Science Practices: Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science. (5.1)

**Understand Scientific Explanations:** Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world. (5.1.A)

<table>
<thead>
<tr>
<th>Essential Questions</th>
<th>Enduring Understandings</th>
<th>Labs, Investigation, and Student Experiences</th>
</tr>
</thead>
</table>
| How do we build and refine models that describe and explain the natural and designed world? | Measurement and observation tools are used to categorize, represent and interpret the natural world. | **Instructional Guidance**
*To assist in meeting this CPI, students may:*
- Learn fundamental concepts, principles, theories, and models.
- Build organized and meaningful conceptual structures that incorporate these concepts, principles and theories.
- Use these relationships to revise claims and to discuss alternative explanations.
- Use mathematical, physical, and computational tools to observe, measure, and explain natural phenomena.
- Develop evidence-based models to explain the relationships between fundamental concepts and principles.
- Construct and refine models and propose revised theories as new evidence becomes available.
- Evaluate the strengths of arguments based on the evidence presented.
- Critique scientific arguments by considering the quality of the experimental design and data. |

<table>
<thead>
<tr>
<th>Content Statements</th>
<th>Cumulative Progress Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core scientific concepts and principles represent the conceptual basis for model-building and facilitate the generation of new and productive questions.</td>
<td>Demonstrate understanding and use interrelationships among central scientific concepts to revise explanations and to consider alternative explanations. <strong>5.1.8.A.1</strong></td>
</tr>
<tr>
<td>Results of observation and measurement can be used to build conceptual-based models and to search for core explanations.</td>
<td>Use mathematical, physical, and computational tools to build conceptual-based models and to pose theories. <strong>5.1.8.A.2</strong></td>
</tr>
<tr>
<td>Predictions and explanations are revised based on systematic observations, accurate measurements, and</td>
<td>Use scientific principles and models to frame and synthesize scientific arguments and pose theories. <strong>5.1.8.A.3</strong></td>
</tr>
</tbody>
</table>

**Resources**

- Bright Ideas for Middle School Teachers (A resource for middle school science)
  
- Interactive Science Simulations (University of Chicago)
Desired Results

To show evidence of meeting this CPI, students may answer the following questions:

To show evidence of meeting this CPI, students may complete the following assessments (correlate with Physical Science CPI 5.2.8.C.1):

1. Explore digital simulations to examine the cause and effect relationship between thermal energy from the sun and global ocean circulation patterns. Construct a written or oral explanation for the phenomenon.

2. You are an entomologist studying the relationship between nutritional needs and life cycle stages in insects. You are interested in raising the healthiest insect colony possible. Choose a model species (darkling beetle, butterfly, fruit fly, etc.) to study its life cycle course. Conduct a series of experiments that track the growth of the insect over time to determine which media or food are the best choices for each life cycle stage. Grow the same type of insect in different nutritional media (oatmeal, fruits, meats, dairy, etc.) and track the growth (length, weight) at several intervals within the life cycle. Why would growth patterns differ over the course of an insect’s lifetime? Are there different nutritional needs for different life cycles? Justify your conclusions using the growth data (length, weight) that you collect. Share and discuss your findings in a class entomology poster session.

3. Create an orrery model of the Solar System that illustrates the

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http://phet.colorado.edu/

- NetLogo is a multi-agent programmable modeling environment. It is used by tens of thousands of students, teachers and researchers worldwide:
  
  [http://ccl.northwestern.edu/netlogo/](http://ccl.northwestern.edu/netlogo/)
relative motions and positions of bodies in the Solar System. Works together as a class to create a human-powered orrery to model the movements of the four inner planets. Assist in setting up this moving model of the Solar System and take turns playing the roles of Mercury, Venus, Earth, and Mars.

4. Create project of choice (baking a cake model, music video, comic book or 3-D model) answering questions about history of planet, planet’s name, basic facts, support of life etc. Present final project to class.

5. Observe a model of the planets in motion and form conclusions about the orbital periods of the inner planets. Afterwards, predict as a class, the orbital periods of the outer planets using the mapped scale model.
Science Practices: Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science. (5.1)

**Generate Scientific Evidence Through Active Investigations:** Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims. (5.1.B)

