cell Phone Work?
- 86–87, How Does Satellite Communication Work?
A Correlation of
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment
to the Next Generation Science Standards for Middle School

MS. Structure, Function, and Information Processing
MS-LS1-1

Students who demonstrate understanding can:

Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living cells, and understanding that living things may be made of one cell or many and varied cells.]

INTERACTIVE SCIENCE: In the Cells and Heredity module, the online Performance Expectation Activity “Structure, Function and Information Processing (MS-LS1-1)” addresses this performance expectation.

The citations below indicate areas in Interactive Science where this idea is introduced.

Students obtain information about what cells are, how they are seen, and the difference between unicellular and multicellular in the Cells and Heredity module in Chapter 1, Lesson 1, on SE/TE pages 4-11, and in Lesson 2, SE/TE pages 20-21 “How Do Cells Work Together in an Organism?” Similar information is found in The Diversity of Life module in Chapter 1, Lesson 1, on SE/TE pages 5-6.

In the Cells and Heredity TLR, students conduct an investigation where they observe and compare plant and animal cells in “Comparing Cells” on TLR page 10. Students use a microscope to make observations and inferences in “Observing Cells” on TLR page 11. Students investigate and model the organization of a multicellular organism in “Tissues, Organs, Systems” on TLR page 23. In The Diversity of Life TLR, students investigate the characteristics of living things in “Is It Living or Non-Living?” on TLR page 9.

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

Science and Engineering Practices
Planning and Carrying Out Investigations
Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
• Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.

Cells and Heredity
TLR:
10, Comparing Cells
11, Observing Cells
23, Tissues, Organs, Systems

The Diversity of Life
TLR:
9, Is It Living or Non-Living?

Disciplinary Core Ideas

LS1.A: Structure and Function
• All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).

Cells and Heredity
SE/TE:
4-11, Discovering Cells
20-21, How Do Cells Work Together in an Organism?

TLR:
10, Comparing Cells
11, Observing Cells
23, Tissues, Organs, Systems

The Diversity of Life
SE/TE:
5-6, What Are the Characteristics of All Living Things?

TLR:
9, Is It Living or Non-Living?

Crosscutting Concepts

Scale, Proportion, and Quantity
• Phenomena that can be observed at one scale may not be observable at another scale.

Cells and Heredity
SE/TE:
8-11, How Do Microscopes Work?
38, Science Matters, Electron Eyes

Connections to Engineering, Technology, and Applications of Science

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

Cells and Heredity
SE/TE:
8-11, How Do Microscopes Work?
38, Science Matters, Electron Eyes
## MS. Structure, Function, and Information Processing

### MS-LS1-2

Students who demonstrate understanding can:

**Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.** [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity “Structure, Function and Information Processing (MS-LS1-2)” addresses this performance expectation.

The citations below indicate areas in *Interactive Science* where this idea is introduced.

Information about how cells function is presented in the *Cells and Heredity* module in Chapter 1, Lesson 2, “Looking Inside Cells,” on SE/TE pages 12-21. Students **identify** and **describe** the functions of cell structures in Figure 3, Interactive Art, Cells in Living Things on SE/TE pages 16-17. Students **model** cell structures that are most like parts of a store in the Apply It on SE/TE page 18. Students **model** a cell and **describe** the functions of cell structures in “Gelatin Cell Model” on TLR page 22.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>LS1.A: Structure and Function</strong></td>
<td></td>
</tr>
<tr>
<td>Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.</td>
<td><strong>Structure and Function</strong></td>
</tr>
<tr>
<td>• Develop and use a model to describe phenomena.</td>
<td><strong>Cells and Heredity</strong></td>
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<tr>
<td><strong>Cells and Heredity</strong></td>
<td><strong>SE/TE:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>SE/TE:</strong></td>
<td>12-21, Looking Inside Cells</td>
<td></td>
</tr>
<tr>
<td>18, Apply It</td>
<td>16-17, Figure 3, Interactive Art, Cells in Living Things</td>
<td></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td>18, Apply It</td>
<td></td>
</tr>
<tr>
<td>19, Differentiated Instruction,</td>
<td><strong>TE Only:</strong></td>
<td></td>
</tr>
<tr>
<td>Making Models</td>
<td>19, Differentiated Instruction, Making Models</td>
<td></td>
</tr>
<tr>
<td>21F, Enrich—Looking Inside Cells</td>
<td>21F, Enrich—Looking Inside Cells</td>
<td></td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
<td></td>
</tr>
<tr>
<td>22, Gelatin Cell Model</td>
<td>22, Gelatin Cell Model</td>
<td></td>
</tr>
</tbody>
</table>

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
Students who demonstrate understanding can:

**Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.** [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]

**INTERACTIVE SCIENCE:** In the *Human Body Systems* module, the online Performance Expectation Activity “Structure, Function and Information Processing (MS-LS1-3)” addresses this performance expectation.

The citations below indicate areas in *Interactive Science* where this idea is introduced.

Information pertaining to levels of organization in living things is presented in the *Cells and Heredity* module in Chapter 1, Lesson 2, “How Do Cells Work Together in an Organism?” on SE/TE pages 20-21. In “Tissues, Organs, Systems” on TLR page 23, students model the organization of a multicellular organism and use that model as evidence to answer questions. Information regarding body organization can also be found in the *Human Body Systems* module in Chapter 1, Lesson 1, SE/TE pages 4-9. In “How Is Your Body Organized?” on TLR page 9, students examine a model and use their observations as evidence to answer questions.

Information pertaining to how body systems interact is presented in the *Human Body Systems* module in Chapter 1, Lesson 2, SE/TE pages 10-17. In “How Does Your Body Respond?” on TLR page 11, students identify parts of the body that work together to perform life functions and use their observations as evidence to answer questions. In “Working Together, Act I” on TLR page 21, students model the interaction among different body systems involved in delivering oxygen and removing carbon dioxide and other wastes. Students use their observations as evidence to answer questions. In “Working Together, Act II” on TLR page 22, students model the interaction of the nervous system with other body systems and use their observations as evidence to answer questions.

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

**Science and Engineering Practices**

**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).
- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.

**Cells and Heredity**

**TE Only:**
21, Differentiated Instruction, Cells in Tissues

**TLR:**
23, Quick Lab, Tissues, Organs, Systems

**Disciplinary Core Ideas**

**LS1.A: Structure and Function**
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are special for particular body functions.

**Cells and Heredity**

**SE/TE:**
20-21, How Do Cells Work Together in an Organism?

**TE Only:**
21, Differentiated Instruction, Cells in Tissues

**TLR:**
23, Quick Lab, Tissues, Organs, Systems

**Crosscutting Concepts**

**Systems and System Models**
- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.

**Cells and Heredity**

**SE/TE:**
20-21, How Do Cells Work Together in an Organism?

**TLR:**
23, Quick Lab, Tissues, Organs, Systems

**Human Body Systems SE/TE:**
4-9, How Is Your Body Organized?
11-12, How Do You Move?
16-17, Which Systems Control Body Functions?
### Human Body Systems

**TE Only:**
- 9A, After the Inquiry Warm-Up, Body Organization
- 15, Differentiated Instruction, All Systems Go
- 17A, After the Inquiry Warm-Up, System Interactions
- TLR, Enrich, System Interactions

**TLR:**
- 9, Inquiry Warm-Up, How Is Your Body Organized?
- 11, Inquiry Warm-Up, How Does Your Body Respond?
- 21, Quick Lab, Working Together, Act I
- 22, Quick Lab, Working Together, Act II

### Human Body Systems SE/TE:

- 4-9, How Is Your Body Organized?
- 11-12, How Do You Move?
- 16-17, Which Systems Control Body Functions?

**TE Only:**
- 9A, After the Inquiry Warm-Up, Body Organization
- 15, Differentiated Instruction, All Systems Go
- 17A, After the Inquiry Warm-Up, System Interactions
- TLR, Enrich, System Interactions

**TLR:**
- 9, Inquiry Warm-Up, How Is Your Body Organized?
- 11, Inquiry Warm-Up, How Does Your Body Respond?
- 21, Quick Lab, Working Together, Act I
- 22, Quick Lab, Working Together, Act II

**Quest:** Peak Performance Plan
- Training Systems
- Heart Beat, Health Beat
- Why Practice Makes Perfect
- Reflect on Peak Performance Plan

---

### Connections to Nature of Science

**Science is a Human Endeavor**
- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

### Cells and Heredity

**TE Only:**
- 9E, Enrich, Body Organization
**MS. Structure, Function, and Information Processing**

**MS-LS1-8**

Students who demonstrate understanding can:

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]

**INTERACTIVE SCIENCE:** In the *Human Body Systems* module, the online Performance Expectation Activity “Structure, Function and Information Processing (MS-LS1-8)” addresses this performance expectation.

Information pertaining to the nervous systems, stimuli, and response is introduced in the *Human Body Systems* module in Chapter 1, Lesson 2, pages 16-17. In Figure 4 on SE/TE page 16, students synthesize information regarding stimuli and response.


Students identify the parts of the central nervous system, including the spinal cord and the brain on SE/TE pages 221-224. They write about how sight receptors work on SE/TE page 231. Students write about the functions of the outer, middle, and inner ear in Figure 5, The Ear, on SE/TE page 234. Students sequence the steps involved in sensing taste in Figure 1, Taste Buds on SE/TE page 237. They write about different types of touch sensing in the Apply it! feature on SE/TE page 238.

In “Ready or Not!” on TLR pages 187-195, students gather and synthesize information by conducting an experiment to determine if a person’s reaction time varies depending on the time of day. In “Modeling a Neuron” on TLR page 196, students model the three different types of neurons to determine the role of each in responding to stimuli. They also model responses passing through neurons in “What Are the Parts of the Nervous System” in TLR page 198. Students model the brain and explain the function of the parts in “Making a Model of the Brain” in TLR page 199. Students gather information on how useful eyes and ears are in interpreting stimuli in “Eyes and Ears” in TLR page 202. Students gather and synthesize information on how touch sensors respond to different stimuli in “What’s in the Bag?” on TLR page 207.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtaining, Evaluating, and</td>
<td>LS1.D: Information</td>
<td></td>
</tr>
<tr>
<td>Communicating Information</td>
<td>Processing</td>
<td></td>
</tr>
<tr>
<td>Obtaining, evaluating, and</td>
<td>• Each sense receptor</td>
<td></td>
</tr>
<tr>
<td>communicating information in</td>
<td>responds to different</td>
<td></td>
</tr>
<tr>
<td>6-8 builds on K-5 experiences</td>
<td>inputs (electromagnetic,</td>
<td></td>
</tr>
<tr>
<td>and progresses to evaluating</td>
<td>mechanical, chemical),</td>
<td></td>
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<tr>
<td>the merit and validity of ideas</td>
<td>transmitting them as</td>
<td></td>
</tr>
<tr>
<td>and methods.</td>
<td>signals that travel</td>
<td></td>
</tr>
<tr>
<td>• Gather, read, and synthesize</td>
<td>along nerve cells to the</td>
<td></td>
</tr>
<tr>
<td>information from multiple</td>
<td>brain. The signals are</td>
<td></td>
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<tr>
<td>appropriate sources and</td>
<td>then processed in the</td>
<td></td>
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<tr>
<td>assess the credibility,</td>
<td>brain, resulting in</td>
<td></td>
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<tr>
<td>accuracy, and possible bias of</td>
<td>immediate behaviors or</td>
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<tr>
<td>each publication and</td>
<td>memories.</td>
<td></td>
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<tr>
<td>methods used, and describe how</td>
<td></td>
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<tr>
<td>they are supported or not</td>
<td></td>
<td></td>
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<tr>
<td>supported by evidence.</td>
<td></td>
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</tr>
</tbody>
</table>

**Human Body Systems**

**SE/TE:**
16-17 Which Systems Control Body Functions?
230, Apply It
234, Relate Cause and Effect

**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
<table>
<thead>
<tr>
<th>Human Body Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLR:</td>
</tr>
<tr>
<td>196, Modeling a Neuron</td>
</tr>
<tr>
<td>198, What Are the Parts of the Nervous System?</td>
</tr>
<tr>
<td>199, Making a Model of the Brain</td>
</tr>
<tr>
<td>202, Eyes and Ears</td>
</tr>
<tr>
<td>207, What’s in the Bag?</td>
</tr>
</tbody>
</table>

|  | 16, Figure 4, Stimulus and Response |
|  | 214-219, How the Nervous System Works |
|  | 220-227, Divisions of the Nervous System |
|  | 228-235, Sight and Hearing |
|  | 236-239, Smell, Taste, and Touch |

| TE Only: |
| 17F, Enrich, System Interactions |
| 217, Differentiated Instruction |
| 219, Differentiated Instruction |
| 219F, Enrich, How the Nervous System Works |

| TLR: |
| 187-195, Ready or Not! |
| 196, Modeling a Neuron |
| 198, What Are the Parts of the Nervous System? |
| 199, Making a Model of the Brain |
| 202, Eyes and Ears |
| 207, What’s in the Bag? |

| SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource | 49 |
Students who demonstrate understanding can:

**Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.** [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity "Matter and Energy in Organisms and Ecosystems (MS-LS1-6)" addresses this performance expectation.

Information on how living things get their energy is presented in the *Cells and Heredity* module in Chapter 2, Lesson 1 in "How do Living Things Get Energy From the Sun?,” SE/TE pages 45-46. In the Apply It! feature on SE/TE page 46, students sequence the flow of energy from the sun to a spider. Students **explain** how energy from the sun gets into their cells in "Assess Your Understanding" feature, #1c, on SE/TE page 46. In "Figure 2 – First Stage of Photosynthesis” on page SE/TE page 47, students **explain** that photosynthesis starts the chain of energy.

Additional information on the role of photosynthesis in the flow of energy can be found in the Ecology and the Environment module in Chapter 2, Lesson 1 in "What Are the Energy Roles in an Ecosystem?,” SE/TE pages 43-45. The role of photosynthesis in the cycling of matter is discussed in Chapter 2, Lesson 2 "Cycles of Matter."

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

**Science and Engineering Practices**
- Constructing Explanations and Designing Solutions
  - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
  - Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

**Ecology and the Environment**
- TLR: 54, Quick Lab, Carbon and Oxygen Blues

**Cells and Heredity**
- TLR: 38, Quick Lab, Energy From the Sun

**Crosscutting Concepts**
- Energy and Matter
  - Within a natural system, the transfer of energy drives the motion and/or cycling of matter.

**Ecology and the Environment**
- SE/TE:
  - 43-45, What Are the Energy Roles in an Ecosystem?
  - 50-51, What Processes Are Involved in the Water Cycle?
  - 52-53, How Are the Carbon and Oxygen Cycles Related?
  - 54-55, How Does Nitrogen Cycle Through Ecosystems?

**Scientific Knowledge is Based on Empirical Evidence**
- Scientific knowledge is based upon logical connections between evidence and explanations.

**Disciplinary Core Ideas**
  - Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.

**Connections to Nature of Science**
- **Energy and Matter**
  - Within a natural system, the transfer of energy drives the motion and/or cycling of matter.

**Ecology and the Environment**
- SE/TE:
  - 43-45, What Are the Energy Roles in an Ecosystem?
  - 50-51, What Processes Are Involved in the Water Cycle?
  - 52-53, How Are the Carbon and Oxygen Cycles Related?
  - 54-55, How Does Nitrogen Cycle Through Ecosystems?
<table>
<thead>
<tr>
<th>Ecology and the Environment</th>
<th>Cells and Heredity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>43-45, What Are the Energy Roles in an Ecosystem?</td>
<td>45, How Do Living Things Get Energy From the Sun?</td>
</tr>
<tr>
<td>52-53, How Are the Carbon and Oxygen Cycles Related?</td>
<td>46, Apply it!</td>
</tr>
<tr>
<td>54-55, How Does Nitrogen Cycle Through Ecosystems?</td>
<td>47, Figure 2 – First Stage of Photosynthesis</td>
</tr>
</tbody>
</table>

**TLR:**
38, Quick Lab, Energy From the Sun

**PS3.D: Energy in Chemical Processes and Everyday Life**

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.

(secondary to MS-LS1-6)

**Cells and Heredity**

**SE/TE:**
47-49, What Happens During Photosynthesis?
47, Figure 2 – First Stage of Photosynthesis
48, Sequence
48, Figure 3 – Producing Food
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<table>
<thead>
<tr>
<th><strong>MS.Matter and Energy in Organisms and Ecosystems</strong></th>
<th><strong>Disciplinary Core Ideas</strong></th>
<th><strong>Crosscutting Concepts</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MS-LS1-7</strong></td>
<td><strong>LS1.C: Organization for Matter and Energy Flow in Organisms</strong></td>
<td><strong>Energy and Matter</strong></td>
</tr>
<tr>
<td>Students who demonstrate understanding can:</td>
<td>• Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.</td>
<td>• Matter is conserved because atoms are conserved in physical and chemical processes.</td>
</tr>
<tr>
<td><strong>INTERACTIVE SCIENCE:</strong> In the Cells and Heredity module, the online Performance Expectation Activity “Matter and Energy in Organisms and Ecosystems (MS-LS1-7)” addresses this performance expectation.</td>
<td><strong>Cells and Heredity</strong></td>
<td><strong>Cells and Heredity</strong></td>
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<tr>
<td></td>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
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<tr>
<td></td>
<td>44-49, Photosynthesis</td>
<td>53, Figure 3 – Opposite Processes</td>
</tr>
<tr>
<td></td>
<td>50-55, Cellular Respiration</td>
<td>54, What Happens During Fermentation?</td>
</tr>
<tr>
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<td>52, Figure 2 – Releasing Energy</td>
<td><strong>TE Only:</strong></td>
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<tr>
<td></td>
<td>53, Comparing Two Energy Processes</td>
<td>53, Differentiated Instruction – All About Glucose</td>
</tr>
<tr>
<td></td>
<td>53, Figure 3 – Opposite Processes</td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td></td>
<td>54, What Happens During Fermentation?</td>
<td>40, Cellular Respiration</td>
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<tr>
<td></td>
<td>55, Energy for Life</td>
<td>41-49, Exhaling Carbon Dioxide</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
<td><strong>The Diversity of Life</strong></td>
</tr>
<tr>
<td></td>
<td>53, Differentiated Instruction – All About Glucose</td>
<td><strong>SE/TE:</strong></td>
</tr>
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<td></td>
<td><strong>TLR:</strong></td>
<td>213, Digestion Inside Cells</td>
</tr>
<tr>
<td></td>
<td>40, Cellular Respiration</td>
<td>214-215 Digestion Outside Cells</td>
</tr>
<tr>
<td></td>
<td>41-49, Exhaling Carbon Dioxide</td>
<td>215, Specialized Digestive Systems</td>
</tr>
<tr>
<td></td>
<td><strong>The Diversity of Life</strong></td>
<td><strong>TE Only:</strong></td>
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<tr>
<td></td>
<td><strong>SE/TE:</strong></td>
<td>215E, Enrich – Rushing to Eat</td>
</tr>
<tr>
<td></td>
<td>213, Digestion Inside Cells</td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td></td>
<td>214-215 Digestion Outside Cells</td>
<td>165, How Do Snakes Feed?</td>
</tr>
<tr>
<td></td>
<td>215, Specialized Digestive Systems</td>
<td>166, Planarian Feeding Behavior</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
<td>167-175, Looking at an Owl’s Leftovers</td>
</tr>
<tr>
<td></td>
<td>215E, Enrich – Rushing to Eat</td>
<td><strong>TLR:</strong></td>
</tr>
</tbody>
</table>

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
### Human Body Systems

**SE/TE:**
66-73, Food and Energy
80-85, The Digestive Process Begins
86-91, Final Digestion and Absorption

**PS3.D: Energy in Chemical Processes and Everyday Life**
- Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary to MS-LS1-7)*

### Cells and Heredity

**SE/TE:**
44-49, Photosynthesis
50-55, Cellular Respiration
A Correlation of
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment
to the Next Generation Science Standards for Middle School

| MS.Matter and Energy in Organisms and Ecosystems | Disciplinary Core Ideas | Crosscutting Concepts |
| MS-LS2-1 |
| Students who demonstrate understanding can:  
  Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.] |
| INTERACTIVE SCIENCE: In the Ecology and the Environment module, the online Performance Expectation Activity "Matter and Energy in Organisms and Ecosystems (MS-LS2-1)" addresses this performance expectation. |
| The concept of populations is explored in the Ecology and the Environment module in Chapter 1, Lesson 2, "Populations." The limiting factors on population growth are defined in "What Factors Limit Population Growth?" on SE/TE pages 15-16. |
| Students graph the factors that could affect a population’s size “Growing and Shrinking” on TLR page 24. They make models about the limiting resources and the growth, and decrease of a population in "Elbow Room" on TLR page 25. |
| The performance expectation above was 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 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.  
      - Analyze and interpret data to provide evidence for phenomena.  
  - Ecology and the Environment  
    - TLR:  
      - 13-21, Lab Investigation, World in a Bottle  
      - 24, Growing and Shrinking  
  - Chapter Activities and Projects  
    - 50-56, What’s a Crowd?  
  - LS2.A: Interdependent Relationships in Ecosystems  
    - Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.  
  - Ecology and the Environment  
    - SE/TE:  
      - 4-9, Living Things and the Environment  
      - TE Only:  
        - 9, Differentiated Instruction, Compare Habitats  
        - 9A, After the Inquiry Warm-Up, What’s in the Scene?  
        - 9F, Enrich  
      - TLR:  
        - 11, Inquiry Warm-Up, What’s in the Scene?  
        - 13-21, Lab Investigation, World in a Bottle  
    - 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.  
  - Ecology and the Environment  
    - SE/TE:  
      - 15-17, What Factors Limit Population Growth?  

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
TE Only:
17, Differentiated Instruction, Classroom Density
TLR:
25, Quick Lab, Elbow Room

Chapter Activities and Projects
50-56, What’s a Crowd?

- Growth of organisms and population increases are limited by access to resources.

Ecology and the Environment
SE/TE:
15-17, What Factors Limit Population Growth?
TE Only:
17, Differentiated Instruction, Classroom Density
TLR:
25, Quick Lab, Elbow Room

Chapter Activities and Projects
50-56, What’s a Crowd?
Students who demonstrate understanding can:

Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

**INTERACTIVE SCIENCE:** In the *Ecology and the Environment* module, the online Performance Expectation Activity “Matter and Energy in Organisms and Ecosystems (MS-LS2-3)” addresses this performance expectation.