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| What constitutes useful scientific evidence? | Evidence is used for building, refining, and/or critiquing scientific explanations. | **Instructional Guidance**
*To assist in meeting this CPI, students may:*  
- Ask scientific questions and determine what data to collect or measure in order to answer the questions.  
- Develop strategies for accurately measuring and collecting data.  
- Organize the data logically so that it may be used to answer questions or validate predictions.  
- Use scientific tools with accuracy and confidence.  
- Use mathematics in the collection, organization and analysis of data.  
- Use tools of data analysis to organize and represent data.  
- Make claims based on the available qualitative and quantitative evidence.  
- Cite evidence and explain the reasoning for a claim.  
- Use data representations to communicate findings.  
- Evaluate the quality of the available data.  
- Justify claims with connections to other fundamental concepts and principles.  
- Use evidence and data to support both a claim and the reasoning behind a scientific argument. |

<table>
<thead>
<tr>
<th>Content Statements</th>
<th>Cumulative Progress Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence is generated and evaluated as part of building and refining models and explanations.</td>
<td>Design investigations and use scientific instrumentation to collect, analyze, and evaluate evidence as part of building and revising models and explanations. [5.1.8.B.1]</td>
</tr>
<tr>
<td>Mathematics and technology are used to gather, analyze, and communicate results.</td>
<td>Gather, evaluate, and represent evidence using scientific tools, technologies, and computational strategies. [5.1.8.B.2]</td>
</tr>
<tr>
<td>Carefully collected evidence is used to construct and defend arguments.</td>
<td>Use qualitative and quantitative evidence to develop evidence-based arguments. [5.1.8.B.3]</td>
</tr>
<tr>
<td>Scientific reasoning is used to support scientific conclusions.</td>
<td>Use quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations. [5.1.8.B.4]</td>
</tr>
</tbody>
</table>
### Desired Results

To show evidence of meeting this CPI, students may answer the following questions:

To show evidence of meeting this CPI, students may complete the following assessments (correlate with Life Science CPI 5.3.8.D.1):

1. Work in groups to conduct experimental crosses using fruit flies. Record the specific traits that appear in each generation (eye color, body color, wing type, etc) to determine the patterns of inheritance between generations.

2. After conducting the experimental crosses, document patterns of inheritance, and draw conclusions about the patterns, citing evidence.

To show evidence of meeting this CPI, students may complete the following assessment (correlate with Earth Systems Science CPI 5.4.8.G.1):

1. Conduct an experiment, collecting and graphing data that shows the temperature change of water over time when heated from ice to water vapor.

To show evidence of meeting this CPI, students may complete the following assessments (correlate with Physical Science CPI 5.2.8.A.5):

1. Design investigations and use scientific instruments to collect, analyze and evaluate evidence as part of building

### Resources

- Bright Ideas for Middle School Teachers (A resource for middle school science)
  
  [http://www.urahead.org/reports/skoog.pdf](http://www.urahead.org/reports/skoog.pdf)

- Interactive Science Simulations (University of Chicago):
  
  [http://phet.colorado.edu/](http://phet.colorado.edu/)

- NetLogo is a multi-agent programmable modeling environment. It is used by tens of thousands of students, teachers and researchers worldwide:
  
  [http://ccl.northwestern.edu/netlogo/](http://ccl.northwestern.edu/netlogo/)
an explanation for classifying samples as a pure substance or a compound. Use partner talk and whole-group discussions in order to learn from other’s ideas.

*To show evidence of meeting this CPI, students may complete the following assessments (correlate with Earth Systems Science CPI 5.4.4.F.2):*

1. Analyze climatographs (graph of the average monthly temperature and rainfall quantities for a location) for coastal and inland locations to identify and generalize patterns.

2. Analyze diurnal temperature patterns for coastal and inland locations to identify and generalize patterns.
**Science Practices:** Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science. (5.1)

### Reflect on Scientific Knowledge: Scientific knowledge builds on itself over time. (5.1.C)

<table>
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</tr>
</thead>
</table>
| How is scientific knowledge constructed? | Scientific knowledge builds upon itself over time. | **Instructional Guidance**

To assist in meeting this CPI, students may:
- Monitor and reflect on their ideas as those ideas change over time.
- Extend investigations beyond inquiry and practice modeling, organizing observations, and historical reconstructions.
- Search for core explanations and connections between fundamental concepts and principles as they develop their understandings.
- Engage in evidence-based arguments as they explore and refine predictions or explanations.
- Explore the reasoning for multiple interpretations for the same phenomenon.
- Justify, citing evidence and reasoning, the revision of explanations or predictions.
- Collaborate with peers to generate new questions and investigations to explore cause-and-effect relationships.
- Create multiple representations of the results of an investigation.
- Move confidently between multiple forms of representations (e.g., graph, chart, data table). |

<table>
<thead>
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</tr>
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<tbody>
<tr>
<td>Scientific models and understandings of fundamental concepts and principles are refined as new evidence is considered.</td>
<td>Monitor one’s own thinking as understandings of scientific concepts are refined. <strong>5.1.8.C.1</strong></td>
</tr>
<tr>
<td>Predictions and explanations are revised to account more completely for available evidence.</td>
<td>Revise predictions or explanations on the basis of discovering new evidence, learning new information, or using models. <strong>5.1.8.C.2</strong></td>
</tr>
<tr>
<td>Science is a practice in which an established body of knowledge is continually revised, refined, and extended.</td>
<td>Generate new and productive questions to evaluate and refine core explanations. <strong>5.1.8.C.3</strong></td>
</tr>
</tbody>
</table>

### Desired Results
Sample Assessments:

1. Describe in written text or as part of classroom discussion what happens to kinetic and gravitational potential energy as a ball is thrown up in the air and lands on the ground. Explain their thinking about what happens to kinetic and potential energy.

2. Design an experiment that determines if the precipitation in their area is acidic. Graph amounts of precipitation, pH levels, and general weather conditions for the course of the experiment. On the basis of their findings, provide an analysis of the problem. If they can identify the sources of acid rain, they may name them, but they must be able to substantiate their allegation.

3. Your class has been invited to compete in a school-science-fiction film festival. The theme of this year’s festival is “A World Without Light”. Using concepts related to photosynthesis and food webs, create a short film (2-8 minutes) depicting the consequences of a world without solar energy. Focus first on the effects on the plant and non-human animal world, and then explore how humans might respond. Present your film at the school’s festival for review.

Resources:

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Science Practices: Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science. (5.1)

Participate Productively in Science: The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms. (5.1.D)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>How does scientific knowledge benefit, deepen, and broaden from scientists sharing and debating ideas and information with peers?</td>
<td>The growth of scientific knowledge involves critique and communication – social practices that are governed by a core set of values and norms.</td>
<td>Instructional Guidance To assist in meeting this CPI, students may:</td>
</tr>
<tr>
<td>Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small group work.</td>
<td>Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences. 5.1.8.D.1</td>
<td>• Engage in productive conversations with their peers.</td>
</tr>
<tr>
<td>In order to determine which arguments and explanations are most persuasive, communities of learners work collaboratively to pose, refine, and evaluate questions, investigations, models, and theories (e.g., argumentation,</td>
<td>Engage in productive scientific discussion practices during conversations with peers, both face-to-face and virtually, in the context of scientific investigations and model-building. 5.1.8.D.2</td>
<td>• Use partner talk, whole-group discussions, and small group work in order to learn from other’s ideas.</td>
</tr>
<tr>
<td>• Pose, refine, and evaluate questions, investigations, models, and theories collaboratively (e.g., argumentation, representation, visualization, etc.)</td>
<td>• Engage in evidence-based scientific arguments.</td>
<td></td>
</tr>
<tr>
<td>• Engage in productive scientific discussion practices during conversations with peers, both face-to-face and virtually, in the context of scientific investigations and model-building. 5.1.8.D.2</td>
<td>• Persuade peers of the validity of one’s own ideas and the ideas of others.</td>
<td></td>
</tr>
<tr>
<td>• Engage in productive conversations with their peers.</td>
<td>• Demonstrate understanding of a safe and accurate measurement in the context of an investigation.</td>
<td></td>
</tr>
<tr>
<td>• Use partner talk, whole-group discussions, and small group work in order to learn from other’s ideas.</td>
<td>• Take proactive measures to insure their personal safety and the safety of their peers.</td>
<td></td>
</tr>
<tr>
<td>• Engage in evidence-based scientific arguments.</td>
<td>• Demonstrate an individual sense of responsibility and good habits for safety.</td>
<td></td>
</tr>
<tr>
<td>• Persuade peers of the validity of one’s own ideas and the ideas of others.</td>
<td>• Investigate potential health hazards such as E Coli, dander, or other allergens prior to bringing them into the classroom.</td>
<td></td>
</tr>
<tr>
<td>• Demonstrate understanding of a safe and accurate measurement in the context of an investigation.</td>
<td>• Demonstrate knowledge about the care of organisms so that both students and specimens stay safe and healthy during all activities.</td>
<td></td>
</tr>
</tbody>
</table>
Instruments of measurement can be used to safely gather accurate information for making scientific comparisons of objects and events. **5.1.8.D.3**

| Instruments of measurement can be used to safely gather accurate information for making scientific comparisons of objects and events. | Demonstrate how to safely use tools, instruments, and supplies.  
5.1.8.D.3 |
|---|---|
| Organisms are treated humanely, responsibly, and ethically. | Handle and treat organisms humanely, responsibly, and ethically.  
5.1.8.D.4 |

### Desired Results

**Sample Assessments:**
1. You are a cargo inspection agent working in Guam to prevent the introduction of non-native species to your island. People coming into your territory often do not understand why you must spend so much time checking their cargo. Working in small groups, develop a public service announcement and media campaign to explain to the public how devastating the introduction of non-native species can be to an island ecosystem. Research how the region has been affected by invasive species. Connect with experts in the field to further your understandings, especially those living in the target country. Use video clips, podcasts, and other authentic media to help explain the impact. Focus your message on how non-native species can become invasive and affect the biodiversity of the island.