Students demonstrate the water cycle in “Are You Part of the Water Cycle” on TLR page 52. Students model the water cycle in “Following the Water” on TLR page 53. Students investigate the carbon and oxygen cycles in “Carbon and Oxygen Blues” on TLR page 54. Students model the nitrogen cycle in “Playing Nitrogen Cycle Roles” on TLR page 55.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education*:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Development and Using Models</strong></td>
<td><strong>LS2.B: Cycle of Matter and Energy Transfer in Ecosystems</strong></td>
<td>Energy and Matter</td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.</td>
<td>• The transfer of energy can be tracked as energy flows through a natural system.</td>
</tr>
<tr>
<td><strong>TE Only:</strong> 53, Differentiated Instruction</td>
<td><strong>TE Only:</strong> 53, Differentiated Instruction</td>
<td><strong>Connections to Nature of Science</strong></td>
</tr>
<tr>
<td>53, Build Inquiry – Predict Carbon and Oxygen Cycling</td>
<td>53, Build Inquiry – Predict Carbon and Oxygen Cycling</td>
<td><strong>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong></td>
</tr>
<tr>
<td>55, Differentiated Instruction, Nitrogen in the Soil</td>
<td>55, Differentiated Instruction, Nitrogen in the Soil</td>
<td>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</td>
</tr>
<tr>
<td>43-51, Laboratory Investigation, Ecosystem Food Chains</td>
<td>52, Inquiry Warm-Up, Are You Part of a Cycle?</td>
<td><strong>TLR:</strong> 43-51, Laboratory Investigation, Ecosystem Food Chains</td>
</tr>
<tr>
<td>53, Quick Lab, Following Water</td>
<td>53, Quick Lab, Following Water</td>
<td>54, Quick Lab, Carbon and Oxygen Blues</td>
</tr>
<tr>
<td>55, Quick Lab, Playing Nitrogen Cycle Roles</td>
<td>55, Quick Lab, Playing Nitrogen Cycle Roles</td>
<td>55, Quick Lab, Playing Nitrogen Cycle Roles</td>
</tr>
</tbody>
</table>
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**TLR:**
43-51, Laboratory Investigation, Ecosystem Food Chains
52, Inquiry Warm-Up, Are You Part of a Cycle?
53, Quick Lab, Following Water
54, Quick Lab, Carbon and Oxygen Blues
55, Quick Lab, Playing Nitrogen Cycle Roles
**MS.Matter and Energy in Organisms and Ecosystems**

**MS-LS2-4**

Students who demonstrate understanding can:

**Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

**INTERACTIVE SCIENCE:** In the *Ecology and the Environment* module, the online Performance Expectation Activity "Matter and Energy in Organisms and Ecosystems (MS-LS2-4)” addresses this performance expectation.

The effect of a biological or physical component upon populations of species is presented in the *Ecology and the Environment* module in Chapter 3, Lesson 5, “Biodiversity.” On SE/TE pages 108-110, the importance of keystone species is highlighted with the example of effects of sea otter decline and recovery. Students learn about the changes to populations caused by human activity, which change both physical and biological components of an ecosystem, in "How Do Humans Affect Biodiversity?” on SE/TE page 114. Students model the concept of keystone in "Modeling Keystones Species” on TLR page 93.

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

- **Science and Engineering Practices**
  - 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.

- **Ecology and the Environment**
  - TLR:
    - 93, Modeling Keystones Species 95, Humans and Biodiversity

- **The Diversity of Life**
  - Quest: Construction without Destruction
    - Reflect on Your Basketball Court Plans

- **Connections to Nature of Science**
  - Scientific Knowledge is Based on Empirical Evidence
    - Science disciplines share common rules of obtaining and evaluating empirical evidence.

- **Ecology and the Environment**
  - TLR:
    - 93, Modeling Keystones Species 95, Humans and Biodiversity

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**Disciplinary Core Ideas**

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

**Ecology and the Environment**

**SE/TE:**
- 109, Ecological Value
- 110, Figure 2, Keystone Otters
- 114, Damaging Biodiversity

**TE Only:**
- 113, Differentiated Instruction
- 114, Make Analogies – Habitat Destruction
- 115, Differentiated Instruction

**TLR:**
- 93, Modeling Keystones Species 95, Humans and Biodiversity

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**Crosscutting Concepts**

**Stability and Change**
- Small changes in one part of a system might cause large changes in another part.

**Ecology and the Environment**

**SE/TE:**
- 108, Ecological Value
- 109, Figure 2, Keystone Otters

**TLR:**
- 93, Modeling Keystones Species 95, Humans and Biodiversity

**The Diversity of Life**

**Quest:** Construction without Destruction
- Protect the Plants
- The Mating Game
- Make Your Construction Case
- Reflect on Your Basketball Court Plans
A Correlation
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment
to the Next Generation Science Standards for Middle School

MS.Interdependent Relationships in Ecosystems
MS-LS2-2

Students who demonstrate understanding can:

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

INTERACTIVE SCIENCE: In the Ecology and the Environment module, the online Performance Expectation Activity “Matter and Energy in Organisms and Ecosystems (MS-LS2-2)” addresses this performance expectation.


Students write about competition in an ecosystem in Figure 2 – Niche and Competition on SE/TE page 21. They explain the predator-prey relationship between wolf and moose on Isle Royale in “Do the Math! – Predator-Prey Interactions” on SE/TE page 24. Students analyze data relating to predator prey relationships in “Understanding Main Ideas” on TE page 27E and in “Analyzing Interactions Among Organisms” on TE page 27F. Students model and explain the relationship between competition and predation in the Quick Lab “Competition and Predation” on TLR page 28. They classify different types of symbiosis in “Type of Symbiosis” on TLR page 29.

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

Science and Engineering Practices

- Constructing Explanations and Designing Solutions
  - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
  - Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.

Ecology and the Environment

SE/TE:
24, Do the Math!

TE Only:
27E, Understanding Main Ideas
27F, Enrich - Analyzing Interactions Among Organisms

TLR:
28, Completion and Predation
29, Type of Symbiosis

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.

Ecology and the Environment

SE/TE:
21-23, What are Competition and Predation?
24, Do the Math!
25, Mutualism
26, Commensalism
34, Review and Assessment #15

TE Only:
23, Differentiated Instruction
25, Differentiated Instruction
27E, Understanding Main Ideas
27F, Enrich - Analyzing Interactions Among Organisms

TLR:
28, Completion and Predation
29, Type of Symbiosis

Crosscutting Concepts

Patterns
- Patterns can be used to identify cause and effect relationships.

Ecology and the Environment

SE/TE:
24, Do the Math!

TE Only:
27E, Understanding Main Ideas
27F, Enrich - Analyzing Interactions Among Organisms
### MS.Interdependent Relationships in Ecosystems

**MS-LS2-5**

Students who demonstrate understanding can:

- Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*  
  [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

**INTERACTIVE SCIENCE**: In the *Ecology and the Environment* module, the online Performance Expectation Activity "Matter and Energy in Organisms and Ecosystems (MS-LS2-5)" addresses this performance expectation.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| **Engaging in Argument from Evidence** | **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**  
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).  
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. | **Stability and Change**  
- Small changes in one part of a system might cause large changes in another part. |
| **Ecology and the Environment** | **LS4.D: Biodiversity and Humans**  
Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. | **Ecology and the Environment**  
89, Relate Cause and Effect  
93, Relate Text and Visuals  
115, Compare and Contrast  
**TE Only**  
115, Differentiated Instruction, Compare and Contrast |
| **STEM Activity Book** | **Ecology and the Environment**  
108-117, Biodiversity  
116-117, Figure 6 | **Connections to Engineering, Technology, and Applications of Science** |
| **STEMQuest: To Cross or Not to Cross** | **Ecology and the Environment**  
92-97, Introduction to Natural Resources  
108-117, Biodiversity  
128-133, Conserving Land and Soil  
142-151, Air Pollution and Solutions  
152-159, Water Pollution and Solutions  
**TE Only:**  
133E, Enrich, The Copper Basin  
**TLR:**  
95, Quick Lab, Humans and Biodiversity | **Influence of Science, Engineering, and Technology on Society and the Natural World**  
- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.  
**Ecology and the Environment**  
86-91, Introduction to Environmental Issues  
156-157, How Can Water Pollution Be Reduced?  
157, Apply It!  
**TLR**  
74, Quick Lab, Comparing Costs and Benefits  
**STEMQuest: To Cross or Not to Cross**  
Research the Effects of Highways and Crossings  
The Community Speaks  
Design an Animal Crossing  
Reflect on Your Animal Crossing |
### ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

#### Ecology and the Environment

<table>
<thead>
<tr>
<th>SE/TE</th>
<th>Introduction to Environmental Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-91</td>
<td>Apply It!</td>
</tr>
</tbody>
</table>

**STEMQuest: To Cross or Not to Cross**
- Research the Effects of Highways and Crossings
- The Community Speaks
- Design an Animal Crossing
- Reflect on Your Animal Crossing

### Connections to Nature of Science

**Science Addresses Questions About the Natural and Material World**

- Scientific knowledge can describe consequence of actions but does not make the decisions that society takes.

<table>
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<tr>
<th>SE/TE</th>
<th>Introduction to Environmental Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-91</td>
<td>Apply It!</td>
</tr>
</tbody>
</table>

**TE Only:**

- 91E, Enrich, Congestion Pricing
- TLR 74, Quick Lab, Comparing Costs and Benefits

**STEMQuest: To Cross or Not to Cross**
- Research the Effects of Highways and Crossings
- The Community Speaks
- Design an Animal Crossing
- Reflect on Your Animal Crossing

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
MS.Growth, Development, and Reproduction of Organisms
MS-LS1-4

Students who demonstrate understanding can:

Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

**INTERACTIVE SCIENCE:** In the Diversity of Life module, the online Performance Expectation Activity “Growth, Development, and Reproductions of Organisms (MS-LS1-4)” addresses this performance expectation.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| 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). | LS1.B: Growth and Development of Organisms  
- Animals engage in characteristic behaviors that increase the odds of reproduction. | Cause and Effect
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. |
| **The Diversity of Life**  
**TE Only:**  
107, Build Inquiry – Modeling Seed Dispersal  
117, 21st Century Learning, Critical Thinking  
251E, Enrich- Animal Reproduction and Fertilization  
279, Differentiated Instruction – Make Analogies  
**TLR:**  
200, To Care or Not To Care | **The Diversity of Life**  
**SE/TE:**  
245-251, How Do Animals Reproduce?  
259-261, How Do Animals Care for Their Young?  
261, Do the Math!  
262-269, What Is Behavior?  
270-279, Patterns of Behavior  
278-279, Birds of a Feather...  
**TE Only:**  
251E, Enrich- Animal Reproduction and Fertilization  
259, Differentiated Instruction – Crocodile Mothers  
260, Support the Big Q  
266, Support the Big Q  
273, Teacher Demo, Competition and Aggression  
274, Build Inquiry – Group Safety  
275, Differentiated Instruction – Drones  
279, Differentiated Instruction – Make Analogies  
**TLR:**  
194, Making More  
200, To Care or Not To Care  
201, What Behaviors Can You Observe?  
202, Animal Behavior  
204, Communicating Without Words | **The Diversity of Life**  
**SE/TE:**  
107, Target Skill: Related Cause and Effect  
274-275, Cooperative Behavior  
278-279, Birds of a Feather...  
**TE Only:**  
117, 21st Century Learning, Critical Thinking  
274, Build Inquiry – Group Safety |
• Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

**The Diversity of Life**

**SE/TE:**
100-109, Plant Structures
106, Figure 6: Story of a Seed
107, Target Skill: Related Cause and Effect
108, Figure 7: Pollinator Matchup
110-117, Plant Reproduction
117, Figure 5, Flower to Fruit

**TE Only:**
105, Differentiated Instruction, Specialized Leaves
106, Lead a Discussion, Seed Dispersal and Germination
107, Build Inquiry – Modeling Seed Dispersal
108, Explain: Teach With Visuals
109, Build Inquiry – Observing the Structure of a Flower
115, Differentiated Instruction, Fire Pines
117, 21st Century Learning, Critical Thinking

**TLR:**
92, Quick Lab, The In-Seed Story
93, Quick Lab: Modeling Flowers Inquiry Warm-Up
94, Inquiry Warm-Up, Make the Pollen Stick
96, Where Are the Seeds?
Students who demonstrate understanding can:

**Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.** [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity “Growth, Development, and Reproductions of Organisms (MS-LS1-5)” addresses this performance expectation.

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

**Science and Engineering Practices**
- Constructing Explanations and Designing Solutions
- Students construct explanations and progress to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

**Disciplinary Core Ideas**
- **LS1.B: Growth and Development of Organisms**
  - Genetic factors as well as local conditions affect the growth of the adult plant.

**Cells and Heredity**
- **SE/TE:**
  - 86-91, Patterns of Inheritance
  - 86, My Planet Diary
  - 87, Figure 1- Other Patterns of Inheritance
  - 91, Assess Your Understanding
- **TE Only:**
  - 90, Lead a Discussion
  - 91, Differentiated Instruction, Sex Determination in Reptiles
  - 91A, After the Inquiry Warm-Up
  - 91B, Assess Your Understanding
- **TLR:**
  - 81, Is It All in the Genes?

**Crosscutting Concepts**
- **Cause and Effect**
  - Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

**Cells and Heredity**
- **SE/TE:**
  - 86, Unlock the Big Question- How Do Genes and the Environment Interact?
  - 88, Apply it!
  - 90, Explore the Big Question- Patterns of Inheritance
- **TE Only:**
  - 91D, Review and Reinforce
  - 91E, Enrich
- **TLR:**
  - 81, Is It All in the Genes?
**MS.Growth, Development, and Reproduction of Organisms**

**MS-LS3-1**

Students who demonstrate understanding can:

**Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.** [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

**INTERACTIVE SCIENCE:** In the Cells and Heredity module, the online Performance Expectation Activity “Growth, Development, and Reproductions of Organisms (MS-LS3-1)” addresses this performance expectation.

Harmful, beneficial, and neutral mutations are addressed in the Cells and Heredity module, Chapter 4, Lesson 3, SE/TE pages 118-123. In the Assess Your Knowledge feature on SE/TE page 120, students explain why mutations are harmful or beneficial. Students model what happens when errors occur in DNA sequences in “Oops!” on TLR page 105. Students model the effects of a mutation and explain why a mutation is beneficial or harmful in “Effects of Mutations” on TLR page 106.

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

**Science and Engineering Practices**

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena.

**Cells and Heredity**

**TE Only:**
- 119, ELL Support
- 119, Support the Big Q

**TLR:**
- 105, Inquiry Warm-Up, Oops!
- 106, Quick Lab, Effects of Mutations

**Disciplinary Core Ideas**

**LS3.A: Inheritance of Traits**
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.

**Cells and Heredity**

**SE/TE:**
- 93-95, How Are Chromosomes, Genes, and Inheritance Related?
- 109-111, What Forms the Genetic Code?
- 118-123, Mutations

**LS3.B: Variation of Traits**
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

**Cells and Heredity**

**SE/TE:**
- 118-123, Mutations

**TE Only:**
- 119, ELL Support
- 119, Support the Big Q

**Crosscutting Concepts**

**Structure and Function**
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function.

**Cells and Heredity**

**TLR:**
- 105, Inquiry Warm-Up, Oops!
- 106, Quick Lab, Effects of Mutations
<table>
<thead>
<tr>
<th>TLR:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>105, Inquiry Warm-Up, Oops!</td>
<td></td>
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<tr>
<td>106, Quick Lab, Effects of</td>
<td></td>
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<tr>
<td>Mutations</td>
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</tbody>
</table>
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### MS.Growth, Development, and Reproduction of Organisms

**MS-LS3-2**

Students who demonstrate understanding can:

**Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.** [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

**INTERACTIVE SCIENCE:** In the Cells and Heredity module, the online Performance Expectation Activity “Growth, Development, and Reproductions of Organisms (MS-LS3-2)” addresses this performance expectation.

Students **obtain information** about sexual and asexual reproduction in the Diversity of Life module in Chapter 7, Lesson 1, "How Do Animals Reproduce?” on SE/TE page 245-247.

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

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<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| Developing and Using Models      | LS1.B: Growth and Development of Organisms  
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.  
- Develop and use a model to describe phenomena.  
**Cells and Heredity**  
71-78, Lab Investigation, Make the Right Call!  
**Quest:** Funky Fruit  
All in the Numbers  
**The Diversity of Life**  
TLR:  
194, Inquiry Warm-Up, Making More  
**Chapter Activities and Projects**  
99-105, All in the Family |  
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)  
**Cells and Heredity**  
**Quest:** Funky Fruit  
An Apple Lesson  
All in the Numbers |  
- Cause and Effect  
- Cause and effect relationships may be used to predict phenomena in natural systems.  
**Cells and Heredity**  
**TLR:**  
67, Quick Lab, Inferring the Parent Generation  
71-78, Lab Investigation, Make the Right Call!  
**The Diversity of Life**  
**SE/TE:**  
245, Asexual Reproduction  
246, Sexual Reproduction  
247, Comparing Asexual and Sexual Reproduction  
247, Figure 3, Asexual and Sexual Reproduction  
**TLR:**  
194, Inquiry Warm-Up, Making More |  
**LS3.A: Inheritance of Traits**  
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.  
**Cells and Heredity**  
**SE/TE:**  
74-79, What Is Heredity?  
80-85, Probability and Heredity  
86-91, Patterns of Inheritance  
92-97 Chromosomes and Inheritance  
**TLR:**  
67, Quick Lab, Inferring the Parent Generation |
**Quest:** Funky Fruit
About Those Chromosomes

**LS3.B: Variation of Traits**
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

**Cells and Heredity**

**SE/TE:**
86-91, Patterns of Inheritance
92-97 Chromosomes and Inheritance

**TLR:**
67, Quick Lab, Inferring the Parent Generation
71-78, Lab Investigation, Make the Right Call!

**Chapter Activities and Projects**
99-105, All in the Family
### MS.Growth, Development, and Reproduction of Organisms

**MS-LS4-5**

Students who demonstrate understanding can:

Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity "Growth, Development, and Reproductions of Organisms (MS-LS4-5)" addresses this performance expectation.

Analysis of the production of desired traits is presented in the *Cells and Heredity* module in Chapter 5, Lesson 3, “How Can Organisms Be Produced With Desired Traits?” on SE/TE pages 146-151.

Students model selective breeding in “Selective Breeding” on TLR page 132 in Lesson 3. They create an outline to organize information about methods of developing organisms with desirable traits in the Ask Questions feature on SE/TE page 147. Students graph and analyze data about production of rice influenced by genetic factors in the Do the Math! feature on SE/TE page 149.

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

#### Science and Engineering Practices

- **Obtaining, Evaluating, and Communicating Information**: Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.
  - Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.

#### Disciplinary Core Ideas

- **LS4.B: Natural Selection**
  - In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.

**Cells and Heredity**

**SE/TE:**
- 146-151, How Can Organisms Be Produced With Desired Traits?

**TE Only:**
- 147, Lead a Discussion – Breeding Pets
- 149, Differentiated Instruction
- 149, Make Analogies - Cloning
- 150, 21st Century Learning
- 151E, Enrich, A Closer Look at Gene Therapy for Cystic Fibrosis

**TLR:**
- 132, Quick Lab, Selective Breeding

#### Crosscutting Concepts

- **Cause and Effect**
  - Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

**Cells and Heredity**

**SE/TE:**
- 148, Apply It!

**Connections to Engineering, Technology, and Applications of Science**

- **Intercdependence of Science, Engineering, and Technology**
  - Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.
### Connections to Nature of Science

Science Addresses Questions About the Natural and Material World
- Science knowledge can describe consequences of actions but does not make the decisions that society takes.

### Cells and Heredity

**SE/TE:**
160, Science Matters, Mini But Mighty

**TE Only:**
149, Differentiated Instruction
150, 21st Century Learning, Information Literacy
MS.Natural Selection and Adaptations
MS-LS4-1

Students who demonstrate understanding can:

**Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.** [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity “Natural Selection and Adaptations (MS-LS4-1)” addresses this performance expectation.

Patterns of change in fossils are explored in the *Earth’s Surface* module in Chapter 4, Lesson 1, “What Do Fossils Show?” on SE/TE pages 108-109. Students **analyze** information about the relationship of an extinct horse-like species to modern horses in the Challenge question on SE/TE page 108. In Assess Your Understanding on SE/TE page 109, students **write to explain** what the fossil record shows. In Review and Assessment, question 23 on SE/TE page 142, students **analyze** an image of a fossil, **make inferences** about the organism and its environment, and **provide evidence** for their inferences. On TE page 109D, Key Concept Summaries, students **explain** how fossils help scientists make discoveries about lives of organisms. On TLR page 102, students will **infer** what trace fossils tell you about an organism in “Modeling Trace Fossils.” Students **infer and model** what fossils can tell you about Earth’s past in “Modeling the Fossil Record” on TLR page 103.

Patterns of change in fossils content is also presented in the *Cells and Heredity* module in Chapter 6, Lesson 2. The relationship between homologous structures in modern and extinct animals is presented on SE/TE page 178. In Chapter 6, Lesson 3, information on how the fossil record provides evidence for the rate of evolution can be found on SE/TE pages 182-183. Students **analyze and interpret** fossils relating to horse evolution in Figure 2 on SE/TE page 182. Students **analyze and interpret** a hypothetical case of punctuated equilibrium in “Rate of Change” on TE page 183E. In “Walking Whales,” SE/TE page 189, students **trace** the fossil history of the ancestor species to whales.

The performance expectation above was 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 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - Analyze and interpret data to determine similarities and differences in findings.

**Disciplinary Core Ideas**
- **LS4.A: Evidence of Common Ancestry and Diversity**
  - The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.

**Earth’s Surface**
- **SE/TE:** 108-109, What Do Fossils Show?
- **TE Only:** 142, Review and Assessment, Q# 23

**Cells and Heredity**
- **TE Only:** 109D, Key Concept Summaries
- **TLR:**
  - 102, Modeling Trace Fossils
  - 103, Modeling the Fossil Record

**Crosscutting Concepts**
- **Patterns**
  - Graphs, charts, and images can be used to identify patterns in data.

**Cells and Heredity**
- **SE/TE:** 178, Similarities in Body Structure

**Connections to Nature of Science**
- **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
  - Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

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**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
Science knowledge is based upon logical and conceptual connections between evidence and explanations.