2. Engage in a globally collaborative project, such as The Noon Day Project, where students from around the

- Follow local, state, and national laws, policies, and regulations when live organisms are included in classroom activities.
- Engage in research and discussions about the ethical questions regarding the use of organisms in instruction.

### Resources:

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<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Design and carry out an investigation involving a chemical change. Compare the mass of the reactants with the mass of the products. Use data derived from the investigation to confirm or reject the principle of conservation of mass.</td>
</tr>
<tr>
<td>4.</td>
<td>Work in groups to conduct experimental crosses using fruit flies. Vary one environmental factor (temperature, light, etc.) and then collect and analyze data. Record the specific traits that appear in each generation (eye color, body color, wing type, etc.) to determine if the offsprings’ traits are altered in any way by the changed environmental factor as compared to control situation.</td>
</tr>
</tbody>
</table>
### 5.2 Physical Science: Physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science. (5.2)

**Properties of Matter:** All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia. (5.2.A)

<table>
<thead>
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</tr>
</thead>
</table>
| How can we explain how materials react when we do things to them?                  | A wide variety of phenomena can be explained by alternative arrangements of vast numbers of invisibly tiny moving parts. | **Instructional Guidance** **To assist in meeting these CPIs, students may:**
  - Predict the elements that will result from electrolysis of water based on the molecular formula for water and revise claims as appropriate based on the evidence derived.
  - Collaborate with peers to develop strategies for describing the types of atoms and their numbers in an element or compound.
  - Collaborate with peers to develop techniques for determining the elements that make common things (e.g., sugar (C6H12O6), salt (NaCl), water (H2O), etc).
  - **Note:** Students should be developing a conceptual understanding of the atomic theory rather than memorizing characteristics of individual elements.
  - Engage in multiple forms of discussion and modeling in order to process, make sense of, and learn from others ideas and observations of the properties of ice, liquid, water and steam.
  - Use digital instructional tools, such as BBC Science Clips and Gizmo Online Interactive Labs, to explore the molecular arrangement and properties of solids, liquids and gasses.
  - Observe properties of elements and sort them into categories (i.e. metals and nonmetals, gases and solids).
  - Explore the reasoning for multiple classification systems described by different groups of students.
  - Watch an Alkali Metal video on [YouTube](https://www.youtube.com). Write about the

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>All matter is made of atoms. Matter made of only one type of atom is called an element.</td>
<td>Explain that all matter is made of atoms, and give examples of common elements. 5.2.8.A.1</td>
</tr>
<tr>
<td>All substances are composed of one or more of approximately 100 elements.</td>
<td>Analyze and explain the implications of the statement “all substances are composed of elements.” 5.2.8.A.2</td>
</tr>
<tr>
<td>Properties of solids, liquids, and gases are explained by a model of matter as composed of tiny particles (atoms) in motion.</td>
<td>Use the kinetic molecular model to predict how solids, liquids, and gases would behave under various physical circumstances, such as heating or cooling. 5.2.8.A.3</td>
</tr>
<tr>
<td>The Periodic Table organizes the elements into families of elements with similar properties.</td>
<td>Predict the physical and chemical properties of elements based on their positions on the Periodic Table. 5.2.8.A.4</td>
</tr>
</tbody>
</table>
Elements are a class of substances composed of a single kind of atom.

Compounds are substances that are chemically formed and have physical and chemical properties that differ from the reacting substances.