<table>
<thead>
<tr>
<th>Cells and Heredity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>178, Similarities in Body Structure</td>
</tr>
<tr>
<td>182-183, What Patterns Describe the Rate of Evolution?</td>
</tr>
<tr>
<td>189, Walking Whales</td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>183E, Rate of Change</td>
</tr>
</tbody>
</table>

182-183, What Patterns Describe the Rate of Evolution?
183, Apply It
189, Walking Whales
A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

<table>
<thead>
<tr>
<th>MS.Natural Selection and Adaptations MS-LS4-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td><strong>Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.</strong> [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]</td>
</tr>
</tbody>
</table>

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity "Natural Selection and Adaptations (MS-LS4-2)" addresses this performance expectation.

Information on patterns of change in fossils is explored in the *Earth's Surface* module in Chapter 4, Lesson 1, “What Do Fossils Show?” on SE/TE pages 108-109. Students **analyze information** about the Hyracotherium to explain its relationship to modern horses in the Challenge question on SE/TE page 108.

Information is also found in the *Cells and Heredity* module in Chapter 6, Lesson 2. Similarities in early development anatomical structures of modern organisms are discussed on SE/TE page 177. How fossils allow scientists to infer the structures of ancient organisms is described on SE/TE page 177. The relationship between homologous structures in modern and extinct animals is discussed on SE/TE page 178. Students **examine** horse evolution and **explain** how the evolution of the shape of the leg and number of toes would have benefited *Equus* on SE/TE page 182. Students **analyze and interpret** a hypothetical case of punctuated equilibrium in "Rate of Change" on TE only page 183E. In "Walking Whales," SE/TE page 189, students **research** the evolutionary history of the ancestor species to whales.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>LS4.A: Evidence of Common Ancestry and Diversity</strong></td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>• Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.</td>
<td>• Patterns can be used to identify cause and effect relationships.</td>
</tr>
<tr>
<td><strong>Earth’s Surface</strong></td>
<td><strong>Earth’s Surface</strong></td>
<td><strong>Cells and Heredity</strong></td>
</tr>
<tr>
<td><strong>SE/TE:</strong></td>
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<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td><strong>Cells and Heredity</strong></td>
<td><strong>178, Similarities in Body Structure</strong></td>
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<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>182-183, What Patterns Describe the Rate of Evolution?</strong></td>
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</tr>
<tr>
<td>178, Similarities in Body Structure</td>
<td>185, Review and Assessment, Q#9</td>
<td><strong>Connections to Nature of Science</strong></td>
</tr>
<tr>
<td>182-183, What Patterns Describe the Rate of Evolution?</td>
<td>189, Walking Whales</td>
<td><strong>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong></td>
</tr>
<tr>
<td>189, Walking Whales</td>
<td><strong>TE Only:</strong></td>
<td><strong>Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</strong></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td>183E, Rate of Change</td>
<td><strong>Cells and Heredity</strong></td>
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<td><strong>SE/TE:</strong></td>
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<td>182-183, What Patterns Describe the Rate of Evolution?</td>
<td>178, Similarities in Body Structure</td>
<td><strong>SE/TE:</strong></td>
</tr>
</tbody>
</table>

**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
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to the Next Generation Science Standards for Middle School

### MS.Natural Selection and Adaptations
#### MS-LS4-3

Students who demonstrate understanding can:

**Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.**

*Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.*

*Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.*

**INTERACTIVE SCIENCE:** In the *Cells and Heredity* module, the online Performance Expectation Activity "Natural Selection and Adaptations (MS-LS4-3)" addresses this performance expectation.

The similarities in early development of different organisms are discussed in the *Cells and Heredity* module in Chapter 6, Lesson 2, "What Evidence Supports Evolution?" on SE/TE page 177. Students **analyze** visual representations to **compare** the anatomical differences between four organisms in Figure 1, "Similarities in Development" on page 177. In the TE, Teach with Visuals supports students in this effort.

The performance expectation above was 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 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze displays of data to identify linear and nonlinear relationships.

#### Crosscutting Concepts

**Patterns**

- Graphs, charts, and images can be used to identify patterns in data.

#### Disciplinary Core Ideas

**LS4.A: Evidence of Common Ancestry and Diversity**

- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.

#### Cells and Heredity

**SE/TE:**

- 177, What Evidence Supports Evolution?
- 177, Figure 1, Similarities in Development

**TE Only:**

- 177, Teach with Visuals

**Cells and Heredity**

**SE/TE:**

- 177, What Evidence Supports Evolution?
- 177, Figure 1, Similarities in Development

**TE Only:**

- 177, Teach with Visuals

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SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
Students who demonstrate understanding can:

Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]

INTERACTIVE SCIENCE: In the Cells and Heredity module, the online Performance Expectation Activity “Natural Selection and Adaptations (MS-LS4-4)” addresses this performance expectation.

Natural selection is explained in the Cells and Heredity module in Chapter 6, Lesson 1, “What Is Natural Selection?” on SE/TE pages 172-176. Students write about the factors that affect natural selection in Figure 5 – Factors That Affect Natural Selection” on SE/TE pages 172-173. In Do the Math!, SE page 174, students speculate on loggerhead turtle nesting sites in the Challenge question. Students draw a conclusion about genetic variation and natural selection in “Figure 6 – Environmental Change” on SE/TE page 175. In Assess Your Understanding, students answer the big question, #2b, and relate cause and effect, #2c. In Enrich, Darwin’s Theory, TE page 175F, students communicate evolution theories of long-necked giraffes to Darwin’s theory of evolution. Students model natural selection in “Nature at Work” on TLR pages 148-156. In Review and Assessment, p. 186, #15, students predict what changes would be observed as a result of environmental change. In Standardized Test Prep, #6, students describe a situation in which natural selection would favor flies with small wings.

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

**Science and Engineering Practices**

- Constructing Explanations and Designing Solutions
  - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
  - Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena.

**Cells and Heredity**

**SE/TE:**
- 175, Assess Your Understanding, #2b, 2c, Got it?
- 186, Review and Assessment, Apply the Big Q, #15.
- 187, Standardized Test Prep, Constructed Response, #6
**TE Only:**
- 175F, Enrich, Darwin’s Theory
**TLR:**
- 148-156, Nature at Work

<table>
<thead>
<tr>
<th><strong>Disciplinary Core Ideas</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LS4.B: Natural Selection</strong></td>
</tr>
<tr>
<td>Natural selection leads to the predominance of certain traits in a population, and the suppression of others.</td>
</tr>
</tbody>
</table>

**Cells and Heredity**

**SE/TE:**
- 172, Factors That Affect Natural Selection, Figure 5- Factors That Affect Natural Selection
- 174, Do the Math!
- 175, Figure 6- Environmental Change, Assess Your Understanding, #2b, 2c, Got it?
**TE Only:**
- 175, Enrich, Darwin’s Theory
**TLR:**
- 148-156, Nature at Work

**Crosscutting Concepts**

- **Cause and Effect**
  - Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

- **Cells and Heredity**
  - 173, Relate Cause and Effect
  - 174, Do the Math!
  - 175, Figure 6- Environmental Change
  - 175, Assess Your Understanding, #2c
**MS.Natural Selection and Adaptations**
**MS-LS4-6**

Students who demonstrate understanding can:

*Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.* [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.]

[Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

**INTERACTIVE SCIENCE:** In the Cells and Heredity module, the online Performance Expectation Activity “Natural Selection and Adaptations (MS-LS4-6)” addresses this performance expectation.


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

### Science and Engineering Practices
**Using Mathematics and Computational Thinking**
Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
- Use mathematical representations to support scientific conclusions and design solutions.

### Disciplinary Core Ideas
**LS4.C: Adaptation**
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

### Cells and Heredity
**SE/TE:**
- 174, Do the Math!
**TLR:**
- 148-156, Nature at Work

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**Cells and Heredity**
**SE/TE:**
- 172-176, What Is Natural Selection?
- 172, Factors That Affect Natural Selection
- 174, Do the Math!
**TLR:**
- 148-156, Nature at Work

**Crosscutting Concepts**
**Cause and Effect**
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

**Cells and Heredity**
**SE/TE:**
- 174, Do the Math!
**TLR:**
- 148-156, Nature at Work
Students who demonstrate understanding can:

- Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

**INTERACTIVE SCIENCE:** In the Astronomy and Space Science module, the online Performance Expectation Activity “Space Systems (MS-ESS1-1)” addresses this performance expectation.

The concept of patterns of motion of celestial bodies, including the motions of Earth, the moon, and the sun, is introduced at the start of the Astronomy and Space Science module with the photograph on SE/TE page 1. From that point on, every section relates occurrences such as the occurrence of day and night, eclipses, and lunar phases to the patterns of the observed motions of celestial bodies. Rotation and day/night cycles are shown on SE/TE page 11, and seasons are shown on pages 14-15. Students learn about lunar phases on SE/TE pages 22-24 and eclipses on pages 25-26.

Students analyze various figures, mark the pictures, and complete illustrations that reinforce the concept of how objects change position in the sky on SE/TE pages 8-12. Students calculate hours of sunlight on SE/TE page 17. On SE/TE page 20, students interpret data from a graph about the moon’s orbit. Students make a model of the Earth-sun-moon system to describe lunar phases in the Apply It! on SE/TE page 24. They use a model of the Earth-sun-moon system to describe lunar phases in Figure 2 on page SE/TE page 24. They use a model of the Earth-sun-moon system to describe eclipses in Figure 3 on SE/TE page 25 and Figure 4 on SE/TE page 26. They use a model of the Earth-sun-moon system to represent eclipses in the Teacher to Teacher activity on TE page 26. They also use a model of the Earth-sun-moon system to describe seasons, lunar phases, and eclipses in Figure 5 on SE/TE page 27. They develop and use a model of the Earth-sun-moon system to represent eclipses in the Differentiated Instruction on TE page 27. They use a model of the Earth-sun-moon system to describe tides on SE/TE page 30. Students demonstrate their content knowledge in Assess Your Understanding, SE/TE: 27, 1a, 1b and Got it? On TE page 27C, students construct explanations of how the interaction of the moon, Earth, and sun cause phases of the moon and eclipses.

Students make models of how Earth’s rotation causes day and night on TLR page 16. They model how tilting of Earth’s axis causes the seasons, on TLR page 19. Students model the Earth-sun-moon system to describe lunar phases on TLR page 31. They model the Earth-sun-moon system to describe eclipses on TLR page 32.

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

**Science and Engineering Practices**
- Developing and Using Models
  - Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
  - Develop and use a model to describe phenomena.
- Astronomy and Space Science
  - SE/TE:
    - Figure 4: Seasons
    - Figure 1: The Moon’s Motion
    - Figure 2: Solar Eclipse
    - Figure 4: Lunar Eclipse
    - Figure 5: Seasons and Shadows

**Disciplinary Core Ideas**
- 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.
- Astronomy and Space Science
  - SE/TE:
    - 11, How Does Earth Move?
    - 15, What Causes Seasons?
    - 24, Phases of the Moon
    - 25, What Are Eclipses?
    - 29, What Are Tides?
  - TE Only:
    - 27C, Key Concept Summaries

**Crosscutting Concepts**
- Patterns
  - Patterns can be used to identify cause and effect relationships.
- Astronomy and Space Science
  - SE/TE:
    - 11, How Does Earth Move?
    - 14, What Causes Seasons
    - 15, Figure 4: Seasons
    - 22, What Causes the Moon’s Phases?
    - 23, Figure 1: The Moon’s Motions
    - 24, Figure 2: Moon Phases

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
TE Only:
15, Build Inquiry: Compare and Contrast Angles of Sunlight
15: Differentiated Instruction: Model
27, Differentiated Instruction: Model Eclipses

TLR:
16, What Causes Day and Night?
17, Sun Shadows
18-26, Reasons for the Seasons
31, Moon Phases
32, Eclipses

ESS1.B: Earth and the Solar System
- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.

Astronomy and Space Science
SE/TE:
11-12, How Does Earth Move?
14-17 What Causes Seasons?
22-24, What Causes the Moon's Phases?
23, Figure 1: The Moon's Motions
24, Figure 2: Moon Phases
25-26, What Are Eclipses?
25, Figure 3: Solar Eclipse
26, Figure 4: Lunar Eclipse

TE Only:
17D, Understanding Main Ideas
27C, Key Concept Summaries
27D, Understanding Main Ideas

TLR:
18-26, Reasons for the Seasons
30, How Does the Moon Move?
31, Moon Phases
32, Eclipses

TE Only:
17E, Enrich – Build a Simple Sundial
27C, Key Concept Summaries

Connections to Nature of Science
Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

Astronomy and Space Science
SE/TE:
8-9, How Do Objects in the Sky Appear to Move?
10-17, Earth in Space
22-27, Phases and Eclipses
28-31, Tides
79-81, What Was the Geocentric Model?

TE Only:
9E, Enrich – The Phases of Venus
17E, Enrich – Build a Simple Sundial
31E, Enrich – What Affects the Heights of Tides?
81E, Enrich – The Phases of Venus

TLR:
16, What Causes Day and Night?
17, Sun Shadows
18-26, Reasons for the Seasons
31, Moon Phases
32, Eclipses
83-91, Speeding Around the Sun
Students who demonstrate understanding can: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state.)] [Assessment Boundary: Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

INTERACTIVE SCIENCE: In the Astronomy and Space Science module, the online Performance Expectation Activity “Space Systems (MS-ESS1-2)” addresses this performance expectation.

Students learn about gravity and the factors that determine the strength of the force of gravity between two objects in Chapter 1, Lesson 3, “Gravity and Motion” on SE/TE pages 18-21 of the Astronomy and Space Science module. Students obtain information about the role gravity plays in orbital motions in “What Keeps Objects in Orbit?” on page 20. Students use a model to predict how the motion of Earth’s moon would change if the force of Earth’s gravity increased in “Figure 2 – Orbital Motion” on SE/TE page 20. Students learn about the role gravity played in the formation of the solar system and gravity’s role in holding the solar system together in “How Did the Solar System Form?” on SE/TE page 86. Students learn about the role gravity plays in the motion of stars within star systems in “What Is a Star System?” on SE/TE page 148. They obtain knowledge about the role gravity plays in pulling together gases to form stars in “Make Analogies” on TE page 152. Students learn how the force of gravity might reverse the current expansion of the universe and begin to pull all the galaxies of the universe together on SE/TE page 156 “The Big Bang and the Future of the Universe.” They use a model to show how gravity might pull all the galaxies of the universe together in “Figure 2 – The Big Crunch” on SE/TE page 156.

On TE page 83, ELL Support, students complete a flowchart to show the formation of the solar system as a result of gravity pulling materials together to form a cloud. On TE page 162, Hot Science, students obtain information about how the gravity of a black hole pulls everything within its gravitational field into it. Students use a model to represent how gravity helps to determine the orbit of objects in the solar system in “Around and Around We Go” on TLR page 29. Students use a model to show the formation of the solar system as a result of gravity pulling together rock, gas, ice and other material in “Clumping Planets” on TLR page 92. Students use a model to show the effect of planetary gravity on the orbits of comets and asteroids in “Changing Orbits” on TLR page 103. Students use a model to describe the movement of galaxies in the universe in “How Does the Universe Expand?” on TLR page 138. Students develop and use a model to describe motions within the solar system in “Speeding Around the Sun” on TLR pages 88-91; in this lab students describe the role gravity plays in the motion of planets in the solar system in “Communicate” on page 91. Students use a model to explore how gravity could pull all the galaxies of the universe together in a “big crunch” in “The Future of the Universe” on TLR page 139.

The performance expectation above was developed using the following elements from the NRC document A Framework for K–12 Science Education:

**Science and Engineering Practices**
- Developing and Using Models
- Astronomy and Space Science

**Disciplinary Core Ideas**
- ESS1.A: The Universe and Its Stars
  - Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.
- Astronomy and Space Science
  - SE/TE: 152-153, What Are the Major Types of Galaxies?
  - 154-155, What Does the Big Bang Theory Say About the Universe?

**Crosscutting Concepts**
- Systems and System Models
- Astronomy and Space Science

**SE/TE**
- 20, Figure 2: Orbital Motion
- 86, Figure 2: Formation of the Solar System
- 149, Figure 1: Invisible Partner
- 156, Figure 2: The Big Crunch

**TLR**
- 29, Around and Around We Go
- 83-91, Speeding Around the Sun
### ESS1.B: Earth and the Solar System
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.

### Astronomy and Space Science

#### SE/TE:
- 82-87, Introducing the Solar System
- 88-93, The Sun
- 94-101, The Inner Planets
- 102-109, The Outer Planets
- 110-115, Small Solar System Objects

#### TE Only:
- 83, Teach Key Concepts, Lead a Discussion
- 84, Teacher to Teacher
- 85, Differentiated Instruction – L1 Make Flashcards
- 91, Differentiated Instruction – L1 Interpret Diagrams
- 101, Differentiated Instruction – L1 Oral Review
- 101D, Review and Reinforce
- 105, 21st Century Learning
- 107, Teacher Demo – Compare and Contrast Planets
- 113, Differentiated Instruction – L1 Make Flashcards
- 115, Differentiated Instruction – L3 Multimedia Presentation

#### TLR:
- 83-91, Speeding Around the Planets
- 97, Characteristics of the Inner Planets
- 99, How Big Are the Planets?
- 100, Density Mystery
- 102, Collecting Micrometeorites

### Connections to Nature of Science

- **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
  - Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

### TE Only:

- 153, Differentiated Instruction – L1 Where in the Milky Way Are We?
- 153E, Enrich – Star Systems and Galaxies
- 135, Why Does the Milky Way Look Hazy?
- 138, How Does the Universe Expand?
- 139, The Future of the Universe Quest: Searching for a Star Searching for the Unseen

### Quest:

- 83, Around and Around We Go
- 92, Clumping Planets
- 103, Changing Orbits
- 138, How Does the Universe Expand?
- 139, The Future of the Universe Quest: Searching for a Star Searching for the Unseen

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ESS1.B: Earth and the Solar System
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

**Astronomy and Space Science**

**SE/TE:**
86-87, How Did the Solar System Form?

**TE Only:**
83, ELL Support

**TLR:**
92, Clumping Planets
MS.Space Systems
MS-ESS1-3

Students who demonstrate understanding can:

**Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]

**INTERACTIVE SCIENCE:** In the *Astronomy and Space Science* module, the online Performance Expectation Activity "Space Systems (MS-ESS1-3)" addresses this performance expectation.

Data and other information about properties of objects in the solar system, including planets, dwarf planets, comets, asteroids, and meteors, are detailed in the *Astronomy and Space Science* module, Chapter 3, Lessons 1-6. The concept of scale and distance in the solar system is discussed in Lesson 2, "Introducing the Solar System," page 83. The relative sizes of the planets and data related to their orbital radii and orbital periods are presented in "Figure 1 - The Solar System" on pages 84-85. The use of the telescopes to obtain data related to objects in the solar system and in the universe is discussed in "My Planet Diary: Galileo Galilei" on SE/TE page 32, "Galileo's Evidence" on SE/TE page 81, "My Planet Diary: Predicting a Planet" on SE/TE page 102, "Figure 3: The Hubble Space Telescope" on SE/TE page 129, and "Black Holes" on SE/TE page 162. The use of spacecraft, including rovers, lunar landers, probes, and space stations, to obtain data is discussed in "After Apollo: Exploring the Moon" on SE/TE page 41, "Figure 2: Major Events in Moon Exploration" on SE/TE pages 54-55, "The History of Space Exploration" on SE/TE pages, "Space Stations" on SE/TE page 58, and the Apply It! activity on SE/TE pages 60-61. Individual spacecraft used to explore specific planets in the solar system is detailed in "What Are the Characteristics of the Inner Planets?" on pages 96-101 and "What Are the Characteristics of the Outer Planets?" on SE/TE pages 104–109.

Students interpret data and draw the scale distance of each planet from the sun in "Figure 1 – The Solar System" on SE/TE pages 84-85 in the *Astronomy and Space Science* module. Students learn about scale properties of the inner planets in Chapter 3, Lesson 4, pages 94-101. Students analyze and interpret data related to scale properties of objects in the universe in "Figure 1 – The Inner Planets," page 95. Students compare the size and mass of Earth with the size and mass of Venus in the Teacher Demo activity on TE page 97. Students interpret data related to the atmospheres of Earth and Venus in "Enrich: Atmosphere of Earth and Venus" on TE page 101E. Students analyze and interpret data related to scale properties of objects in the universe in "Figure 1 – The Outer Planets," page 103. Students calculate the size of Jupiter’s Great Red Spot relative to the size of storms on Earth in "Figure 2 – The Great Red Spot," page 104. Students test each other’s knowledge of properties of the planets, including relative size, in Differentiated Instruction" on TE page 85. Students interpret photographs to compare sizes of Jupiter's moons in "Differentiated Instruction: Photo Research" on TE page 105. Students compare the orbital radii of Neptune and Pluto in "The Outer Planets" on TE page 109E. Students make a model of the solar system to show relative distances from the sun to each planet in "Alternate Assessment" on TE page 117. Students compare the size of Earth to the size of the sun in "How Big Is Earth?" on TLR page 82. Students investigate the relationship between a planet’s period of rotation and its distance from the sun in "Speeding Around the Sun" on TLR pages 83-91. Students make a model of the sun’s layers in "Layers of the Sun" on TLR page 94. Students compare the sizes of the planets in "How Big Are the Planets?" on TLR page 99.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education.*
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Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
• Analyze and interpret data to determine similarities and differences in findings.

Astronomy and Space Science

SE/TE:
79, Apply It!
80-81, Figure 1: Changing Models
102, My Planet Diary: Predicting a Planet

TLR:
79, What Is at the Center?

Quest:
Searching for a Star Space Invaders

Disciplinary Core Ideas

ESS1.B: Earth and the Solar System
• The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.