<table>
<thead>
<tr>
<th>Elements are a class of substances composed of a single kind of atom.</th>
<th>Identify unknown substances based on data regarding their physical and chemical properties. <strong>5.2.8.A.5</strong></th>
<th>reactions viewed in the video and explain how certain metals are more reactive with water than others.</th>
</tr>
</thead>
</table>
| Compounds are substances that are chemically formed and have physical and chemical properties that differ from the reacting substances. | Determine whether a substance is a metal or nonmetal through student-designed investigations. **5.2.8.A.6** | • Model the historic development of the periodic table of elements. Given a palette or strip of paint color chips from a hardware store, arrange them in some logical order and make predictions (e.g., hue, tint, color). Explore the reasoning for multiple arrangements.  
  ✓ **Note:** Students should be developing basic skills for interpreting and using periodic tables rather than memorizing the physical and chemical properties of elements. |
| Substances are classified according to their physical and chemical properties. Acids are a class of compounds that exhibit common chemical properties, including a sour taste, characteristic color changes with litmus and other acid/base indicators, and the tendency to react with bases to produce a salt and water. | Determine the relative acidity and reactivity of common acids, such as vinegar or cream of tartar, through a variety of student-designed investigations. **5.2.8.A.7** | • Design investigations and use scientific instruments to collect, analyze and evaluate evidence as part of building an explanation for classifying samples as a pure substance or a compound. |
| Substances are classified according to their physical and chemical properties. Metals are a class of elements that exhibit physical properties, such as conductivity, and chemical properties, such as producing salts when combined with nonmetals. | | • Use partner talk and whole-group discussions in order to learn from other’s ideas. |
| | | • Given an interactive digital periodic table of elements, identify unknown substances based on their physical and chemical properties. Collaboratively evaluate and refine claims based on peers’ evidence and reasoning. |
| | | • Design and carry out an investigation to determine whether a substance is a metal or nonmetal. Justify, citing evidence and reasoning for the classifications. |
| | | o Include conductivity, and common chemical properties. |
| | | o Identify patterns in the data and generate conclusions. |
| | | o Using appropriate software or online tools, create a presentation to describe and defend the investigation. |
| | | • Investigate the properties of common acids and bases used in cooking (e.g., vinegar, baking soda, and cream of tartar). |
| | | • Determine the relative strength of the acids and bases and then explain how those properties determine their inclusion reactions viewed in the video and explain how certain metals are more reactive with water than others. |
| | | • Model the historic development of the periodic table of elements. Given a palette or strip of paint color chips from a hardware store, arrange them in some logical order and make predictions (e.g., hue, tint, color). Explore the reasoning for multiple arrangements.  
  ✓ **Note:** Students should be developing basic skills for interpreting and using periodic tables rather than memorizing the physical and chemical properties of elements. |
| | | • Design investigations and use scientific instruments to collect, analyze and evaluate evidence as part of building an explanation for classifying samples as a pure substance or a compound. |
| | | • Use partner talk and whole-group discussions in order to learn from other’s ideas. |
| | | • Given an interactive digital periodic table of elements, identify unknown substances based on their physical and chemical properties. Collaboratively evaluate and refine claims based on peers’ evidence and reasoning, |
| | | • Design and carry out an investigation to determine whether a substance is a metal or nonmetal. Justify, citing evidence and reasoning for the classifications. |
| | | o Include conductivity, and common chemical properties. |
| | | o Identify patterns in the data and generate conclusions. |
| | | o Using appropriate software or online tools, create a presentation to describe and defend the investigation. |
| | | • Investigate the properties of common acids and bases used in cooking (e.g., vinegar, baking soda, and cream of tartar). |
| | | • Determine the relative strength of the acids and bases and then explain how those properties determine their inclusion reactions viewed in the video and explain how certain metals are more reactive with water than others. |
Desired Results

To show evidence of meeting this CPI, students may answer the following questions:

1. What would be left if all of the atoms in the chair that you are sitting in were removed? Explain.

2. What does an astronomer mean when she says that we are all made of stardust?

3. Explain why astronomers can use spectroscopy to determine the chemical composition of stars that are millions of light years away.

4. When 1 gram of water is evaporated, the volume of the water vapor increases but the mass remains constant. Why does the mass of the water remain constant?
   - A. The temperature of the water remains constant.
   - B. The pressure acting on the water remains constant.
   - C. The number of atoms in the water remains constant.
   - D. The distance between water molecules remains constant.

5. Magnesium metal (Mg) is grayish-white in color and reacts actively with water. Fluorine (F₂) is a greenish-yellow gas at room temperature and is a member of the halogen family. These two elements react to produce magnesium fluoride (MgF₂), a chemical commonly used in making windows and lenses.

6. According to the Periodic Table of the Elements, which element is most similar to magnesium (Mg)?

in a recipe.