Astronomy and Space Science

SE/TE:
18-21, Gravity and Motion
82-87, Introducing the Solar System
88-93, The Sun
94-101, The Inner Planets
102-109, The Outer Planets
110-115, Small Solar System

Objects
TE Only:
21E, Enrich – Your Weight in the Solar System
83, ELL Support
87E, Enrich – Planets for Human Settlement
91, Differentiated Instruction
93E, Enrich – Sunspot Clues
97, Differentiated Instruction – L1 Compare and Contrast Inner Planets
97, Teacher Demo – Venus’s Rotation
99, Build Inquiry – Interpret the Greenhouse Effect
101E, Enrich – Atmospheres of Earth and Venus
105, 21st Century Learning
105 – Differentiated Instruction – L3 Photo Research
107, Teacher Demo – Compare and Contrast Planets
109E, Enrich – The Orbits of Neptune and Pluto
115E, Enrich – Evidence of a Large Meteorite

TLR:
27, What Factors Affect Gravity?
29, Around and Around We Go
36, Moonwatching
83, Speeding Around the Sun
93, How Can You Safely Observe the Sun?
95, Viewing Sunspots
99, How Big Are the Planets?
101, Make a Model of Saturn
102, Collecting Micrometeorites

Quest:
Searching for a Star Space Invaders

Crosscutting Concepts

Scale, Proportion, and Quantity
• Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Astronomy and Space Science

SE/TE:
24, Apply It!
27, Figure 5, Seasons and Shadows
78-81, Models of the Solar System
80-81, Figure 1: Changing Models
84-85, Figure 1: The Solar System

TE Only:
27, Differentiated Instruction
81, Build Inquiry – Model the Movements of the Inner Planets
84, Teacher to Teacher
104, Teacher Demo – Model the Great Red Spot

TLR:
16, What Causes Day and Night?
16-26, Reasons for the Seasons
28, What’s Doing the Pulling?
32, Eclipses
34, Modeling the Moon’s Pull of Gravity
79, What Is at the Center?
80, Going Around in Circles
82, How Big Is Earth?
83-91, Speeding Around the Sun
92, Clumping Planets
96, Ring Around the Sun
98, Greenhouse Effect
99, How Big Are the Planets?
101, Make a Model of Saturn
103, Changing Orbits

Quest: Searching for a Star Space Invaders

Connections to Engineering, Technology, and Applications of Science

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

Astronomy and Space Science

SE/TE:
46-51, The Science of Rockets
52-61, The History of Space Exploration

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
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to the Next Generation Science Standards for Middle School

62-67, Using Space Science on Earth
72, One Ticket to Space, Please
73, Living in Space: The Expedition 18 Crew
82, Planet Diary – Extreme Conditions
128-131, What Are Telescopes and How Do They Work?

**TE Only:**
46A, Content Refresher – Atlas Rockets
48, Build Inquiry – Draw Conclusions About Rocket Propulsion Technologies
50, 21st Century Learning
51 Differentiated Instruction
51F, Enrich – The Science of Rockets
52A, Content Refresher – History of NASA
55, Build Inquiry – Apply the Concept of Moon Exploration
64, 21st Century Learning
67, Differentiated Instruction – L1 Make a Concept Map
67F, Enrich – Geostationary Orbits and Polar Orbits
129, Differentiated Instruction – L3 History of the Telescope
131, Teacher Demo – Locating Radio Waves

**TLR:**
49, Modeling Multistage Rockets
51, Humans in Space
54, Using Space Science
56-64, Space Spinoffs
65, Useful Satellites
11-125, Design and Build a Telescope

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
Students who demonstrate understanding can:

**Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** *(Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.)* *(Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.)*

**INTERACTIVE SCIENCE: In the Earth’s Surface module, the online Performance Expectation Activity “History of Earth (MS-ESS1-4)” addresses this performance expectation.**

The concept that fossils preserved in rock are a source of evidence about past life and environments on Earth is presented in the Earth’s Surface module in Chapter 4, Lesson 1, on SE/TE pages 104-109. How scientists use rock strata and fossil records to determine the relative ages of rocks is explored in “The Relative Age of Rocks” on SE/TE pages 110-115. How scientists use rock strata and the fossil record to develop the geologic time scale is described in Chapter 4, Lesson 4, on SE/TE pages 120-123. How scientists use radioactive dating of rocks to determine major events in Earth’s past, such as the formation of Earth and the formation of the continents, is discussed in “Early Earth” on SE/TE pages 124-127. The organization of the geologic time scale and the evolution of living organisms (including humans) is described in “Eras of Earth’s History” on SE/TE pages 128-139.

Students obtain information about the concepts of relative and absolute age of rock, along with the law of superposition for sedimentary layering, on SE/TE page 111. Students learn how igneous intrusion and faulting in rock strata can be used to determine the relative age of rock on SE/TE page 112. Gaps in the geologic record caused by erosion, deposition, and folding of rock strata are covered on SE/TE page 114-115. Students interpret diagrams of index fossils in rock strata in SE/TE “Figure 4 – Index Fossils” on SE/TE page 113. Students identify which organisms lived during specific geologic eras and geologic periods in “Figure 2 – The Geologic Time Scale” on SE/TE page 122 and in “Figure 6 – Geologic Periods” on SE/TE pages 136-139. Students interpret a diagram of rock layers in the Grand Canyon in “Enrich – A Young Canyon Made of Old Layers” on TE page 123E. Students describe the extinction of the dinosaurs in “Figure 4 – The End of the Dinosaurs” on SE/TE page 134. Students sequence events related to the formation of Earth’s oceans on SE/TE page 126. Students model layering and deformed rock sequences in “Which Layer Is the Oldest” on TLR page 104 and “How Did It Form?” on TLR page 114. Students model core samples of rock as evidence used to organize geologic time in “Exploring Geologic Time Through Core Samples” on TLR page 105-113.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| Constructing Explanations and Designing Solutions | **ESS1.C:** The History of Planet Earth  
- The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. **Earth’s Surface**  
**SE/TE:**  
108, What Do Fossils Show?  
110, How Old Are Rock Layers?  
111, Figure 1: Rock Layers in the Grand Canyon  
112, Figures 2 & 3: Intrusion, Fault  
112, Apply It!  
113, Index Fossils | **Scale Proportion and Quantity**  
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **Earth’s Surface**  
**SE/TE:**  
111, Figure 1: Rock Layers in the Grand Canyon  
113, Figure 4: Index Fossils  
114, Figure 5: Unconformities and Folding  
120, My Planet Diary – Earth’s History in a Day  
136, How Do Scientists Study Earth’s past? |

**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
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| SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource |
|---|---|---|
| 112, Apply It! | 114, How Can Rock Layers Change? | 139, Answer the Big Question |
| 113, Figure 4: Index Fossils | 114, Figure 5: Unconformities and Folding | **TE only:** |
| 115, Apply It! | 115, Apply It! | **TLR:** |
| 125, How Did Earth Form? | 116, What is Radioactive Dating? | 101, Fossils |
| 126, Sequence and Apply It! | 117, Half-Life | 102, Modeling Trace Fossils |
| 134, Figure 4: The End of the Dinosaurs | 118, What Is Radioactive Dating? | 103, Modeling the Fossil Record |
| **TE Only:** | 118, Do the Math | 105, Exploring Geologic Time Through Core Samples |
| 127E, Enrich – Life and Earth’s Atmosphere | 120, My Planet Diary | **Quest:** The Big Fossil Hunt |
| 139F, Enrich – The End of an Era | 145, Frozen Evidence | Fossils Around the World |
| **TLR:** | **TE Only:** | A Matter of Time |
| 100, What’s In a Rock? | 113, Build Inquiry, Compare Rock Samples | Time to Choose the Dig Site |
| 105–113, Exploring Geologic Time Through Core Samples | 115, Differentiated Instruction | Reflect on the Big Fossil Hunt |
| 114, How Did It Form? | 115, Make Analogies – Folding Layers Under | **Quest:** The Big Fossil Hunt |
| 124, Modeling an Asteroid Impact Quest: The Big Fossil Hunt | 119, Build Inquiry – Model Radioactive Dating | Fossils Around the World |
| Fossils Around the World | 123, Differentiated Instruction | Time to Choose the Dig Site |
| A Matter of Time | 123, Build Inquiry – Compare and Contrast Visuals | Reflect on the Big Fossil Hunt |
| Time to Choose the Dig Site | 123E, Enrich – The Geologic Time Scale | **TLR:** |
| Reflect on the Big Fossil Hunt | 127E, Enrich – Life and Earth’s Atmosphere | 100, What’s In a Rock? |
| | 129, 21st Century Learning | 104, Which Layer Is the Oldest? |
| | 139F, Enrich – The End of an Era | 105–113, Exploring Geologic Time Through Core Samples |
| | **TLR:** | 114, How Did It Form? |
| | 116, The Dating Game | 116, The Dating Game |
| | 117, How Old Is It? | 117, How Old Is It? |
| | 123, Graphing the Fossil Record | 123, Graphing the Fossil Record |
| | **Quest:** The Big Fossil Hunt | **Quest:** The Big Fossil Hunt |
| | Clues in the Rock Layers | Clues in the Rock Layers |
| | Fossils Around the World | Fossils Around the World |
| | A Matter of Time | A Matter of Time |
| | Time to Choose the Dig Site | Time to Choose the Dig Site |
| | Reflect on the Big Fossil Hunt | Reflect on the Big Fossil Hunt |
Students who demonstrate understanding can:

**Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales.** [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, air, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]

**INTERACTIVE SCIENCE:** In the *Earth’s Surface* module, the online Performance Expectation Activity “History of Earth (MS-ESS2-2)” addresses this performance expectation.

The processes of weathering, erosion, and deposition, and how these processes change Earth’s surface, are explored in Chapter 2, Lesson 1 and Chapter 3, Lesson 1-5 of the *Earth’s Surface* module. Students learn about erosion and deposition by water, air and wind in the Chapter 3 lessons on Water Erosion, Glacial Erosion, Wave Erosion, and Wind Erosion. Landslides and other forms of mass movement that change Earth’s surface are discussed in the Chapter 3 lesson on Mass Movement.

How forces deep inside Earth and at Earth’s surface build, destroy, and change rock on Earth’s surface (and in Earth’s crust) is discussed in Chapter 2, Lesson 6 “The Rock Cycle” on pages 62-65 of the module *Earth’s Structure*. The ways in which Earth’s tectonic plates move to change Earth’s surface both slowly and quickly are discussed in Chapter 3, “Plate Tectonics”, Chapter 4, “Earthquakes,” and Chapter 5, “Volcanoes.”

Changes to Earth’s surface on a much smaller scale, including the formation of minerals as the result of lava that cools quickly, are discussed in “How Do Minerals Form?” on pages 40-43 in the module *Earth’s Structure*. Changes due to the impact of meteorites are discussed in “Meteoroids” on page 115 of the *Astronomy and Space Science* module.

In the module *Earth’s Surface*, students **construct an explanation** for how creep affects Earth’s surface in Apply It! on SE/TE page 69. Students **interpret photos** to **construct an explanation** of how erosion by a river can change with the seasons in “Figure 3 – River Erosion” on SE/TE page 73. They **explain** how erosion and deposition can shape limestone caves in “Figure 8 – Groundwater Erosion and Deposition” on SE/TE page 78. They **explain** how waves erode by abrasion on page SE/TE pages 87. They **explain** to a classmate how a sea cave can become a sea arch in Apply It! on SE/TE page 89.

In the module *Earth’s Structure*, students **construct an explanation** for how plate motions acting over millions of years created the Himalayas in “Enrich – Sea-Floor Spreading” on TE page 85F. Students can **construct an explanation** for how the Appalachian Mountains formed in Differentiated Instruction on TE page 107. They **explain** the formation of fault-block mountains in “Figure 5 – Tension and Normal Faults” on SE/TE page 108 and the formation of plateaus in “Figure 6 – The Kaibab Plateaus” on SE/TE page 109. They **explain** how movement along faults can cause sudden changes in Earth’s crust in “Enrich – Evidence of Movement Along Faults” on TE page 109F. Students **construct an explanation based on evidence** to explain where volcanoes form on Earth when they revise their hypotheses in “Figure 1 – The Ring of Fire” on SE/TE page 135. Students **explain** how different types of volcanoes form in “Figure 2 – Volcanic Mountains” on SE/TE page 148.

On page 40 of the TLR *Earth’s Surface*, students **construct an explanation based on evidence** of chemical weathering in “Rusting Away.” Students **use evidence** from their own observations to **explain** the force involved in landslides and erosion in the Open Inquiry version of the lab “Sand Hills” on pages 72-75. Students **use evidence** from their own observations to **construct an explanation** for the effect glaciers can have on Earth’s surface in “How Do Glaciers Change the Land?” on TLR page 79. Students **explain** how a model of erosion by wind can be used to infer how wind affects sediments on Earth’s surface in “How Does Moving Air Affect Sediment?” on TLR page 84.

In the TLR *Earth’s Structure*, students **use evidence** from their own observations to **construct an explanation** for how Earth’s surface changes when tectonic plates collide in “Plate Interactions” on TLR page 85. Students use their own observations to **construct an explanation** for how lava changes Earth’s surface in “How Do Volcanoes Change Land?” on TLR page 137. Students **model** how the cooling and hardening of magma beneath Earth’s surface can eventually change Earth’s surface in “How Can Volcanic Activity Change Earth’s Surface?” on TLR page 139.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education.*
### Science and Engineering Practices

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

### Disciplinary Core Ideas

**ESS2.A: Earth’s Materials and Systems**

- The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future.

### Earth’s Structure

**SE/TE**

8, Figure 3: From Sea to Mountain
65, Apply It!
94, Apply the Big Question
105, Apply It!
108, Figure 5: Tension and Normal Faults
109, Figure 6: The Kaibab Plateau
135, Figure 1: The Ring of Fire

**TE Only:**

109F, Enrich – Evidence of Movement Along Faults
137D, Review and Reinforce – Understanding Main Ideas

**TLR:**

40, How Does the Rate of Cooling Affect Crystals?
85, Plate Interactions
137, How Do Volcanoes Change Land?

**STEMQuest:** To Hike or Not to Hike Patterns in the Cascade Range Mount Rainier’s Threat Monitoring a Volcano Signs of Eruption?

### Earth’s Surface

**SE/TE**

38-39, What Breaks Down Rock?
69, Apply It!

**TLR:**

40, Rusting Away
67-75, Sand Hills
79, How Do Glaciers Change the Land?
84, How Does Moving Air Affect Sediment

### Crosscutting Concepts

**Scale, Proportion, and Quantity**

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

**Earth’s Structure**

**SE/TE:**

106, Figure 1: Folded Rock

**TE Only:**

89, Teacher Demo – Make a Model of Plates
107, Teacher Demo – Modeling Synclines and Anticlines
149, Build Inquiry – Make Models of Composite Volcanoes

**TLR:**

11, What Forces Shape Earth?
63, Recycling Rocks
72, Moving the Continents
76-84, Modeling Sea-Floor Spreading
85, Plate Interactions
100, Modeling Faults
101, Modeling Stress
124, Moving Volcanoes
137, How Do Volcanoes Change Land?
139, How Can Volcanic Activity Change Earth’s Surface?

**STEMQuest:** To Hike or Not to Hike Patterns in the Cascade Range Mount Rainier’s Threat Monitoring a Volcano Signs of Eruption?

**Earth’s Surface**

**SE/TE:**

75, Figure 5: Oxbow Lakes

**TE Only:**

45, Differentiated Instruction – L3 Use Maps
69, Teacher Demo – Modeling Mass Movement
69, Differentiated Instruction – Make Dioramas
89, Teacher Demo – Model Wave Refraction

**TLR:**

55, Soil Conservation
67-75, Sand Hills
76, How Does Moving Water Wear Away Rock?
79, How Do Glaciers Change the Land?
### Chapter Activities and Projects
234–237, Plates Move!

<table>
<thead>
<tr>
<th>Earth’s Surface</th>
<th>Water and the Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>38–45, Rocks and Weathering</td>
<td>52–53, How Do Waves Affect the Shore?</td>
</tr>
<tr>
<td>49, The Process of Soil Formation</td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>51, Figure 4– From Rock to Soil</td>
<td>9F, Enrich – Evaporation, Precipitation, and Runoff</td>
</tr>
<tr>
<td>66-69, Mass Movement</td>
<td>53, Build Inquiry</td>
</tr>
<tr>
<td>80-85, Glacial Erosion</td>
<td>59E, Enrich – The Sargasso Sea</td>
</tr>
<tr>
<td>86-89, Wave Erosion</td>
<td>187, Differentiated Instruction – L1 Pangaea</td>
</tr>
<tr>
<td>90-93, Wind Erosion</td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>124-127, Early Earth</td>
<td></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td></td>
</tr>
<tr>
<td>43, Teacher Demo – Chemical Weathering</td>
<td></td>
</tr>
<tr>
<td>69E, Enrich – It’s Creepy!</td>
<td></td>
</tr>
<tr>
<td>77, Build Inquiry – Illustrate River Environments</td>
<td></td>
</tr>
<tr>
<td>89D, Review and Reinforce – Understanding Main Ideas</td>
<td></td>
</tr>
<tr>
<td>89E, Enrich – My Beach Is Shrinking!</td>
<td></td>
</tr>
<tr>
<td>93E, Enrich – Kinds of Sand Dunes</td>
<td></td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td></td>
</tr>
<tr>
<td>39, Freezing and Thawing</td>
<td></td>
</tr>
<tr>
<td>40, Rusting Away</td>
<td></td>
</tr>
<tr>
<td>52, The Contents of Soil</td>
<td></td>
</tr>
<tr>
<td>66, Weathering and Erosion</td>
<td></td>
</tr>
<tr>
<td>76, How Does Moving Water Wear Away Rock?</td>
<td></td>
</tr>
<tr>
<td>77, Raindrops Falling</td>
<td></td>
</tr>
<tr>
<td>79, How Do Glaciers Change the Land?</td>
<td></td>
</tr>
<tr>
<td>81, Modeling Valleys</td>
<td></td>
</tr>
<tr>
<td>83, Shaping a Coastline</td>
<td></td>
</tr>
<tr>
<td>84, How Does Moving Air Affect Sediment?</td>
<td></td>
</tr>
<tr>
<td>100, What’s In a Rock?</td>
<td></td>
</tr>
<tr>
<td>120, How Could Planet Earth Form in Space?</td>
<td></td>
</tr>
<tr>
<td>81, Modeling Valleys</td>
<td></td>
</tr>
<tr>
<td>83, Shaping a Coastline</td>
<td></td>
</tr>
<tr>
<td>84, How Does Moving Air Affect Sediment?</td>
<td></td>
</tr>
</tbody>
</table>
ESS2.C: The Roles of Water in Earth’s Surface Processes

- Water’s movements—both on the land and underground—cause weathering and erosion, which change the land’s surface features and create underground formations.

Earth’s Structure

SE/TE:
52-53, How Do Sedimentary Rocks Form?

TLR:
51, What Causes Layers

STEMQuest: To Hike or Not to Hike
Mount Rainier’s Threat
Monitoring a Volcano
Signs of Eruption?

Earth’s Surface

SE/TE:
40-43, What Causes Weathering?
44-45, How Fast Does Weathering Occur?
52-55, Soil Conservation
56-67, What Processes Wear Down and Build Up Earth’s Surface?
70-79, Water Erosion
80-85, Glacial Erosion
86-89, Wave Erosion
98, Floodwater Fallout

TE Only:
42, 21st Century Learning
43, Teacher Demo – Chemical Weathering
55, 21st Century Learning
69E, Enrich – It’s Creepy!
71, Lead a Discussion
74, 21st Century Learning
75, Differentiated Instruction – L3 Locate River Features
76, Build Inquiry – Compare and Contrast Deltas
77, Differentiated Instruction – L1 Describe River Features
79, Address Misconceptions
89, Differentiated Instruction – L3 Investigate Beach Erosion
89E, Enrich – My Beach is Shrinking!

TLR:
39, Freezing and Thawing
53, How Can You Keep Soil From Washing Away?
55, Soil Conservation
<table>
<thead>
<tr>
<th><strong>Weathering and Erosion</strong></th>
<th><strong>Water and the Atmosphere</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>66, Weathering and Erosion</td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>77, Raindrops Falling</td>
<td>18-23, Water Underground</td>
</tr>
<tr>
<td>78, Erosion Cube</td>
<td>52-53, How Do Waves Affect the Shore?</td>
</tr>
<tr>
<td>79, How Do Glaciers Change the Land?</td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>81, Modeling Valleys</td>
<td>23E, Enrich – Evaporation, Precipitation, and Runoff</td>
</tr>
<tr>
<td>83, Shaping a Coastline</td>
<td>53, Build Inquiry – Model Barrier Beaches</td>
</tr>
<tr>
<td></td>
<td>53E, Enrich – How Far From Shore Do Waves Break?</td>
</tr>
</tbody>
</table>
Students who demonstrate understanding can:

- Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]

**INTERACTIVE SCIENCE:** In the *Earth’s Structure* module, the online Performance Expectation Activity "History of Earth (MS-ESS2-3)" addresses this performance expectation.

The theory of plate tectonics is explored in Chapter 3, Lesson 1 of the *Earth’s Structure* module. The chapter opens with Alfred Wegener's ideas on continental drift and presents the evidence for his hypothesis based on fossils, land features, and climate on SE/TE pages 77-79. Students obtain information about seafloor structures that evidence plate motions on SE/TE pages 81-85. Plate motions are presented in Lesson 3 on SE/TE pages 86-91.

Students interpret maps to indicate how the shapes of continents fit together in "Figure 1: Piecing It All Together" on SE/TE page 77. Students analyze and interpret data for continental drift, including distribution of fossils and rocks, on SE/TE pages 78 and 79. On TE page 79, students use knowledge available in the 1900s to debate the theory of continental drift. In Elaborate, TE page 78, students make models of continents and recreate the drift. On SE/TE page 79, Differentiated Instruction, students create models of the continents motion through a flip book. On TE page 79, students interpret locations where fossils of Mesosaurus have been found to support the theory of continental drift. Students research a major change in Earth’s surface caused by plate movement in “An Ocean Is Born” on SE/TE page 97.

The performance expectation above was 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 6-8 builds on K-5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - Analyze and interpret data to provide evidence for phenomena.