Resources

- National Science Digital Library, Science Digital Literacy Maps The Physical Setting: States of Matter http://strandmaps.nsdl.org/?id=SMS-MAP-1341
A. calcium (Ca)  
B. iodine (I)  
C. sodium (Na)  
D. sulfur (S)

7. When sodium metal reacts with chlorine gas, sodium chloride (table salt) forms. The data table below shows information about sodium, chlorine, and sodium chloride.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Physical Appearance</th>
<th>Boiling Point (°C)</th>
<th>Change When Added to Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (Na)</td>
<td>Shiny, soft, solid metal</td>
<td>883</td>
<td>Forms new compound</td>
</tr>
<tr>
<td>Chlorine (Cl)</td>
<td>Greenish gas</td>
<td>–34</td>
<td>Forms new compound</td>
</tr>
<tr>
<td>Sodium chloride (NaCl)</td>
<td>White crystals</td>
<td>1,465</td>
<td>Dissolves in water</td>
</tr>
</tbody>
</table>

8. Which statement best describes the properties of sodium, chlorine, and sodium chloride?

A. All have similar chemical and physical properties.  
B. All have different chemical and physical properties.  
C. All have similar physical properties but different chemical properties.  
D. All have similar chemical properties but different physical properties.

9. When Chemical X is added to a certain liquid, the chemical breaks into Substances Y and Z. It is not possible to break Substances Y and Z into simpler particles.

10. Which statement is best supported by this evidence?
   
   A. Chemical X is an element.
   B. Chemical X is soluble in water.
   C. Substances Y and Z are elements.
   D. Substances Y and Z are compounds.

11. A metal spoon and a plastic spoon are placed in hot water. After a minute, the metal spoon feels hot and the plastic spoon feels warm. Explain why the heat transfer is different between the two spoons.

12. During an investigation, students were given chemical data for several common household products, as shown in the data table below. Students were to determine if a substance was an acid or base by using litmus paper. Litmus paper turns red in an acid and turns blue in a base.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Color of Solution</th>
<th>Melting Point (°C)</th>
<th>Boiling Point (°C)</th>
<th>Soluble in Water</th>
<th>Odor</th>
<th>Litmus Paper Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpet cleaner</td>
<td>Clear</td>
<td>0</td>
<td>100</td>
<td>Yes</td>
<td>Weak</td>
<td>Blue</td>
</tr>
<tr>
<td>Vinegar</td>
<td>Clear</td>
<td>-2</td>
<td>118</td>
<td>Yes</td>
<td>Strong</td>
<td>Red</td>
</tr>
<tr>
<td>Oven cleaner</td>
<td>Clear</td>
<td>-1</td>
<td>93</td>
<td>Yes</td>
<td>Weak</td>
<td>Blue</td>
</tr>
<tr>
<td>Bleach</td>
<td>Clear, light yellow</td>
<td>0</td>
<td>100</td>
<td>Yes</td>
<td>Strong</td>
<td>Blue</td>
</tr>
</tbody>
</table>

1. Which physical property best classifies vinegar in a separate group of substances from oven cleaner?

A. boiling point  
B. melting point  
C. color of solution  
D. solubility in water

2. Which conclusion is supported by the data from the investigation?

A. Many cleaning supplies are soluble in water.  
B. Cleaning solutions with a weak odor are acids.  
C. Water is the main ingredient in many cleaning supplies.  
D. A substance changes from a gas to a liquid as the temperature of the substance increases.

3. During lunch, you and your friends decided to eat as many tacos as you could. Now, at the end of the day, you are experiencing heartburn so you decide to ask the school nurse for antacid tablets. You read on the label that the active ingredient is calcium carbonate. Explain to your friends, who are also in pain, how and why the antacid works in the stomach.

Substances are classified as acidic, basic, or neutral. The pH scale can be used to classify a substance.
4. Which feature suggests that a substance is basic?

A. The pH is 0.
B. The pH is 7.
C. The pH is less than 7.
D. The pH is greater than 7.
**Physical Science:** Physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science. (5.2)

**Changes in Matter:** Substances can undergo physical or chemical changes to form new substances. Each change involves energy. (5.2.B)

<table>
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<th>Essential Questions</th>
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</table>
| How does conservation of mass apply to the interaction of materials in a closed system? | When materials interact within a closed system, the total mass of the system remains the same. | **Instructional Guidance**

*To assist in meeting these CPIs, students may:*

- Design and carry out an investigation to show that mass is conserved when substances undergo phase change. Engage in evidence-based arguments as they explore and refine their explanations for their data.
- Design and carry out an investigation involving a chemical change (e.g., Alka Seltzer and water). Compare the mass of the reactants with the mass of the products. Use data derived from the investigation to confirm or reject the principle of conservation of mass.
- Predict, sharing their reasoning, the result of combining iron or steel wool and water (forms rust). Explain the formation of rust using conceptual understanding of conservation of mass.
- Compare the properties of the Diet Coke® and Mentos® with the products of the reaction. Using concept-based models explain why the products are different than the products in this reaction.
- Compare and contrast the properties of the reactants and products involved in photosynthesis and cellular respiration.