**Earth’s Structure**

**SE/TE:**
- 78, Figure 2: Pangaea and Continental Drift
- 79, Apply It!
- 122–123, Figure 3: Earthquakes Around the World
- 135, Figure 1: The Ring of Fire

**TE Only:**
- 79, Differentiated Instruction – Debate Continental Drift
- 83, Differentiated Instruction – Cause and Effect Table
- 91E, Enrich – Magnetic Reversals Through the Ages
- 123E, Enrich – Earthquake Probability

**Disciplinary Core Ideas**

- ESS1.C: The History of Planet Earth
  - Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (secondary to MS-ESS2-3)

**Earth’s Structure**

**SE/TE:**
- 80-85, Sea-Floor Spreading
- 82-83, Figure 2: Sea-Floor Spreading
- 84, Figure 3: Subduction
- 86-91 What is the Theory of Plate Tectonics?
- 87, Figure 1: Earth’s Plates
- 88, Figure 2: Plate Motion
- 89, Figure 3: Breaking Up Is Hard to Do
- 90, Figure 4: The Andes
- 90-91, Figure 6: Earth’s Changing Crust
- 91, Figure 5: Fault Line
- 97, An Ocean Is Born
- 134-137, Where Are Volcanoes Found on Earth’s Surface?
- 135, Figure 1: The Ring of Fire
- 136, Figure 2: Volcanoes and Converging Boundaries

**Crosscutting Concepts**

- Patterns
  - Patterns in rates of change and other numerical relationships can provide information about natural systems.

**Earth’s Structure**

**SE/TE:**
- 88, Plate Motions Over Time
- 88, Figure 2: Plate Motion
- 89, Do the Math!
- 121, Apply It!
- 122–123, Figure 3: Earthquakes and Plate Tectonics
- 144, Figure 5: Cascade Volcanoes

**TE Only:**
- 83, Build Inquiry – Infer
- 89F, Enrich – The Birth of the Himalayas
- 91E, Enrich – Magnetic Reversals Through the Ages
- 123E, Enrich – Earthquake Probability

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SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
### Connections to Nature of Science

**Scientific Knowledge is Open to Revision in Light of New Evidence**
- Science findings are frequently revised and/or reinterpreted based on new evidence.

**Earth’s Structure**

**SE/TE:**
- 79, Wegener’s Hypothesis Rejected
- 135, Figure 2: The Ring of Fire
- 157, An Explosive Secret

**TE Only:**
- 76A, Content Refresher
- 77, Support the Big Question
- 77, 21st Century Learning

**TLR:**
- 72, Moving the Continents

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**TE Only:**
- 84, Make Analogies – Ocean Conveyor Belt
- 85, Differentiated Instruction – Ocean Floor Drawing
- 85E, Understanding Main Ideas
- 89, Differentiated Instruction – L3 Rift Valleys

**TLR:**
- 74, Mid-Ocean Ridges
- 76-84, Modeling Sea-Floor Spreading
- 85, Plate Interactions
- 125, Where Are Volcanoes Found on Earth’s Surface?

**ESS2.B: Plate Tectonics and Large-Scale System Interactions**
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart.

**Earth’s Structure**

**SE/TE:**
- 78, Figure 2: Pangaea and Continental Drift
- 88, Figure 2: Plate Motion

**TE Only:**
- 77, ELL Support: Comprehensible Input
- 85F, Enrich – The Birth of the Himalayas
- 91, Differentiated Instruction – L3 Create a Timeline

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A Correlation of  
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment  
to the Next Generation Science Standards for Middle School

MS.Earth’s Systems  
MS-ESS2-1

Students who demonstrate understanding can:  
**Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.** [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]

**INTERACTIVE SCIENCE:** In the Earth’s Structure module, the online Performance Expectation Activity "Earth Systems (MS-ESS2-1)" addresses this performance expectation.

An overview of how Earth’s materials cycle through the Earth system is given in the Earth’s Structure module, Chapter 1, Lesson 1, SE/TE page 5. The role constructive and destructive forces play in cycling Earth’s materials by creating and destroying Earth’s surface is presented on SE/TE pages 8-9. Information on the chemical and physical processes (including crystallization) that form minerals is given in the section “How Do Minerals Form?” in Chapter 2, Lesson 1 on SE/TE pages 40-42. An overview of how igneous, sedimentary, and metamorphic rocks form is given in the “Origin” section of Chapter 2, Lesson 2 on SE/TE page 47. Students learn further information about igneous rocks, on SE/TE pages 48-50. Sedimentary rocks, including the roles weathering and sedimentation play in their formation, are discussed on SE/TE pages 52-56. Metamorphic rocks and their formation via deformation are presented on SE/TE pages 58-60. A discussion of the processes of the rock cycle, including melting, weathering, erosion, deposition, and metamorphism, is included in Chapter 2, Lesson 6 "The Rock Cycle” on SE/TE pages 62-65.

A discussion of the cycling of materials as the result of weathering of rocks is included in Chapter 2, Lesson 1 "Rocks and Weathering" of the Earth’s Surface module, on SE/TE pages 38-45. Erosion and deposition are further discussed in Chapter 3, Lesson 1 (Mass Movement), Lesson 2 (Water Erosion), Lesson 3 (Glacial Erosion), Lesson 4, (Wave Erosion), and Lesson 5 (Wind Erosion), on SE/TE pages 62-93.

The flow of heat energy inside Earth is discussed in the Earth’s Structure module, Lesson 3, “Convection and the Mantle.” On SE/TE pages 20-21, students learn how heating and cooling of a fluid, changes in the fluid’s density, and the force of gravity combine to set convection currents in motion, driving the movement of Earth’s plates. This concept is further explained in “Support the Big Question” on TE page 20. Students interpret diagrams to explain how convection in Earth’s mantle might drive motion in Earth’s crust in “Enrich – What’s Happening During Convection?” on TE page 21E. Structures and processes driven by this flow of energy, including the formation of mid-ocean ridges, sea-floor spreading, subduction, and the formation of deep-ocean trenches, are explored in Chapter 3, Lesson 2 "Sea-Floor Spreading" on SE/TE pages 80-85. Students make and develop a model of the flow of heat energy within Earth’s mantle in “Modeling Mantle Convection Currents” on TLR pages 17-24. Students make a model showing how the rock cycle can break rock into sediment that later can cycle back to form new rock in “Recycling Rocks” on page 63 of the Earth’s Structure TLR. Students make and develop a model describing sea-floor spreading and explore how sea-floor spreading and subduction work together in a cycle that creates and destroys rock in “Modeling Sea-Floor Spreading” on TLR pages 76-84.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<tr>
<td>Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.</td>
<td>• Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.</td>
</tr>
<tr>
<td>• Develop and use a model to describe phenomena.</td>
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<td><strong>Earth’s Structure</strong></td>
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<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>20, Convection Currents</td>
<td>4-9, The Earth System</td>
<td>4-9, The Earth System</td>
</tr>
<tr>
<td>212, Figure 3 – Mantle Convection</td>
<td>18-21, Convection and the Mantle</td>
<td>5, Figure 1: All Systems Go!</td>
</tr>
<tr>
<td>64, Figure 2 – The Rock Cycle</td>
<td>40-42, How Do Minerals Form?</td>
<td>65, The Rock Cycle and Plate Tectonics</td>
</tr>
<tr>
<td>65, Apply It!</td>
<td>47, Origin</td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td>47, Figure 2: Rock Origins</td>
<td>61E, Enrich – The Metamorphic Rocks</td>
</tr>
<tr>
<td>21, Differentiated Instruction – L1 Model Convection Currents</td>
<td>48-50, How Do Geologists Classify Igneous Rocks?</td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>57, Differentiated Instruction – Model Rock Formation</td>
<td>49, Figure 1: Igneous Rock Origins and Textures</td>
<td>17-24, Modeling Mantle Convection Currents</td>
</tr>
<tr>
<td>64, Teacher to Teacher – Describe the Rock Cycle</td>
<td>53, Figure 1: How Sedimentary Rock Forms</td>
<td>61, A Sequined Rock</td>
</tr>
<tr>
<td>65, Differentiated Instruction – L3 Make Sequence Drawings</td>
<td>54-56, What Are the Three Major Types of Sedimentary Rocks?</td>
<td><strong>Earth’s Surface</strong></td>
</tr>
<tr>
<td>83, Build Inquiry – Model of the Ocean Floor</td>
<td>58-60, What Are Metamorphic Rocks</td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td>62-65, What Is the Rock Cycle?</td>
<td>68-69, What Are the Different Types of Mass Movement?</td>
</tr>
<tr>
<td>11, What Forces Shape Earth?</td>
<td>63, Figure 1: Stone Mountain</td>
<td>68, Figure 1: Mass Movement</td>
</tr>
<tr>
<td>17, Modeling Mantle Convection Currents</td>
<td>64, Figure 2: Be a Rock Star!</td>
<td>69, Apply It!</td>
</tr>
<tr>
<td>40, How Does the Rate of Cooling Affect Crystals?</td>
<td>80-85, Sea-Floor Spreading</td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>46, Liquid to Solid</td>
<td>83, Figure 2: Sea-Floor Spreading</td>
<td>69, Teacher Demo – Modeling Mass Movement</td>
</tr>
<tr>
<td>50, How Does Pressure Affect Particles of Rock?</td>
<td>84, Figure 3: Subduction</td>
<td>89, Teacher Demo – Model Wave Refraction</td>
</tr>
<tr>
<td>63, Recycling Rocks</td>
<td>84, Apply it!</td>
<td>89E, Enrich – My Beach Is Shrinking!</td>
</tr>
<tr>
<td>76-84, Modeling Sea-Floor Spreading</td>
<td><strong>TE Only:</strong></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>101, Modeling Stress</td>
<td>21E, Enrich – Convection and the Mantle</td>
<td>65, How Does Gravity Affect Materials on a Slope?</td>
</tr>
<tr>
<td><strong>Earth’s Surface</strong></td>
<td>51E, Enrich – The Same, But Different</td>
<td>67-74, Sand Hills</td>
</tr>
<tr>
<td><strong>SE/TE:</strong></td>
<td>57F, Enrich – The Formation of Coal</td>
<td>83, Shaping a Coastline</td>
</tr>
<tr>
<td>67, Relate Text and Visuals</td>
<td>61, Teacher Demo – Model Foliated Rock</td>
<td><strong>Ecology and the Environment</strong></td>
</tr>
<tr>
<td>72, Figure 2 – Stream Formation</td>
<td>61E, Enrich – The Metamorphic Rocks</td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>75, Figure 5 – Oxbow Lakes</td>
<td>65E, Enrich – Alternate Pathways</td>
<td>29, Figure 1 – Primary Succession</td>
</tr>
<tr>
<td>77, Figure 7 – Rolling Through the Hills</td>
<td>83, Build Inquiry – Model of the Ocean Floor</td>
<td>30, Apply It!</td>
</tr>
<tr>
<td>82, Apply It!</td>
<td><strong>TLR:</strong></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>83, Figure 2 – Glacial Erosion</td>
<td>11, What Forces Shape Earth?</td>
<td>42, Observing Decomposition</td>
</tr>
<tr>
<td>84, Figure 3 – Glacial Landforms</td>
<td>17, Modeling Mantle Convection Currents</td>
<td>55, Playing Nitrogen Cycle Roles</td>
</tr>
<tr>
<td>87, Figure 1 – Wave Erosion</td>
<td>40, How Does the Rate of Cooling Affect Crystals?</td>
<td></td>
</tr>
<tr>
<td>88, Figure 2 – The Changing Coast</td>
<td>44, How Do Rocks Compare?</td>
<td></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td>45, Classify These Rocks</td>
<td></td>
</tr>
<tr>
<td>43, Differentiated Instruction – Model Surface Area</td>
<td>46, Liquid to Solid</td>
<td></td>
</tr>
<tr>
<td>69, Teacher Demo – Modeling Mass Movement</td>
<td>47, How Do Igneous Rock Form?</td>
<td></td>
</tr>
<tr>
<td>85, Differentiated Instruction – Model Glacial Landforms</td>
<td>49, Acid Test for Rocks</td>
<td></td>
</tr>
<tr>
<td>89, Teacher Demo – Model Wave Refraction</td>
<td>50, How Does Pressure Affect Particles of Rock?</td>
<td></td>
</tr>
<tr>
<td>93E, Enrich – Kinds of Sand Dunes</td>
<td>51, What Causes Layers</td>
<td></td>
</tr>
<tr>
<td><strong>SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource</strong></td>
<td>62, How Do Grain Patterns Compare?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>63, Recycling Rocks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>64, Which Rock Came First?</td>
<td></td>
</tr>
<tr>
<td>TLR:</td>
<td>SE/TE:</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td>76, How Does Moving Water Wear Away Rocks?</td>
<td>38, Rocks and Weathering</td>
<td></td>
</tr>
<tr>
<td>79, How Do Glaciers Change the Land?</td>
<td>42, Figure 3 – Weathering and</td>
<td></td>
</tr>
<tr>
<td>81, Modeling Valleys</td>
<td>Surface Area</td>
<td></td>
</tr>
<tr>
<td>84, How Does Moving Air Affect Sediment?</td>
<td>46–51, How Soil Forms</td>
<td></td>
</tr>
<tr>
<td>85, Desert Pavement</td>
<td>51, Figure 4: From Rock to Soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>66-69, Mass Movement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70-79, Water Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>73, Figure 3: River Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76, Figure 6: Deposits by Rivers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>78, Figure 8: Groundwater</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Erosion and Deposition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80-85, Glacial Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>82, Apply It!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>86-89, Wave Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>87, Figure 1 – Wave Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>88-89, Figure 2 – The Changing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>89, Apply It!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90-93, Wind Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>41, Teacher Demo – Mechanical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weathering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>43, Teacher Demo – Chemical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weathering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>69E, Enrich – It’s Creepy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and Distributary Channels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>79, Differentiated Instruction – L1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compare and Contrast Table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>87, Make Analogies – Wave</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abrasion</td>
<td></td>
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<tr>
<td></td>
<td>89, Teacher Demo – Model Wave</td>
<td></td>
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<tr>
<td></td>
<td>Refraction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>89E, Enrich – My Beach Is</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shrinking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>93E, Enrich – Kinds of Sand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dunes</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TLR:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39, Freezing and Thawing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41, It’s All on the Surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42, What Is Soil?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>52, The Contents of Soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>66, Weathering and Erosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76, How Does Moving Water Wear</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Away Rocks?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>79, How Do Glaciers Change the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>81, Modeling Valleys</td>
<td></td>
</tr>
<tr>
<td></td>
<td>83, Shaping a Coastline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>84, How Does Moving Air Affect</td>
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<tr>
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<td>Sediment?</td>
<td></td>
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<td></td>
<td>85, Desert Pavement</td>
<td></td>
</tr>
</tbody>
</table>

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
Ecology and the Environment
SE/TE:
29, Primary Succession
30–31, Secondary Succession
42–49, Energy Flow in Ecosystems
46, Figure 3 – Food Chain
47, Figure 4 – Food Web
48, Figure 5 – Energy Pyramid
50–51, What Processes Are Involved in the Water Cycle?
52–53, How Are the Carbon Cycle and Oxygen Cycle Related?
53, Figure 2 – Carbon and Oxygen Cycles
54–55, How Does Nitrogen Cycle Through Ecosystems?
Figure 4, Nitrogen Cycle
56–57, Figure 5 – Cycles of Matter
130, Figure 2: Structure of Fertile Soil

TE Only:
45, Differentiated Instruction – L1 Concept Map
49E, Enrich – Energy Flow in Ecosystems
53, Differentiated Instruction – L3 Research Effects of Carbon Dioxide in the Atmosphere

TLR:
42, Observing Decomposition
53, Following Water
55, Playing Nitrogen Cycle Roles
Students who demonstrate understanding can:

**Develop a model to describe the cycling of water through Earth’s systems by energy from the sun and the force of gravity.** [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

**INTERACTIVE SCIENCE:** In the *Water and Atmosphere* module, the online Performance Expectation Activity “Earth’s Systems (MS-ESS2-4)” addresses this performance expectation.

The water cycle is presented in the *Water and the Atmosphere* module in Chapter 1, Lesson 1, “Water on Earth” on SE/TE pages 8-9. Students **learn** how the sun’s energy is the driving force for the water cycle in Chapter 4, Lesson 1, “Water in the Atmosphere” on SE/TE pages 118-119. They **obtain knowledge** about how water changes state during the process that forms clouds in Chapter 4, Lesson 2 “Clouds” on SE/TE pages 122-125. They **learn** how water changes state during the formation of rain, freezing rain, snow, hail, and sleet in Chapter 4, Lesson 3 “Precipitation” on SE/TE pages 126-129.

Students **model** the water cycle by completing a diagram in “Figure 3 – The Water Cycle” on SE/TE pages 8-9. In the Differentiated Instruction activity, TE page 9, students **describe** the roles gravity and the sun’s energy play in the water cycle. In the RTI activity, TE page 9, students **model** the water cycle pathway by drawing a diagram. Students **model** the water cycle by drawing a cycle diagram in “Figure 6 – An Endless Cycle” on SE/TE page 17. On SE/TE page 119, students **model** the water cycle pathway in Figure 1, Summarize. They **interpret** diagrams to **model** how clouds form in “Figure 1 – How Clouds Form” on SE/TE page 123. They **review** how cold the air temperature needs to be in order for specific types of precipitation to fall in “Figure 3 – Freezing and Precipitation” on SE/TE page 128. They **investigate** the distribution of water on Earth on TLR page 14. They **investigate** the role of trees in the water cycle in “Water From Trees” on TLR, pages 15-23. Students **model** evaporation of liquid water by heat energy in “Where Did the Water Go?” on TLR page 114. They **observe** how water vapor changes into liquid water in “Water in the Air” on TLR page 115. Students **model** the formation of a cloud in “How Clouds Form” on TLR page 118. They model the formation of hail in “How Can You Make Hail?” on TLR page 120. They **observe** how liquid water crystallizes into ice on TLR page 120. They **model** the water cycle in “Following Water” on page 53 of the TLR *Ecology and the Environment*.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>ESS2.C: The Roles of Water in Earth’s Surface Processes</strong></td>
<td><strong>Energy and Matter</strong></td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.</td>
<td>• Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.</td>
</tr>
<tr>
<td><strong>Water and the Atmosphere</strong></td>
<td><strong>Water and the Atmosphere</strong></td>
<td><strong>Water and the Atmosphere</strong></td>
</tr>
<tr>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>8–9, Figure 3: The Water Cycle</td>
<td>8–9, What Is the Water Cycle?</td>
<td>8–9, What Is the Water Cycle?</td>
</tr>
<tr>
<td>17, Figure 6: An Endless Cycle</td>
<td>8–9, Figure 3: The Water Cycle</td>
<td>118–199, How Does Water Move Through the Atmosphere?</td>
</tr>
<tr>
<td>119, Figure 1: The Water Cycle</td>
<td>17, Figure 6: An Endless Cycle</td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>123, How Clouds Form</td>
<td>118–119, How Does Water Move Through the Atmosphere?</td>
<td>9, Differentiated Instruction</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
<td>119, Figure 1: The Water Cycle</td>
<td></td>
</tr>
<tr>
<td>12, Where Does the Water Come</td>
<td>122–125, Clouds</td>
<td></td>
</tr>
<tr>
<td>From?</td>
<td>123, Figure 3: How Clouds Form</td>
<td></td>
</tr>
<tr>
<td>15, Water From Trees</td>
<td>126–131, Precipitation</td>
<td></td>
</tr>
<tr>
<td>114, Where Did the Water Go?</td>
<td>128–129, Figure 3: Freezing Precipitation</td>
<td></td>
</tr>
</tbody>
</table>

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
<table>
<thead>
<tr>
<th>Ecology and the Environment</th>
<th>Water and the Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLR: 53, Following Water</td>
<td>8-9, What Is the Water Cycle?</td>
</tr>
<tr>
<td></td>
<td>8-9, Figure 3: The Water Cycle</td>
</tr>
<tr>
<td></td>
<td>54-59, Currents and Climate</td>
</tr>
<tr>
<td></td>
<td>118-119, How Does Water Move Through the Atmosphere?</td>
</tr>
<tr>
<td></td>
<td>119, Figure 1: The Water Cycle</td>
</tr>
<tr>
<td></td>
<td>122-125, Clouds</td>
</tr>
<tr>
<td></td>
<td>123, Figure 3: How Clouds Form</td>
</tr>
<tr>
<td></td>
<td>126-131, Precipitation</td>
</tr>
<tr>
<td></td>
<td>128-129, Figure 3: Freezing Precipitation</td>
</tr>
</tbody>
</table>

**TE Only:**

9, Differentiated Instruction
9, RTI
93, Enrich – Understanding Main Ideas
9F, Enrich – Evaporation, Precipitation, and Runoff
131E, Enrich – Snow Crystals

**TLR:**

12, Where Does the Water Come From?
15-22, Water From Trees
114, Where Did the Water Go?
115, Water in the Air
120, How Can You Make Hail?

**ESS2.C: The Roles of Water in Earth’s Surface Processes**

- Global movements of water and its changes in form are propelled by sunlight and gravity.

### Water and the Atmosphere

- 8-9, What Is the Water Cycle?
- 8-9, Figure 3: The Water Cycle
- 54-59, Currents and Climate
- 118-119, How Does Water Move Through the Atmosphere?
- 119, Figure 1: The Water Cycle
- 122-125, Clouds
- 123, Figure 3: How Clouds Form
- 126-131, Precipitation
- 128-129, Figure 3: Freezing Precipitation

**TE Only:**

9, Differentiated Instruction
9, RTI
57, Differentiated Instruction
93, Enrich – Understanding Main Ideas
9F, Enrich – Evaporation, Precipitation, and Runoff
59E, Enrich – The Sargasso Sea
131E, Enrich – Snow Crystals

**TLR:**

15-22, Water From Trees
49-57, Modeling Ocean Currents
58, Deep Currents
114, Where Did the Water Go?
115, Water in the Air
120, How Can You Make Hail?
Students who demonstrate understanding can:

**Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.**

[Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

**INTERACTIVE SCIENCE:** In the *Earth’s Surface* module, the online Performance Expectation Activity “Earth Systems (MS-ESS3-1)” addresses this performance expectation.

The various processes that lead to the formation and distribution of minerals are described in the *Earth’s Structure* module, Chapter 2, Lesson 1, “Properties of Minerals,” on SE/TE pages 40-43. Students **construct a scientific explanation** for the process by which minerals form in geodes in “Figure 10: Geodes” on SE/TE page 40. Students can **discuss** the types of minerals that form in Death Valley in “Differentiated Instruction: Death Valley Minerals” on TE page 41. Students **research** the distribution of evaporative mineral deposits in the United States in “Differentiated Instruction: Mineral Map” on TE page 41. A world map showing the distribution of mineral resources appears on SE/TE page 43. Students **match** minerals to the variety of geologic processes responsible for their formation on SE/TE page 42. Students **model** the effects of mining on landscapes in “How Does Mining Affect the Land?” in the *Ecology and the Environment* TLR on page 107. Students **analyze** costs of mining ores in “Enrich: The Copper Basin” on TE page 133E.