**Note:** The focus of this CPI is that the physical properties of reactants and the physical properties of the products are different after a chemical reaction. The intent is not to focus on the process of photosynthesis.

<table>
<thead>
<tr>
<th>Content Statements</th>
<th>Cumulative Progress Indicators</th>
</tr>
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<tbody>
<tr>
<td>Chemical changes can occur when two substances, elements, or compounds react and produce one or more different substances. The physical and chemical properties of the products are different from those of the reacting substances.</td>
<td>Explain, using an understanding of the concept of chemical change, why the mass of reactants and the mass of products remain constant. 5.2.8.B.1</td>
</tr>
<tr>
<td>Compare and contrast the physical properties of reactants with products after a chemical reaction, such as those that occur during photosynthesis and cellular respiration. 5.2.8.B.2</td>
<td></td>
</tr>
</tbody>
</table>
To show evidence of meeting this CPI, students may answer the following question:

1. How are transforming liquid water to ice similar to or different than transforming steel wool into rust?

2. Compare and contrast the physical properties of the reactants in the photosynthesis reaction with the physical properties of the products.

Resources

- Science Curriculum Topic Study: Conservation of Matter p. 163
- Science Curriculum Topic Study: Chemical Properties and Change p. 161
### Essential Questions

Where does the energy come from that drives Earth’s weather and climate systems?

The Sun’s energy drives almost all weather and climate systems.

### Content Statements

A tiny fraction of the light energy from the Sun reaches Earth. Light energy from the Sun is Earth’s primary source of energy, heating Earth surfaces and providing the energy that results in wind, ocean currents, and storms.

Energy is transferred from place to place. Light energy can be thought of as traveling in rays. Thermal energy travels via conduction and convection.

### Cumulative Progress Indicators

Structure evidence to explain the relatively high frequency of tornadoes in “Tornado Alley.”

Model and explain current technologies used to capture solar energy for the purposes of converting it to electrical energy.

### Desired Results

### Instructional Guidance

**To assist in meeting these CPIs, students may:**

- Explore digital simulations to examine the cause and effect relationship between thermal energy from the sun and global ocean circulation patterns. Construct a written or oral explanation for the phenomenon.
- Use data and computational tools to construct explanations for the observation that it always seems hotter in the city than in the suburbs during the summer.
- Organize multiple data sets to engage in evidence-based arguments to explain the relatively high frequency of tornadoes in “Tornado Alley.”
- Identify all the energy forms and energy transformations in a Rube Goldberg machine or pinball machine. Share with class and explain reasoning.
- In text or drawings, explain the mechanisms by which radiation, conduction, and convection could be used to heat and cook food – or given different cooking appliances (convection oven, heat lamp, open flame, stove top), identify which mechanism is utilized to cook the food.
- Explore and explain how solar energy is being harnessed to provide easier, more environmentally friendly, access to basic needs in developing regions around the world (e.g., solar ovens, solar water purification systems, solar water...
To show evidence of meeting this CPI, students may answer the following question:

1. A travel agent has offered you significant discounts on hotels in the Caribbean if you will agree to travel on your vacation in August or September. Based on your understanding of how hurricanes form, would it be worth the discount to travel to the Caribbean in late summer rather than in June?

2. When toasting bread in an electric toaster (or roasted a chicken in a regular oven) identify what types of energy are present before, during, and after the toasting (roasting) and explain where the energy forms are coming from, where they went, and how they traveled.

Resources
- National Science Digital Library, Science Digital Literacy Maps The Physical Setting: Energy Transformations http://strandmaps.nsdl.org/?id=SMS-MAP-2071
- The Physical Setting: Weather and Climate http://strandmaps.nsdl.org/?id=SMS-MAP-1698
### Physical Science: Physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science. (5.2)

### Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another. (5.2.D)

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</table>
| How can energy be transferred from one system to another? | Energy is transferred to matter through the action of forces. Different forces are responsible for the transfer of the different forms of energy. | **Instructional Guidance**  
To assist in meeting these CPIs, students may:  
- Determine the relative qualitative amounts of kinetic energy of a car moving at different speeds (10 mph, 30 mph, and 60 mph).  
- In whole class discussion when working on a kinetic energy problem, identify what they need to know in order to determine if something has kinetic energy (or the amount of kinetic energy that an object has), and explain why it is helpful to know whether something has kinetic energy.  
- Describe in written text or as part of classroom discussion, what happens to kinetic, and gravitational potential energy as a ball is thrown up in the air and lands on the ground. Explain their thinking about what happens to kinetic and potential energy.  
- Use measurements from a model roller coaster or scaled video file to compare the kinetic and potential energies of the roller coaster at various points on its path and identify patterns and/or discrepancies in the results.  
- Trace the transformations of energy from chemical potential energy in a student’s snack to the potential energy in a rubber band stretched by the student to the gravitational potential energy of a large paper clip at the top of its motion when |