Students **learn** about the distribution of methane hydrates, their possible importance as a new energy resource, and the geoscience processes by which they are formed in the Lead a Discussion activity on TE page 164 in the *Ecology and the Environment* module. The formation of traditional energy resources, including coal, oil, and natural gas, is described in Chapter 5, Lesson 1 “Fossil Fuels” on SE/TE pages 178-184. The uneven distribution of fossil fuels is described on SE/TE page 185. The reason fossil fuels are considered nonrenewable is described on SE/TE page 185. The formation of coal is also described in the *Earth’s Surface* module, Chapter 4, Lesson 6, “Eras of Earth’s History.” In this module, 21st Century Learning, SE/TE page 131, students **locate** the coal deposits in North America that formed during the Carboniferous.

Soil resources are described in the *Earth’s Surface* module in “The Process of Soil Formation” on SE/TE page 49. Students **construct a scientific explanation** for the distribution of soil resources in “Figure 2: Soil Layers” on SE/TE page 49. The relationship between volcanic activity and soil fertility is described in the “Apply It!” activity in the *Earth’s Structure* module on SE/TE page 149. The distribution of soil as a function of climate is described in “Enrich – Different Soils for Different Climates” on TE page 51E. Soil damage, loss, and conservation as a result of human impacts is discussed in Chapter 2, Lesson 4 “Soil Conservation” on SE/TE page 52-55.

The distribution of water on Earth is described in the *Water and the Atmosphere* module, SE/TE pages 6-7 “Where Is Water Found?” Students **construct a scientific explanation** for the distribution of water into zones in “Figure 2: Groundwater Formation” on SE/TE page 20. A discussion of the distribution of water into aquifers is provided SE/TE pages 21-23. Students **interpret data** related to how humans use water in “Do the Math!” on SE/TE page 21. Students **draw** on a diagram to indicate where they would put a regular well and an artesian well in order to obtain fresh water in “Figure 3 – Springs and Wells” on SE/TE pages 22-23. The ways in which humans are affecting water resources, including water shortages and water pollution, is discussed in the *Ecology and the Environment* module in Chapter 4, Lesson 4 “Water Pollution and Solution” on SE/TE pages 152-159.

A discussion of renewable versus nonrenewable resources and the impact of humans on these resources can be found in the *Ecology and the Environment* module, Chapter 3, Lesson 1 “Introduction to Natural Resources” on SE/TE pages 92-97.
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

### Science and Engineering Practices

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

### Disciplinary Core Ideas

#### ESS3.A: Natural Resources

- Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

#### Earth’s Structure

**SE/TE:**

- 40, Figure 10: Geodes
- 43, Where Mineral Resources Are Found
- 55, Organic Rocks
- 55, Figure 3: Organic Rocks
- 51, What Causes Layers?

**TE Only:**

- 40-43, How Do Minerals Form?
- 4, Figure 12: Where Minerals Form
- 41, Differentiated Instruction: L1 Death Valley Minerals
- 41, Differentiated Instruction: L3 Mineral Map
- 43, Differentiated Instruction: L3 Debate
- 57F, Enrich – The Formation of Coal
- 57E, Enrich – Alternate Pathways

**TLR:**

- 51, What Causes Layers?
- 40, Figure 10: Geodes
- 156, Figure 3: Wastewater Treatment

### Crosscutting Concepts

#### Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

#### Earth’s Structure

**SE/TE:**

- 40, Figure 10: Geodes
- 51, What Causes Layers?

**TE Only:**

- 40-43, How Do Minerals Form?
- 4, Figure 12: Where Minerals Form
- 55, Organic Rocks
- 55, Figure 3: Organic Rocks

**TLR:**

- 51, What Causes Layers?

#### Earth’s Surface

**SE/TE:**

- 23, Relate Cause and Effect
- 29, Figure 1 – Primary Succession
- 30, An Artesian Well
- 156, Figure 3: Wastewater Treatment

**TLR:**

- 30, An Artesian Well

#### Ecology and the Environment

**SE/TE:**

- 181, Figure 3: Coal Formation
- 182, Figure 4: Oil Formation
- 29, Figure 1 – Primary Succession
- 30, Apply It!
- 156, Figure 3: Wastewater Treatment

**TLR:**

- 52-60, Testing Rock Flooring
- 54, Using it Up
- 55, Soil Conservation

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**Connections to Engineering, Technology, and Applications of Science**

**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.
<table>
<thead>
<tr>
<th>Topic</th>
<th>SE/TE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water and the Atmosphere</td>
<td>5, Why is Water Important?</td>
</tr>
<tr>
<td></td>
<td>6-7, Where Is Water Found?</td>
</tr>
<tr>
<td></td>
<td>18-23, Water Underground</td>
</tr>
<tr>
<td></td>
<td>201, Bacterial Rainmakers</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td></td>
<td>7, Differentiated Instruction: L3 Your Community’s Water Source</td>
</tr>
<tr>
<td></td>
<td>21, Differentiated Instruction: L3 Groundwater Contaminants</td>
</tr>
<tr>
<td></td>
<td>23E, Enrich – Water Underground</td>
</tr>
<tr>
<td></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td></td>
<td>13, Water, Water, Everywhere</td>
</tr>
<tr>
<td></td>
<td>24, Mapping Surface Waters</td>
</tr>
<tr>
<td></td>
<td>30, An Artesian Well</td>
</tr>
<tr>
<td>Ecology and the Environment</td>
<td>92–97, Introduction to Natural Resources</td>
</tr>
<tr>
<td></td>
<td>128–133, Conserving Land and Soil</td>
</tr>
<tr>
<td></td>
<td>152–159, Water Pollution and Solutions</td>
</tr>
<tr>
<td></td>
<td>160–167, Ocean Resources</td>
</tr>
<tr>
<td></td>
<td>162, Figure 1: Ocean Resources</td>
</tr>
<tr>
<td></td>
<td>178–185, Fossil Fuels</td>
</tr>
<tr>
<td></td>
<td>196–201, Energy Use and Conservation</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td></td>
<td>164, Lead a Discussion – Future Energy Source</td>
</tr>
<tr>
<td></td>
<td>164, Lead a Discussion – Nutrients for Algae</td>
</tr>
<tr>
<td></td>
<td>165, Differentiated Instruction – L1 Explaining Upwelling</td>
</tr>
<tr>
<td></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td></td>
<td>75, Using Resources</td>
</tr>
<tr>
<td></td>
<td>76, Natural Resources</td>
</tr>
<tr>
<td></td>
<td>107, How Does Mining Affect the Land?</td>
</tr>
<tr>
<td></td>
<td>109, Modeling Soil Conservation</td>
</tr>
<tr>
<td></td>
<td>126, How Does the Water Change?</td>
</tr>
<tr>
<td></td>
<td>127, Where’s the Water?</td>
</tr>
<tr>
<td></td>
<td>128, Cleaning Up Oil Spills</td>
</tr>
<tr>
<td></td>
<td>129, Getting Clean</td>
</tr>
<tr>
<td></td>
<td>140, What’s In a Piece of Coal?</td>
</tr>
<tr>
<td></td>
<td>142, Fossil Fuels</td>
</tr>
<tr>
<td></td>
<td>155, Human Energy Use</td>
</tr>
<tr>
<td>Earth’s Structure</td>
<td>51, How Are Igneous Rocks Used?</td>
</tr>
<tr>
<td></td>
<td>56, Apply It!</td>
</tr>
<tr>
<td></td>
<td>57, How Are Sedimentary Rocks Used?</td>
</tr>
<tr>
<td></td>
<td>61, How Metamorphic Rocks are Used</td>
</tr>
<tr>
<td></td>
<td>70, Struggling to Survive</td>
</tr>
<tr>
<td></td>
<td>149, Apply It!</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td></td>
<td>43, Differentiated Instruction – L3 Debate</td>
</tr>
<tr>
<td></td>
<td>57F, Enrich – The Formation of Coal</td>
</tr>
<tr>
<td></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td></td>
<td>52–60, Testing Rock Flooring</td>
</tr>
<tr>
<td>Earth’s Surface</td>
<td>52–55, Soil Conservation</td>
</tr>
<tr>
<td></td>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td></td>
<td>55, Soil Conservation</td>
</tr>
<tr>
<td>Water and the Atmosphere</td>
<td>21, How Do People Use Groundwater?</td>
</tr>
<tr>
<td></td>
<td>21, Do the Math!</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td></td>
<td>21, Differentiated Instruction – LE Groundwater Contaminants</td>
</tr>
<tr>
<td>Ecology and the Environment</td>
<td>128–133, Conserving Land and Soil</td>
</tr>
<tr>
<td></td>
<td>129, Figure 1: Land Use</td>
</tr>
<tr>
<td></td>
<td>131, Figure 3: Terracing</td>
</tr>
<tr>
<td></td>
<td>133, Figure 4: Land Reclamation</td>
</tr>
<tr>
<td></td>
<td>136, Figure 1: Sanitary Landfill Design</td>
</tr>
<tr>
<td></td>
<td>152–159, Water Pollution and Solutions</td>
</tr>
<tr>
<td></td>
<td>172, Old MacDonald Had a Satellite</td>
</tr>
<tr>
<td></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td></td>
<td>131, Differentiated Instruction – L3 Researching Organic Fertilizers</td>
</tr>
<tr>
<td></td>
<td>133E, Enrich – The Copper Basin</td>
</tr>
<tr>
<td></td>
<td>155, Differentiated Instruction – L3 Thermal Pollution</td>
</tr>
<tr>
<td></td>
<td>159F, Enrich – Sewage Treatment</td>
</tr>
</tbody>
</table>

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
**Science and Engineering Practices**

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
  - Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

**Water and the Atmosphere**

**TLR:**
- 49-57, Modeling Ocean Currents
- 58, Deep Currents
- 115, Water in the Air
- 116, Measuring to Find the Dew Point
- 118, How Clouds Form
- 123, How Do Fluids of Different Densities Move?
- 125, Weather Fronts
- 126, Cyclones and Anticyclones
- 128, Where Do Hurricanes Come From?
- 130, Predicting Weather

**Disciplinary Core Ideas**

**ESS2.C: The Roles of Water in Earth’s Surface Processes**
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.

**Water and the Atmosphere**

**SE/TE:**
- 54-59, Currents and Climate
- 100–107, Winds
- 118–121, Water in the Atmosphere
- 122–125, Clouds
- 126–131, Precipitation
- 132–139, Air Masses
- 140–147, Storms
- 150–155, Predicting the Weather
- 170, Distance From Large Bodies of Water
- 171, Ocean Currents
- 172–173, What Factors Affect Precipitation?

**TE Only:**
- 103, Differentiated Instruction – L1 Compare and Contrast Local Winds
- 128, Differentiated Instruction – L3 Create a Weather Display

**Crosscutting Concepts**

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**Water and the Atmosphere**

**SE/TE:**
- 54-59, Currents and Climate
- 101, What Causes Winds?
- 103, Figure 3: Local Winds
- 104, Global Winds
- 104, Figure 4: Heating Earth’s Surface
- 105, The Coriolis Effect
- 105, Apply It!
- 107, Figure 6: Parts of the Atmosphere
- 122, How Do Clouds Form?
- 123, Figure 1: How Clouds Form
- 128–129, Figure 3: Freezing Precipitation
- 133, What Are the Major Air Masses
- 134, Figure 2: North American Air Masses
- 136–137, Figure 4: Types of Fronts
- 138, What Weather Do Cyclones and Anticyclones Bring?
- 140–147, Storms
### A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page Numbers</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differentiated Instruction – L3 Weather Forecasts</td>
<td>137</td>
<td>L3 Weather Formation</td>
</tr>
<tr>
<td>Teacher Demo – Modeling Front Formation</td>
<td>137</td>
<td>L3 Modeling Cyclones</td>
</tr>
<tr>
<td>Differentiated Instruction – L3 Modeling Cyclones</td>
<td>139F</td>
<td>Enrich – Occluded Fronts</td>
</tr>
<tr>
<td>Differentiated Instruction – L3 Rocky Mountain Thunderstorms</td>
<td>145</td>
<td>Hurricane Movement</td>
</tr>
<tr>
<td>Differentiated Instruction – L1 Sequencing Tornado Formation</td>
<td>147</td>
<td>Generalizations about Fronts</td>
</tr>
<tr>
<td>Differentiated Instruction – L3 Rocky Mountain Thunderstorms</td>
<td>155</td>
<td>Enrich – Wind and Air Pressure</td>
</tr>
<tr>
<td>Differentiated Instruction – L1 Illustrate Winds Crossing a Mountain Range</td>
<td>173</td>
<td>TLR: 49-57, Modeling Ocean Currents</td>
</tr>
<tr>
<td>Differentiated Instruction – L3 Accuracy of Local Weather Forecasts</td>
<td>145</td>
<td>TLR: 58, Deep Currents</td>
</tr>
<tr>
<td>Differentiated Instruction – L1 Hurricane Movement</td>
<td>147</td>
<td>TLR: 115, Water in the Air</td>
</tr>
<tr>
<td>Measuring to Find the Dew Point</td>
<td>116</td>
<td>TLR: 116, Measuring to Find the Dew Point</td>
</tr>
<tr>
<td>How Does Fog Form?</td>
<td>117</td>
<td>TLR: 117, How Does Fog Form?</td>
</tr>
<tr>
<td>How Clouds Form</td>
<td>118</td>
<td>TLR: 118, How Clouds Form</td>
</tr>
<tr>
<td>How Can You Make Hail?</td>
<td>120</td>
<td>TLR: 120, How Can You Make Hail?</td>
</tr>
<tr>
<td>How Do Fluids of Different Densities Move?</td>
<td>123</td>
<td>TLR: 123, How Do Fluids of Different Densities Move?</td>
</tr>
<tr>
<td>Weather Fronts</td>
<td>125</td>
<td>TLR: 125, Weather Fronts</td>
</tr>
<tr>
<td>Cyclones and Anticyclones</td>
<td>126</td>
<td>TLR: 126, Cyclones and Anticyclones</td>
</tr>
<tr>
<td>Can You Make a Tornado?</td>
<td>127</td>
<td>TLR: 127, Can You Make a Tornado?</td>
</tr>
<tr>
<td>Predicting Weather</td>
<td>130</td>
<td>TLR: 130, Predicting Weather</td>
</tr>
<tr>
<td>Reading a Weather Map</td>
<td>132-140</td>
<td>TLR: 132-140, Reading a Weather Map</td>
</tr>
</tbody>
</table>

- Because these patterns are so complex, weather can only be predicted probabilistically.

### Water and the Atmosphere

**SE/TE Only:**
- Predicting the Weather
- Limits of Weather Forecasts
- Tracking Hurricanes with Latitudes and Longitudes

**TE Only:**
- Differentiated Instruction – L3 Accuracy of Local Weather Forecasts

**TLR:**
- Predicting Weather

---

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
Develop and use a model to describe how unequal heating and rotation of the Earth causes patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sun-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean conveyor cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]

INTERACTIVE SCIENCE: In the Water and Atmosphere module, the online Performance Expectation Activity “Weather and Climate (MS-ESS2-6)” addresses this performance expectation.

The Water and the Atmosphere module explores ocean currents in Chapter 2, Lesson 3, “Currents and Climate” on SE/TE pages 54–59. The effect of Earth’s rotation on ocean currents is described in “Coriolis Effect” on SE/TE page 55. Students learn how winds drive surface currents in “What Causes Surface Currents?” on SE/TE pages 55-57. Students learn how ocean currents affect climate in “Effects on Climate” on SE/TE page 56. Students obtain knowledge about how ocean temperatures and winds can combine to influence weather patterns in “El Niño” and “La Niña” on SE/TE page 57. They learn how cold ocean currents and warm ocean currents circulate water in “Figure 3: Global Conveyor” on SE/TE pages 58-59. Circulation of heat within the troposphere is covered in “Figure 3: Heating the Troposphere” on SE/TE page 99. Unequal heating of the air is identified as the cause of wind in “What Causes Winds?” on SE/TE page 101. Local wind and global wind are described in “How Do Local Winds and Global Winds Differ” on SE/TE page 103. Students develop a model of land breezes by drawing on a diagram in “Figure 3: Local Winds” on SE/TE page 103. Students model the effects of latitude in “Figure 4 – Heating of Earth’s Surface” on SE/TE page 104 and in “Figure 5 – Global Wind Belts” on SE/TE page 106. The effect of Earth’s rotation is modeled in the Apply It! feature on SE/TE page 105. Students model the cause and effect relationship between unequal heating and winds in “Differentiated Instruction: Model Wind” on TE page 107. Students develop a model to illustrate how the sun’s radiation drives the formation of global winds in “Figure 6: Parts of the Atmosphere” on SE/TE page 107. Students learn how latitude, altitude, distances from oceans, and mountain ranges affect temperature and precipitation patterns in Chapter 5, Lesson 1, “What Causes Climate.” Students obtain knowledge about latitudinal banding on SE/TE page 168. Students interpret photos to describe how temperature conditions at the top of a mountain differ from conditions at the bottom of the same mountain in “Figure 3: Altitude and Temperature” on SE/TE page 169. Students predict how ocean currents affect the climate of western Europe in “Figure 4: Currents and Temperature” on SE/TE page 171. Students model the effect a mountain range can have on precipitation in “Figure 5: Rain Shadow” on SE/TE pages 172–173. Students learn how oceans, heating from the sun, altitude, and ice caps affect the six main climate regions in “What Are the Six Main Climate Regions?” on SE/TE pages 176–182. Students tell how winds, oceans, and topography affect climate in “Enrich: Factors That Affect Climate Regions” on TE page 183E.

Students model the effect of wind on surface and deep currents in “Bottom to Top” on TLR page 48. Students develop and use a model of currents in the North Atlantic in “Modeling Ocean Currents” on TLR pages 49-57. They model the effects of temperature on currents in “Deep Currents” on TLR page 58. They model global wind systems in “Does the Wind Turn?” on TLR page 98. They model global wind belts in “Global Wind Belts” on TLR page 100. They model the effect of latitude on temperature in “How Does Latitude Affect Climate?” on TLR page 151. They develop and use a model of how the unequal heating of Earth’s surface affects temperature in “Sunny Rays and Angles” on TLR pages 152-160.

The performance expectation above was developed using the following elements from the NRC document A Framework for K–12 Science Education:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing and Using Models</td>
<td>ESS2.C: The Roles of Water in Earth’s Surface Processes</td>
<td>Systems and System Models</td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.</td>
<td>• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.</td>
</tr>
</tbody>
</table>
Develop and use a model to describe phenomena. (MS-ESS2-6)

### Water and the Atmosphere

**SE/TE:**
- 55, Figure 1: Surface Currents
- 57, Figure 2: Warming Sea Temperature
- 58, Figure 3: Global Ocean Conveyor
- 104, Figure 4: Heating of Earth’s Surface
- 105, Apply It!
- 106, Figure 5: Global Wind Belts
- 107, Figure 6: Parts of the Atmosphere
- 172, Figure 5: Rain Shadow
- 173, Figure 6: Monsoons

**TE Only:**
- 107, Differentiated Instruction – L1 Mode
- 171, Make Analogies

**TLR:**
- 47, Modeling Currents
- 48, Bottom to Top
- 49-57, Modeling Ocean Currents
- 58, Deep Currents
- 98, Does the Wind Turn?
- 100, Global Wind Belts
- 151, How Does Latitude Affect Climate?
- 152–160, Sunny Rays and Angles

**ESS2.D: Weather and Climate**
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

**Water and the Atmosphere**

**SE/TE:**
- 58–59, What Causes Deep Currents?
- 58–59, Global Ocean Conveyor

**TE Only:**
- 59, Differentiated Instruction – L3
- 104, Figure 4: Heating of Earth’s Surface
- 105, Apply It!
- 106, Figure 5: Global Wind Belts
- 160, The S’Cool Project
- 172, Figure 5: Rain Shadow
- 173, Figure 6: Monsoons

**TE Only:**
- 171, Make Analogies

**TLR:**
- 47, Modeling Currents
- 48, Bottom to Top
- 49-57, Modeling Ocean Currents
- 58, Deep Currents
- 98, Does the Wind Turn?
- 100, Global Wind Belts
- 131, Modeling Weather Satellites
- 151, How Does Latitude Affect Climate?
- 152–160, Sunny Rays and Angles

**Water and the Atmosphere**

**SE/TE:**
- 55, Figure 1: Surface Currents
- 57, Figure 2: Warming Sea Temperature
- 58, Figure 3: Global Ocean Conveyor
- 104, Figure 4: Heating of Earth’s Surface
- 105, Apply It!
- 106, Figure 5: Global Wind Belts
- 160, The S’Cool Project
- 172, Figure 5: Rain Shadow
- 173, Figure 6: Monsoons

**TE Only:**
- 107, Differentiated Instruction, L1-Model Wind
- 171, Make Analogies

**TLR:**
- 47, Modeling Currents
- 48, Bottom to Top
- 49-57, Modeling Ocean Currents
- 58, Deep Currents
- 98, Does the Wind Turn?
- 100, Global Wind Belts
- 131, Modeling Weather Satellites
- 151, How Does Latitude Affect Climate?
- 152–160, Sunny Rays and Angles
A Correlation of
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment
to the Next Generation Science Standards for Middle School

<table>
<thead>
<tr>
<th>TE Only:</th>
<th>TLR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>42, Teacher to Teacher</td>
<td>47, Modeling Currents</td>
</tr>
<tr>
<td>57, Differentiated Instruction – L3</td>
<td>48, Bottom to Top</td>
</tr>
<tr>
<td>59, Differentiated Instruction – L3</td>
<td>49-57, Modeling Ocean Currents</td>
</tr>
<tr>
<td>Surface and Deep Current</td>
<td>58, Deep Currents</td>
</tr>
<tr>
<td>59E, Enrich – The Sargasso Sea</td>
<td>86–94, Heating Earth’s Surface</td>
</tr>
<tr>
<td>95E, Enrich – Reflection of Solar Radiation</td>
<td>98, Does the Wind Turn?</td>
</tr>
<tr>
<td>107, Differentiated Instruction – L1 Model Wind</td>
<td>100, Global Wind Belts</td>
</tr>
<tr>
<td>137, Teacher Demo – Modeling Front Formation</td>
<td>125, Weather Fronts</td>
</tr>
<tr>
<td>139F, Enrich – Occluded Fronts</td>
<td>128, Where Do Hurricanes Come From?</td>
</tr>
<tr>
<td>169, Differentiated Instruction – L1 Angles of Sunlight</td>
<td>151, How Does Latitude Affect Climate?</td>
</tr>
<tr>
<td>169, Teacher Demo – Air Temperature and Altitude</td>
<td>152–160, Sunny Rays and Angles</td>
</tr>
<tr>
<td>171, Make Analogies</td>
<td>161, Inferring United States Precipitation Patterns</td>
</tr>
<tr>
<td>173, Differentiated Instruction – L3, Illustrate Winds Crossing a Mountain Range</td>
<td>167, Earth’s Movement and Climate</td>
</tr>
<tr>
<td>173E, Enrich – Earth’s Deserts</td>
<td>168, What Is the Greenhouse Effect?</td>
</tr>
<tr>
<td>176, Teach With Visuals</td>
<td>169, Greenhouse Gases and Global Warming</td>
</tr>
<tr>
<td>183E, Enrich – Factors that Affect Climate Regions</td>
<td></td>
</tr>
<tr>
<td>193, 21st Century Learning</td>
<td></td>
</tr>
<tr>
<td>193, Address Misconceptions</td>
<td></td>
</tr>
<tr>
<td>195E, Enrich – The Carbon Cycle</td>
<td></td>
</tr>
</tbody>
</table>

TLR:
- 47, Modeling Currents
- 48, Bottom to Top
- 49-57, Modeling Ocean Currents
- 58, Deep Currents
- 86–94, Heating Earth’s Surface
- 98, Does the Wind Turn?
- 100, Global Wind Belts
- 125, Weather Fronts
- 128, Where Do Hurricanes Come From?
- 151, How Does Latitude Affect Climate?
- 152–160, Sunny Rays and Angles
- 161, Inferring United States Precipitation Patterns
- 167, Earth’s Movement and Climate
- 168, What Is the Greenhouse Effect?
- 169, Greenhouse Gases and Global Warming

The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.
### Water and the Atmosphere

**SE/TE:**
- 54–59, Currents and Climate
- 56, Apply It!
- 57, Figure 2 – Warming Sea Temperatures
- 58, Figure 3 – Global Conveyor
- 103, Figure 3: Local Winds
- 144–145, Hurricanes
- 170, Distance From Large Bodies of Water
- 170, Apply It!
- 171, Ocean Currents
- 171, Figure 4: Currents and Temperatures

**TE Only:**
- 57, Differentiated Instruction – L3

**News Article**
- 170 Build Inquiry – Comparing Water and Soil
- 171, Make Analogies

**TLR:**
- 86–94, Heating Earth’s Surface

### Scenario-Based Investigations

- 122–123, What Causes Our Climate?
MS.Weather and Climate
MS-ESS3-5

Students who demonstrate understanding can:

**Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

**INTERACTIVE SCIENCE:** In the *Water and Atmosphere* module, the online Performance Expectation Activity "Weather and Climate (MS-ESS3-5)") addresses this performance expectation.

Natural causes of climate change are discussed in the *Water and the Atmosphere* module in Chapter 5, Lesson 3 "Changes in Climate" on SE/TE pages 184–189. Students interpret data of a graph showing average global temperatures over time in "Do the Math!" on SE/TE page 188. Global warming is discussed in Chapter 5, Lesson 4 "Human Activities and Climate Change" on SE/TE pages 190–195. Students obtain knowledge related to evidence of global warming and the role human activities play in the rise in global temperatures in “Figure 2: Carbon Dioxide Levels” on SE/TE page 192. Students learn the effects of global warming in "Figure 3: Sea Level Rise" on SE/TE page 193. They learn about solutions to global warming in “Limiting Global Warming” on SE/TE page 194.

Students ask questions about the greenhouse effect in the Targeted Reading Skill on SE/TE page 190. Students use a graph to analyze carbon dioxide levels over time in “Figure 2: Carbon Dioxide Levels” on SE/TE page 192. Students interpret maps showing the vulnerability of the eastern part of the United States to rising sea levels in “Figure 3: Sea Level Rise” on SE/TE page 193. They make models of a particular technology that will reduce greenhouse gas emissions on SE/TE page 194. They evaluate evidence, reliability, and bias of media coverage of global warming in "Figure 4: Climate in the Media" on SE/TE page 195. They interpret photographs showing evidence of how melting glaciers have changed particular landscapes over the past several decades in "Differentiated Instructions: Photographic Evidence” on TE page 195. They make observations about a block of ice to understand how scientists use evidence from ice cores to learn about conditions in the atmosphere thousands of years ago in "Greenhouse Gases and Global Warming" on TLR page 169.

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asking Questions and Defining Problems</strong></td>
<td><strong>ESS3.D: Global Climate Change</strong></td>
<td><strong>Stability and Change</strong></td>
</tr>
<tr>
<td>Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, clarify arguments and models.</td>
<td>• Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.</td>
<td>• Stability might be disturbed either by sudden events or gradual changes that accumulate over time.</td>
</tr>
<tr>
<td>• Ask questions to identify and clarify evidence of an argument.</td>
<td><strong>Ecology and the Environment</strong></td>
<td><strong>Water and the Atmosphere</strong></td>
</tr>
<tr>
<td><strong>Water and the Atmosphere</strong></td>
<td><strong>SE/TE:</strong> 52, Human Impact</td>
<td><strong>SE/TE:</strong> 188, Do the Math!</td>
</tr>
<tr>
<td><strong>SE/TE:</strong> 191, Ask Questions</td>
<td><strong>SE/TE:</strong> 190–195, Human Activities and Climate Change</td>
<td><strong>189, Figure 5 – Volcanic Activity and Climate</strong></td>
</tr>
<tr>
<td>195, Figure 4 – Climate in the Media</td>
<td><strong>SE/TE:</strong> 192, Figure 2: Carbon Dioxide Levels</td>
<td><strong>192, Figure 2 – Volcanic Activity and Climate</strong></td>
</tr>
<tr>
<td>200, Tracking Earth’s Gases From Space</td>
<td><strong>TE Only:</strong></td>
<td><strong>193, Figure 3 – Sea Level Rise</strong></td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
<td><strong>195E, Enrich – The Carbon Cycle</strong></td>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>195, Differentiated Instruction – L3 Photographic Evidence</td>
<td><strong>184A, Content Refresher – Earth’s Changing Orbit</strong></td>
<td><strong>189, Differentiated Instruction – L3 Year Without Summer</strong></td>
</tr>
<tr>
<td><strong>STEMQuest:</strong> Shrinking Your Carbon Footprint</td>
<td><strong>TLR:</strong></td>
<td><strong>168, What Is the Greenhouse Effect?</strong></td>
</tr>
</tbody>
</table>

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
| 193, Figure 3: Sea Level Rise | Ecology and the Environment |
| 194, Apply It! | SE/TE: |
| 195, Figure 4: Climate in the Media | 99, Do the Math! |
| 200, Tracking Earth’s Gases From Space | 148, The Ozone Hole |

**TE Only:**
- 192, Teach With Visuals
- 193, 21st Century Learning
- 195, Differentiated Instruction – L1 Efficiency

**TLR:**
- 169, Greenhouse Gases and Global Warming

**STEMQuest:** Shrinking Your Carbon Footprint
- Footprint Steps
- Energy Savings at School
- Make a Difference
- Reflect on Shrinking Your Carbon Footprint

**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
A discussion of earthquakes and their potential to cause sudden damage appears in Chapter 4, Lesson 2 of the *Earth’s Structure* module on SE/TE pages 110–117. How scientists use seismographic data to create maps showing where earthquakes have occurred in the past (and thus, where they are likely to occur in the future) is described in “What Patterns Do Seismographic Data Reveal?” on SE/TE pages 121–123. Students learn about earthquake risk in “Earthquake Risk in North America” SE/TE page 121 and “Earthquake Risk Around the World” on SE/TE page 122. Students interpret data to forecast earthquake risk in the Apply It! on SE/TE page 121. They discuss the importance of predicting earthquakes and how to mitigate their effects in the “Lead a Discussion” activity on TE page 121. They analyze data on the locations of past earthquakes to indicate where buildings should be built to withstand future earthquakes in “Figure 3: Earthquakes Around the World” on SE/TE page 122. They analyze data on the probability of an earthquake occurring along the San Andreas fault on TE page 123E. They obtain knowledge of how buildings can be engineered to mitigate the effects of earthquakes in “Seismic-Safe Buildings” on SE/TE page 128.

A discussion of volcanoes and plate tectonics appears in the *Earth’s Structure* module on SE/TE pages 134–137. Students analyze data related to the location of volcanoes around the world in “Figure 1: The Ring of Fire” on SE/TE page 135. Students learn that volcanoes can erupt quietly or explosively in “Two Types of Volcanic Eruptions” on SE/TE pages 140–142. They obtain knowledge of phenomena that allow for reliable predictions of volcanic eruptions in “What Are the Stages of Volcanic Activity?” on SE/TE page 144. They interpret data related to the location and frequency of eruptions in the Cascade range in “Figure 5: Cascade Volcanoes” on SE/TE page 144.

A discussion of tsunamis appears in the *Water and the Atmosphere* module on SE/TE page 51. Students learn how the occurrence of tsunamis in the Pacific Ocean led to the development of a tsunami warning system on SE page 51. A discussion of flood plains appears in the *Earth’s Surface* module on SE page 74. Students research flood plains and ways to mitigate the effects of floods in “Floodwater Fallout” on SE/TE page 98. They learn further details about mitigating floods in “Science and Society” on TE page 98. A discussion of floods and droughts appears in the *Water and the Atmosphere* module on SE/TE pages 130–131 “What Are the Causes of Floods and Droughts?” Students learn about flood prevention in “Lead a Discussion” on TE page 130. They learn about flood control projects in “Differentiated Instruction: Flood Control” on TE page 131.

A discussion of hurricanes appears in the *Water and the Atmosphere* module on SE/TE pages 144–145. Students interpret data related to the paths of hurricanes in “Differentiated Instruction: Hurricane Movement” on TE page 145. Students obtain knowledge about how scientists predict hurricanes in “Support the Big Question” on TE page 148 and “Think Like a Scientist” on TE page 161. Students can map hurricane paths in the Teacher To Teacher activity on TE page 148. A discussion of tornadoes appears on SE/TE pages 146–147. Students interpret maps related to tornado alley in “Figure 6: Tornado Formation” on SE/TE page 146. Students interpret photographs showing the magnitude of damage due to a hurricane in “Figure 7: Tornado Damage” on SE/TE page 147.

**INTERACTIVE SCIENCE:** In the *Earth’s Structure* module, the online Performance Expectation Activity “Human Impacts (MS-ESS3-2)” addresses this performance expectation.

Students who demonstrate understanding can:

- **Analyze and interpret data** on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]
### Science and Engineering Practices

<table>
<thead>
<tr>
<th>Analyzing and Interpreting Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
</tr>
<tr>
<td>- Analyze and interpret data to determine similarities and differences in findings.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Earth’s Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>129, Forensic Seismology</td>
</tr>
<tr>
<td>135, Figure 1 – The Ring of Fire</td>
</tr>
<tr>
<td>157, An Explosive Secret</td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>117F, Enrich – Comparing the Richter and Moment Magnitude Scales</td>
</tr>
<tr>
<td>129, Technology and Society</td>
</tr>
<tr>
<td>137, Teacher Demo – Interpreting Maps</td>
</tr>
<tr>
<td>137E, Enrich – Volcanoes and Plates</td>
</tr>
<tr>
<td><strong>STEMQuest:</strong> To Hike or Not to Hike Patterns in the Cascade Range Mount Rainier’s Threat Monitoring a Volcano Signs of Eruption?</td>
</tr>
</tbody>
</table>

### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>ESS3.B: Natural Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Earth’s Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>86–91, The Theory of Plate Tectonics</td>
</tr>
<tr>
<td>90–91, Figure 6: Earth’s Changing Crust</td>
</tr>
<tr>
<td>97, An Ocean Is Born</td>
</tr>
<tr>
<td>121–123, What Patterns Do Seismographic Data Reveal?</td>
</tr>
<tr>
<td>121, Apply It!</td>
</tr>
<tr>
<td>122–123, Figure 3 – Earthquakes Around the World</td>
</tr>
<tr>
<td>134–137, Volcanoes and Plate Tectonics</td>
</tr>
<tr>
<td>135, Figure 1 – The Ring of Fire</td>
</tr>
<tr>
<td>137, Apply It!</td>
</tr>
<tr>
<td>144, What are the Stages of Volcanic Activity?</td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>83, Differentiated Instruction – L1 Cause-and-Effect Table</td>
</tr>
<tr>
<td>88, Teacher to Teacher</td>
</tr>
<tr>
<td>98, From the Author</td>
</tr>
<tr>
<td>121, Lead a Discussion – Earthquake Predictions</td>
</tr>
<tr>
<td>121, Differentiated Instruction – L3 New Madrid Fault</td>
</tr>
<tr>
<td>123E, Enrich – Earthquake Probability</td>
</tr>
<tr>
<td>128, Technology and Society</td>
</tr>
<tr>
<td>137, Teacher Demo – Interpreting Maps</td>
</tr>
<tr>
<td>145, Differentiated Instruction – L3 Predict Eruptions</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>115, Earthquake Patterns</td>
</tr>
<tr>
<td>125, Where Are Volcanoes Found on Earth’s Surface?</td>
</tr>
<tr>
<td><strong>STEMQuest:</strong> To Hike or Not to Hike Patterns in the Cascade Range Mount Rainier’s Threat Monitoring a Volcano Signs of Eruption?</td>
</tr>
</tbody>
</table>

### Crosscutting Concepts

<table>
<thead>
<tr>
<th>Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Graphs, charts, and images can be used to identify patterns in data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Earth’s Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>121, Apply It!</td>
</tr>
<tr>
<td>122–123, Figure 3 – Earthquakes Around the World</td>
</tr>
<tr>
<td>135, Figure 1 – The Ring of Fire</td>
</tr>
<tr>
<td>140, Do the Math!</td>
</tr>
<tr>
<td>144, Figure 5 – Cascade Volcanoes</td>
</tr>
<tr>
<td>146, Figure 6: Tornado Formation</td>
</tr>
<tr>
<td><strong>TE Only:</strong></td>
</tr>
<tr>
<td>123E, Enrich – Earthquake Probability</td>
</tr>
<tr>
<td>131, Differentiated Instruction – L1 Droughts and Floods</td>
</tr>
<tr>
<td><strong>STEMQuest:</strong> To Hike or Not to Hike Patterns in the Cascade Range Mount Rainier’s Threat Monitoring a Volcano Signs of Eruption?</td>
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</tbody>
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<table>
<thead>
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<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>79, Apply It!</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario-Based Investigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>95–97, High-Priority Earthquake Zones</td>
</tr>
<tr>
<td><strong>TLR:</strong></td>
</tr>
<tr>
<td>103–105, Jane Versus the Volcano</td>
</tr>
</tbody>
</table>

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### Connections to Engineering, Technology, and Applications of Science

<table>
<thead>
<tr>
<th>Influence of Science, Engineering, and Technology on Society and the Natural World</th>
</tr>
</thead>
<tbody>
<tr>
<td>- The uses of technologies and limitations on their use are driven by people’s needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Earth’s Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SE/TE:</strong></td>
</tr>
<tr>
<td>119, How Do Seismographs Work?</td>
</tr>
<tr>
<td>122–123, Figure 3: Earthquakes Around the World (“Make Judgments”)</td>
</tr>
</tbody>
</table>

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**SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource**
A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

Earth’s Surface
SE/TE:
79, Karst Topography
79, Apply It!
98, Floodwater Fallout
TE Only:
98, Science and Society

Water and the Atmosphere
SE/TE:
51, Tsunami
130–131, What Are the Causes of Floods and Droughts?
144–145, Hurricanes
146–147, Tornadoes
146, Figure 6 – Tornado Formation
147, Figure 7 – Tornado Damage
TE Only:
130, Lead a Discussion – Flood Prevention
131, Differentiated Instruction – L3 Flood Control
143, Differentiated Instruction – L3 Rocky Mountain Thunderstorms
145, Differentiated Instruction – L1 Hurricane Movement
148, Support the Big Question
148, Teacher to Teacher
161, Think Like a Scientist

Scenario-Based Investigations
95–97, High-Priority Earthquake Zones
103–105, Jane Versus the Volcano

128, Seismic-Safe Buildings
129, Forensic Seismology
144, What Are the Stages of Volcanic Activity?
TE Only:
128, Technology and Society

Water and the Atmosphere
SE/TE:
46, My Planet Diary – Rogue Waves
51, Tsunami
126, My Planet Diary – Cloud Seeding
152, Using Technology
152, Figure 2 – Weather Technology
TE Only:
46A, Content Refresher – Wave Power and Tsunamis
Students who demonstrate understanding can:

**Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.** *(Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).)

**INTERACTIVE SCIENCE:** In the *Ecology and the Environment* module, the online Performance Expectation Activity "Human Impacts (MS-ESS3-3)" addresses this performance expectation.

Students **design a solution** to minimize the impact of stormwater runoff at their middle school in "The Problem With Runoff" on pages 20–21 of the *Scenario-Based Investigations* book. They **design a solution** for monitoring and reducing energy use in their school in "Energy Audit" on pages 38–42 of the *Chapter Activities and Projects* book. They **design a water filtration system** to clean dirty water in "A Precious Resource" on pages 45–49 of the *Chapter Activities and Projects* book. They **design a solution** for monitoring water use in "Every Drop Counts" on pages 290–294 of the *Chapter Activities and Projects* book. They **design a landfill** to minimize the human impact of wastes in "Waste Away!" on TLR pages 111–119 of the *Ecology and the Environment* module. They **design a solar cooker** to minimize the impact of humans' use of energy resources in "Design and Build a Solar Cooker" on TLR pages 144–152. They **design a dam** and evaluate how it affects the land upstream and downstream in "It's All Water Under the Dam" on pages 17–20 of the *STEM Activity Book*.

A discussion of the human impacts on soil fertility is included in Chapter 2, Lesson 3 "Soil Conservation" on SE/TE pages 52–55 of the *Earth's Surface* module. A discussion of how to minimize the impacts on soil due to agriculture, mining, and development appears in Chapter 4, Lesson 1 "Conserving Land and Soil" on SE/TE pages 128–133. Students **research** methods farmers use to minimize loss of soil fertility in "Differentiated Instruction: Soil Fertility" in the *Earth's Surface* module on TE page 55. Students **learn** about George Washington Carver and the importance of farming techniques such as crop rotation in "The Plant Doctor" on SE/TE page 61.


Students **map** the Chesapeake Bay watershed to show how fertilizers enter the bay in "A Pearl of a Solution" on SE/TE page 34 of the *Water and the Atmosphere* module. Students **design a plan** to help minimize global warming in the Apply It! on SE/TE page 194 of the *Water and the Atmosphere* module.

Students **devise a method** to increase fish harvests in the "Apply It!" activity on SE/TE page 161 of the *Ecology and the Environment* module. Students **solve problems** by identifying a method to reduce oil pollution in "Do the Math" on SE/TE page 166. Students **research** the use of satellites to help protect water supplies from agricultural contamination in "Old MacDonald Had a Satellite" on SE/TE page 172. Using scientific principles, they **evaluate** how energy technologies minimize human impact in "How Low Is Low Impact?" on SE/TE page 206.
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td><strong>ESS3.C: Human Impacts on Earth Systems</strong></td>
<td>Cause and Effect</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.</td>
</tr>
<tr>
<td>Ecology and the Environment SE/TE:</td>
<td></td>
<td>Earth’s Surface</td>
</tr>
<tr>
<td>161, Apply It!</td>
<td>27, Save the Seeds, Save the World</td>
<td>SE/TE:</td>
</tr>
<tr>
<td>TE Only:</td>
<td>7, Differentiated Instruction – L3 Human Impact</td>
<td>54, Soil Damage and Loss</td>
</tr>
<tr>
<td>116–119, Waste Away!</td>
<td></td>
<td>Water and the Environment SE/TE:</td>
</tr>
<tr>
<td>149–152, Design and Build a Solar Cooker</td>
<td></td>
<td>16, The Human Role</td>
</tr>
<tr>
<td></td>
<td>21, Do the Math!</td>
<td>192, Figure 2 – Carbon Dioxide Levels</td>
</tr>
<tr>
<td></td>
<td>193, Figure 3 – Sea Level Rise</td>
<td>193, Figure 3 – Carbon Dioxide Levels</td>
</tr>
<tr>
<td>Water and the Environment SE/TE:</td>
<td>52–55, Soil Conservation</td>
<td>TE Only:</td>
</tr>
<tr>
<td>194, Apply It!</td>
<td>61, The Plant Doctor</td>
<td>17, Differentiated Instruction – L3 Fertilizers</td>
</tr>
<tr>
<td>STEMQuest: Shrinking Your Carbon Footprint</td>
<td>55, Differentiated Instruction – L3 Soil Fertility</td>
<td>STEMQuest: Shrinking Your Carbon Footprint</td>
</tr>
<tr>
<td>Make a Difference</td>
<td></td>
<td>Footprint Steps</td>
</tr>
<tr>
<td>Reflect on Shrinking Your Carbon Footprint</td>
<td></td>
<td>Energy Savings at School</td>
</tr>
<tr>
<td>Chapter Activities and Projects</td>
<td></td>
<td>Make a Difference</td>
</tr>
<tr>
<td>38–42, Energy Audit</td>
<td></td>
<td>Reflect on Shrinking Your Carbon Footprint</td>
</tr>
<tr>
<td>45–49, A Precious Resource</td>
<td></td>
<td>Ecology and the Environment SE/TE:</td>
</tr>
<tr>
<td>20–21, The Problem With Runoff</td>
<td>21, Do the Math!</td>
<td>101, Identify the Main Idea</td>
</tr>
<tr>
<td></td>
<td>28–29, Why Are Wetlands Important?</td>
<td>106, How Can Fisheries Be Managed for a Sustainable Yield?</td>
</tr>
<tr>
<td></td>
<td>34, A Pearl of a Solution</td>
<td>110, Figure 2: Keystone Otters</td>
</tr>
<tr>
<td>TE Only:</td>
<td>17, Differentiated Instruction – L3 Fertilizers</td>
<td>114–115, How Do Humans Affect Biodiversity?</td>
</tr>
<tr>
<td></td>
<td>18A, Content Refresher</td>
<td>131, Soil Use Problems</td>
</tr>
<tr>
<td></td>
<td>29, Differentiated Instruction – L3 Wetland Advocacy</td>
<td>131, Figure 3: Terracing</td>
</tr>
<tr>
<td></td>
<td>29E, Enrich – The Shrinking Everglades</td>
<td>143–145, Outdoor Air Pollution</td>
</tr>
<tr>
<td></td>
<td>STEMQuest: Shrinking Your Carbon Footprint</td>
<td>145, Apply It!</td>
</tr>
<tr>
<td></td>
<td>Footprint Steps</td>
<td>148, The Ozone Hole</td>
</tr>
<tr>
<td></td>
<td>Energy Savings at School</td>
<td>148, Figure 7 – Ozone and Ultraviolet Radiation</td>
</tr>
<tr>
<td></td>
<td>Make a Difference</td>
<td>154–155, What Are the Major Sources of Water Pollution?</td>
</tr>
<tr>
<td></td>
<td>Reflect on Shrinking Your Carbon Footprint</td>
<td>154, Figure 2 – Farm Pollution</td>
</tr>
<tr>
<td></td>
<td>Ecology and the Environment SE/TE:</td>
<td>155, Outline</td>
</tr>
<tr>
<td>93, What Are Natural Resources?</td>
<td>161, Apply It</td>
<td>161, Apply It</td>
</tr>
<tr>
<td>102–107, Forests and Fisheries</td>
<td>166, Human Activities</td>
<td>166, Do the Math!</td>
</tr>
<tr>
<td>104, Figure 2 – Tree Harvest</td>
<td>190, Apply It</td>
<td>190, Apply It</td>
</tr>
<tr>
<td>107, Figure 3 – Aquaculture</td>
<td>TE Only:</td>
<td>STEMQuest: Shrinking Your Carbon Footprint</td>
</tr>
<tr>
<td>113, Extinction of Species</td>
<td>88, Teacher to Teacher</td>
<td>Footprint Steps</td>
</tr>
<tr>
<td></td>
<td>102A, Content Refresher – Deforestation and Climate Change</td>
<td>Make a Difference</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reflect on Shrinking Your Carbon Footprint</td>
</tr>
</tbody>
</table>
ESS3.C: Human Impacts on Earth Systems
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Water and the Atmosphere
SE/TE:
4, Planet Diary – How Much Water Do You Use?
TE Only:
29E, Enrich – The Shrinking Everglades
STEMQuest: Shrinking Your Carbon Footprint
Footprint Steps
Energy Savings at School
Make a Difference
Reflect on Shrinking Your Carbon Footprint

Ecology and the Environment
SE/TE:
101, Medical Care and Technology
101, Identify the Main Idea
128–131, Conserving Land and Soil
129, Figure 1 – Land Use
149, What’s Being Done?
150–151, How Can Air Pollution Be Reduced?
156–157, How Can Water Pollution Be Reduced?
156, Figure 3 – Wastewater Treatment
158–159, Figure 4 – Pollution and Solutions
186–193, Renewable Sources of Energy
188, Figure 2 – Solar-Powered House
189, Figure 3 – Hydroelectric and Wind Power
191, Figure 5 – Geothermal Power in Iceland
192–193, Figure 6 – The Energy Around Us
192, Electric Cars and Hydrogen Fuel Cells
194, Figure 7: Nuclear Power Plants
198–201, How Can We Ensure There Will Be Enough Energy for the Future?

133E, Enrich – The Copper Basin
149, Differentiated Instruction – LE Researching Ozone Depletion Potential
167E, Enrich – Fishing on Georges Bank
195, Differentiated Instruction – L1 Relate Cause and Effect

TLR:
87, Human Population Growth
89, What Happened to the Tuna?
91, Managing Fisheries
93, Modeling Keystone Species
107, How Does Mining Affect the Land?
129, Getting Clean
155, Human Energy Use

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
- The uses of technologies and limitations on their use are driven by people’s needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Water and the Atmosphere
SE/TE:
35, What Was Fort Miami?
126, My Planet Diary – Cloud Seeding
STEMQuest: Shrinking Your Carbon Footprint
Footprint Steps
Energy Savings at School
Make a Difference
Reflect on Shrinking Your Carbon Footprint

Ecology and the Environment
SE/TE:
136, Landfills
136, Figure 1 – Sanitary Landfill Design
163, Figure 2 – Desalination Process
191, Tapping Earth’s Energy
191, Figure 5 – Geothermal Power in Iceland
192, Electric Cars and Hydrogen Fuel Cells
194–195, How Does a Nuclear Power Plant Produce Electricity?
**TE Only:**

- 88, 21st Century Learning
- 96, Teach With Visuals
- 97, Differentiated Instruction – L1 Calculate Your Ecological Footprint
- 101, 21st Century Learning
- 101, Differentiated Instruction – L1 Medical Care and Human Survival
- 124, From the Author

**TLR:**

- 25, Elbow Room
- 75, Using Resources
- 76, Natural Resources
- 86, Doubling Time
- 87, Human Population Growth
- 108, Land Use

**194, Figure 7 – Nuclear Power Plants**

**206, How Low Is Low Impact?**

**207, Hydrokinetic Energy**

**TE Only:**

- 107E, Enrich – Modern Fishing Equipment
- 134A, Content Refresher – Municipal Solid Waste Disposal
- 193, Differentiated Instruction – L3 Hydrogen Power Plants
- 198, Teacher to Teacher
- 201, Differentiated Instruction – L3 Timeline of Automotive Efficiency
- 206, Quick Facts

**TLR:**

- 155, Human Energy Use

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
## MS.Human Impacts
**MS-ESS3-4**

Students who demonstrate understanding can:

**Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.** [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

**INTERACTIVE SCIENCE:** In the *Ecology and the Environment* module, the online Performance Expectation Activity “Human Impacts (MS-ESS3-4)” addresses this performance expectation.

A discussion of how population growth of all living organisms is affected by the availability of food and water, the amount of available space, and climate appears in “What Factors Limit Population Growth?” on SE/TE pages 15–17 in the *Ecology and the Environment* module. Water shortages as a result of population growth are discussed in “Population Growth” on SE/TE page 88. Factors affecting human population growth are discussed in Chapter 3, Lesson 3 “Human Population Growth” on SE/TE pages 98–101. Consumption of natural resources as it relates to population growth is discussed in “Population Growth and Natural Resources” on SE/TE page 101. Students model how space can be a limiting factor for population growth in “Differentiated Instruction: Classroom Density” on TE page 17.

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

### Science and Engineering Practices

**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.

**Water and the Atmosphere**

SE/TE: 192, Figure 2 – Carbon Dioxide Levels

TLR: 168, What Is the Greenhouse Effect?

**Ecology and the Environment**

SE/TE: 145, Apply It

148, The Ozone Hole

TLR: 25, Elbow Room

**Scenario-Based Investigations**

20–21, The Problem With Runoff

### Disciplinary Core Ideas

**ESS3.C: Human Impacts on Earth Systems**

- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

**Water and the Atmosphere**

SE/TE:

4, Planet Diary – How Much Water Do You Use?

TE Only:

29E, Enrich – The Shrinking Everglades

**Ecology and the Environment**

SE/TE:

15–17, What Factors Limit Population Growth

88, Population Growth

95, Why Are Natural Resources Important?

96, Apply It!

98–101, Human Population Growth

101, Population Growth and Natural Resources

101, Identify the Main Idea

110, Figure 2 – Keystone Otters

129, Development

129, Figure 1 – Land Use

### Crosscutting Concepts

**Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**Water and the Atmosphere**

SE/TE:

191, Greenhouse Effect

191, Figure 1 – Greenhouse Effect

192, Effects of Global Warming

192, Figure 3 – Sea Level Rise

**Ecology and the Environment**

SE/TE:

101, Identify the Main Idea

110, Figure 2 – Keystone Otters

122, Sustainable Seafood

131, Soil Use Problems

148–149, Figure 6 – The Ozone Hole

149, What’s Being Done

143–146, What Causes Outdoor and Indoor Air Pollution?

154–155, What Are the Major Sources of Water Pollution?

161, Apply It!

TE Only:

97E, Enrich – Keeping Water Clean

133E, Enrich – The Copper Basin

167E, Enrich – Fishing on Georges Bank
A Correlation of Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment to the Next Generation Science Standards for Middle School

**TE Only:**
- 17, Differentiated Instruction – L1 Classroom Density
- 88, 21st Century Learning
- 96, Teach With Visuals
- 97, Differentiated Instruction – L1 Calculate Your Ecological Footprint
- 98A, Content Refresher – Human Population Studies
- 101, 21st Century Learning
- 101, Differentiated Instruction – L1 Medical Care and Human Survival
- 124, From the Author

**TLR:**
- 25, Elbow Room
- 75, Using Resources
- 76, Natural Resources
- 86, Doubling Time
- 87, Human Population Growth
- 108, Land Use

**Connections to Engineering, Technology, and Applications of Science**

**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. (MS-ESS3-4)

**Water and the Atmosphere**
- SE/TE: 126, My Planet Diary – Cloud Seeding
- 192, Figure 2 – Carbon Dioxide Levels
- 194, Limiting Global Warming
- 194, Apply It!

**Ecology and the Environment**
- SE/TE: 104, Figure 2 – The Harvest
- 107, Figure 3 – Aquaculture
- 107E, Enrich – Modern Fishing Equipment
- 114, Figure 5 – Habitat Fragmentation
- 122, Sustainable Seafood
- 128–129, How Do People Use Land?
- 131, Figure 3 – Terracing
- 133, Figure 4 – Land Reclamation
- 148–149, Figure 6 – The Ozone Hole
- 149, What’s Being Done
- 150, How Can Air Pollution Be Reduced?
- 156–157, How Can Water Pollution Be Reduced?
- 156, Figure 3 – Wastewater Treatment
- 157, Apply It!
- 163, Figure 2 – Desalination Process
- 172, Old MacDonald Had a Satellite
- 206, How Low Is Low Impact?
- 207, Hydrokinetic Energy

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## Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Science knowledge can describe consequences of actions but does not make the decisions that society takes. (MS-ESS3-4)

### Water and the Atmosphere

**SE/TE:**
- 192, Levels of Greenhouse Gases
- 192, Figure 2 – Carbon Dioxide Levels

### Ecology and the Environment

**SE/TE:**
- 101, Identify the Main Idea
- 104, Logging Methods
- 107, Fishing Methods
- 110, Figure 2 – Keystone Otters
- 122, Sustainable Seafood
- 131, Soil Use Problems
- 135–139, What Are Three Solid Waste Disposal Methods?
- 148–149, Figure 6 – Ozone Hole
- 148–149, Figure 6 – Ozone Hole
- 149, What’s Being Done
- 143–146, What Causes Outdoor and Indoor Air Pollution?
- 154–155, What Are the Major Sources of Water Pollution?
- 161, Apply It!
- 198–201, How Can We Ensure There Will Be Enough Energy for the Future?

**TE Only:**
- 97, Differentiated Instruction – L1 Ecological Footprints and Food Choices
- 133E, Enrich – The Copper Basin
- 159F, Enrich – Sewage Treatment

### TLR:
- 153, Producing Electricity

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### TE Only:
- 97, Differentiated Instruction – L1 Ecological Footprints and Food Choices
- 133E, Enrich – The Copper Basin
- 159F, Enrich – Sewage Treatment

### TLR:
- 89, What Happened to the Tuna?
- 91, Managing Fisheries
- 93, Modeling Keystone Species
- 107, How Does Mining Affect the Land?
- 109, Modeling Soil Conservation
### Students who demonstrate understanding can:

**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.**

### INTERACTIVE SCIENCE:  
Chapter 4, Lesson 2 of the *Science and Technology* module explores the steps for designing technology. On SE/TE page 128, students obtain information about evaluating constraints of a design. In Apply It!, students model stages of the design process. On SE/TE page 138, Values and Trade-offs, students learn the process of evaluating technology’s risks and benefits, taking long and short term consequences into consideration. On TLR page 118, students brainstorm possible solutions to a problem and evaluate ideas. In the *Ecology and the Environment* module, students learn about costs and benefits of making environmental decisions, SE/TE pages 90-91. In Differentiated Instruction, TE page 91, students present two proposals to solve issues for evaluation. Students compare and contrast the pros and cons of three methods of solid waste disposal on SE/TE pages 135-137.

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

### Science and Engineering Practices

**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, 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.

### Science and Technology

**SE/TE:**
- 128, Apply It!

**TE Only:**
- 127, 21st Century Learning, Critical Thinking

**TLR:**
- 117, Inquiry Warm-Up-Why Redesign?

**STEM Activity Book**
- 17-20, It’s All Water Under the Dam

**Introduction to Chemistry**

**STEMQuest:** Hot and Cool Chemistry
- Design Your Pack
- Reflect on Your Pack

### Disciplinary Core Ideas

**ETS1.A: Defining and Delimiting an Engineering Problem**
- 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.

### Science and Technology

**SE/TE:**
- 127, Design a Solution
- 128, Apply it
- 128, Evaluate Constraints, Apply it!
- 131, Assess Your Understanding

**TE Only:**
- 131A, After the Inquiry Warm-Up: Technological Design
- 131B, Assess Your Understanding
- 131C, Key Concept Summary

**TLR:**
- 117, Inquiry Warm-Up-Why Redesign?
- 118, Quick Lab-Watch Ideas take Off

### Ecology and the Environment

**SE/TE:**
- 135-137, What Are Three Solid Waste Disposal Methods?

**TE Only:**
- 137, Differentiated Instruction

### Crosscutting Concepts

**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.

**Ecology and the Environment**

**SE/TE:**
- 86-91, Introduction to Environmental Issues
- 90, Apply It!
- 91, Figure 3, Weighing Costs and Benefits

**TE Only:**
- 91, Differentiated Instruction, Multimedia Presentation

**TLR:**
- 74, Quick Lab, Comparing Costs and Benefits

### Science and Technology

**SE/TE:**
- 132-133, How Has Technology Impacted Society?
- 134-136, What Are the Consequences of Technology?
| Forces and Energy | Introduction to Chemistry | 137-139, How Do You Decide Whether to Use a Technology? |
| STEMQuest: Keep Hot Liquids | STEMQuest: Hot and Cool Chemistry | TE Only: |
| Hot | Design Your Pack | 137, Differentiated Instruction, Choose Technology |
| Contain the Heat | Reflect on Your Pack | 138, 21st Century Learning, Information Literacy |
| Reflect on Your Insulating Container | | TLR: |
| Sound and Light | Forces and Energy | 119, Inquiry-Technology Hunt |
| STEMQuest: Design to Stop a Thief | STEMQuest: Keep Hot Liquids | 120, Quick Lab-Time-Saving Technology |
| An Optimal Optical Solution | Hot | 121, Quick Lab-How Does Technology Affect Your Life? |
| Reflect on Your Demonstration | Contain the Heat | 122, Quick Lab-Considering Impacts |

| Chapter Activities and Projects | |
| 15-21, Design and Build a Chair | |

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
MS. Engineering Design

**MS-ETS1-2**

Students who demonstrate understanding can:

**Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**

**INTERACTIVE SCIENCE:** In the *Science and Technology* module, Chapter 4, Lesson 2, SE/TE pages 124-131, students learn how to design a solution to a problem.

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

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<thead>
<tr>
<th>Science and Engineering Practices</th>
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<tbody>
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<td><strong>Engaging in Argument from Evidence</strong></td>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
</tr>
<tr>
<td>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.</td>
<td>• There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.</td>
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<td>• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.</td>
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<tr>
<td><strong>Forces and Energy</strong></td>
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<tr>
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<tr>
<td>Keep the Heat In</td>
<td>127-128, Design a Solution</td>
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<tr>
<td>Keep the Cold Out</td>
<td>129, Build a Prototype</td>
</tr>
<tr>
<td>Reflect on Your Insulating Container</td>
<td>130, Troubleshoot and Redesign</td>
</tr>
<tr>
<td><strong>Sound and Light</strong></td>
<td>131, Communicate the Solution</td>
</tr>
<tr>
<td>STEMQuest: Design to Stop a Thief</td>
<td>TLR:</td>
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<tr>
<td>An Optimal Optical Solution</td>
<td>117, Inquiry Warm-Up, Why Redesign?</td>
</tr>
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</tr>
<tr>
<td><strong>STEM Activity Book</strong></td>
<td>STEMQuest: Hot and Cool Chemistry</td>
</tr>
<tr>
<td>1-4, Shake, Rattle, and Roll</td>
<td>Reflect on Your Pack</td>
</tr>
<tr>
<td>17-20, It’s All Water Under the Dam</td>
<td><strong>Forces and Energy</strong></td>
</tr>
<tr>
<td>37-40, Sail Away</td>
<td>STEMQuest: Keep Hot Liquids Hot</td>
</tr>
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<td><strong>Chapter Activities and Projects</strong></td>
<td>Keep the Heat In</td>
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<tr>
<td>218-224, Design and Build an Earthquake Safe-House</td>
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<td>7-9, This Isn’t Science</td>
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<td>123</td>
</tr>
</tbody>
</table>
### MS. Engineering Design

**MS-ETS1-3**

Students who demonstrate understanding can:

**Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**

**INTERACTIVE SCIENCE:** In the *Science and Technology* module, Chapter 4, Lesson 2, SE/TE pages 124-131, students **learn** how to design a solution to a problem and redesign if necessary. In “Why Redesign?” on TLR page 117, students **design** a boat and then **redesign** the boat based on observations of the first design.

The performance expectation above was 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 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - Analyze and interpret data to determine similarities and differences in findings.

**STEM Activity Book**

- 9-12, I Wouldn't Drink That
- 21-24, Energy Boosters
- 45-48, Optical Security

<table>
<thead>
<tr>
<th><strong>Science and Engineering Practices</strong></th>
<th><strong>Disciplinary Core Ideas</strong></th>
</tr>
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<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
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<td>- Analyze and interpret data to determine similarities and differences in findings.</td>
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**Introduction to Chemistry**

**STEMQuest:** Hot and Cool Chemistry
- Reflect on Your Pack

**Forces and Energy**

**STEMQuest:** Keep Hot Liquids Hot
- Keep the Cold Out
- Reflect on Your Insulating Container

**Sound and Light**

**STEMQuest:** Design to Stop a Thief An Optimal Optical Solution
- Reflect on Your Demonstration

- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.

**Science and Technology**

**SE/TE:**
- 127-128, Design a Solution
- 129, Build a Prototype
- 130, Troubleshoot and Redesign
- 131, Communicate the Solution

**TLR:**
- 117, Inquiry Warm-Up, Why Redesign?

<table>
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**TLR:**
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ETS1.C: Optimizing the Design Solution
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.

### Science and Technology

**SE/TE:**
- 130, Troubleshoot and Redesign
- 130, Figure 6-Troubleshooting and Redesigning

**TE Only:**
- 130, Lead a Discussion, Identifying Problems and Redesigning
- 131A, After the Inquiry Warm-Up: Technological Design
- 131E, Enrich, A Redesigned Mouse

**TLR:**
- 117, Inquiry Warm-Up, Why Redesign?

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Sound and Light

STEMQuest: Design to Stop a Thief
An Optimal Optical Solution
Reflect on Your Demonstration

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
A Correlation of
Interactive Science Grades 6-8 Modules, ©2016 Digital Refreshment
to the Next Generation Science Standards for Middle School

### MS.Engineering Design
**MS-ETS1-4**

Students who demonstrate understanding can:

**Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

**INTERACTIVE SCIENCE:** In the *Science and Technology* module, Chapter 3, Lesson 4, SE/TE pages 92-99, students **learn** how to use models and systems.

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

**Science and Engineering Practices**
- Developing and Using Models
  - Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
  - Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.

**Science and Technology**
**SE/TE:**
- 98, Figure 5, How Arctic Sea Ice Melts
**TE Only:**
- 97, 21st Century Learning, Creativity
- 99, Build Inquiry, Earth Systems Model
**TLR:**
- 89, Quick Lab, Systems
- 108-116, Lab Investigation, Investigating a Technological System

**STEM Activity Book**
- 1-4, Shake, Rattle, and Roll

**Chapter Activities and Projects**
- 295-301, Design and Build an Erosion-Proof Beach
- 435-441, Design and Build an Optical Instrument

### Disciplinary Core Ideas
**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.

**Science and Technology**
**SE/TE:**
- 130, Troubleshoot and Redesign

**Introduction to Chemistry**
**STEMQuest:** Hot and Cool Chemistry
  - Pack Building
  - Reflect on Your Pack

**Forces and Energy**
**STEMQuest:** Keep Hot Liquids Hot
  - Keep the Cold Out
  - Reflect on Your Insulating Container

**Sound and Light**
**STEMQuest:** Design to Stop a Thief
  - An Optimal Optical Solution
  - Reflect on Your Demonstration

**STEM Activity Book**
- 13-16, Life on Mars
- 21-24, Energy Boosters
- 33-36, Crystal Clear
- 45-48, Optical Security

**Chapter Activities and Projects**
- 435-441, Design and Build an Optical Instrument

SE = Student Edition; TE = Teacher’s Edition; TLR = Teacher’s Lab Resource
- Models of all kinds are important for testing solutions.

**Science and Technology**

**SE/TE:**
92-99, Models as Tools in Science

**TE Only:**
98, Lead a Discussion, Model Storms
99, Differentiated Instruction, Telephone Model
99F, Enrich, A Scientific Model

**TLR:**
89, Quick Lab, Systems
90, Quick Lab, Models in Nature

ETS1.C: Optimizing the Design Solution
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.

**Introduction to Chemistry**

**STEMQuest:** Hot and Cool Chemistry
Pack Building
Reflect on Your Pack

**Forces and Energy**

**STEMQuest:** Keep Hot Liquids
Hot
Keep the Cold Out
Reflect on Your Insulating Container

**Sound and Light**

**STEMQuest:** Design to Stop a Thief
An Optimal Optical Solution
Reflect on Your Demonstration

**STEM Activity Book**
21-24, Energy Boosters
37-40, Sail Away

**Chapter Activities and Projects**
15-21, Design and Build a Chair

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