<table>
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| When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. As an object falls, its potential energy decreases as its speed, and consequently its kinetic energy, increases. While an object is falling, some of the object’s kinetic energy is transferred to the medium through which it falls, setting the medium into motion and heating it. | Relate the kinetic and potential energies of a roller coaster at various points on its path.  
5.2.8.D.1 |
Nuclear reactions take place in the Sun.

In plants, light energy from the Sun is transferred to oxygen and carbon compounds, which in combination, have chemical potential energy (photosynthesis).

Describe the flow of energy from the Sun to the fuel tank of an automobile. 5.2.8.D.2

- Make measurements to estimate the thermal energy available from a known mass of dry grass and compare this to an estimate of the solar energy that fell upon the grass as it grew, and account for the differences in these estimates.

**Desired Results**

*To show evidence of meeting this CPI, students may answer the following questions:*

1. Which has more kinetic energy, a typical loaded large 18-wheel truck traveling at 5 mph (on average they weigh 50,000 pounds) or a typical car traveling at 100 mph (on average they weigh 3000 pounds)? Explain your reasoning. Which do you think will cause more damage if it, by accident, ran into a building located on the side of the road? (Teacher may want to include pictures of the truck and car to give students and image of these objects).

2. Is a hamburger an example of stored energy? Explain why or why not. (NAEP)

3. Right before Anna was about to run in a long race, she drank a large glass of orange juice to get energy. Tell how the energy that was in the orange juice actually came from the Sun. (NAEP)

**Resources**

- National Science Digital Library, Science Digital Literacy Maps The Physical Setting: Energy Transformations http://strandmaps.nsdl.org/?id=SMS-MAP-2071
4. Some people have proposed that ethyl alcohol (ethanol), which can be produced from corn, should be used in automobiles as a substitute for gasoline. Explain an environmental and an economic impact that could result from substituting ethyl alcohol for gasoline.
## Physical Science

Physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science. (5.2)

### Forces and Motion

It takes energy to change the motion of objects. The energy change is understood in terms of forces. (5.2.E)

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</table>
| How can energy be transferred from one material to another? | Changes take place because of the transfer of energy. Energy is transferred to matter through the action of forces. | **Instructional Guidance**

*To assist in meeting these CPIs, students may:*  
- Make measurements and use graphing software to create graphs that support a written description of an object's motion to include position and speed as a function of time.  
- Make measurements and use graphing software to display a position-time graph for a moving object.  
- Use probeware to measure the speed of a moving object and display it using graphing software.

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<tbody>
<tr>
<td>An object is in motion when its position is changing. The speed of an object is defined by how far it travels divided by the amount of time it took to travel that far.</td>
<td>Calculate the speed of an object when given distance and time. <strong>5.2.8.E.1</strong></td>
</tr>
<tr>
<td>Forces have magnitude and direction. Forces can be added. The net force on an object is the sum of all the forces acting on the object. An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion at constant velocity will continue at the same</td>
<td>Compare the motion of an object acted on by balanced forces with the motion of an object acted on by unbalanced forces in a given specific scenario. <strong>5.2.8.E.2</strong></td>
</tr>
</tbody>
</table>

- Use probeware or simple tools to measure the motion of an object sliding to a stop and infer the force of friction acting on the object during the slide.  
- Use probeware or mechanical devices to measure the net force produced by a set of forces acting in one dimension and compare the net and individual forces.  
- Obtain information to estimate the kinetic energy of an "average" 10-year-old in an automobile moving at 30 mph (48 km/hr) and then estimate the force required to stop such a child over a distance of 3 meters, as in an accident.  
- Observe, record, and compare the speed and path of an object moving in very low friction conditions and normal friction conditions. Explain how the experiment models real world scenarios.  
- Use probeware to measure the effect of different forces on the linear motion of an object and use this to infer an unknown force such as the force of friction.
5.2.8.E | 2011

<table>
<thead>
<tr>
<th>velocity unless acted on by an unbalanced force.</th>
<th>Resources:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Results</td>
<td>• National Science Digital Library, Science Digital Literacy Maps The Physical Setting: <a href="http://strandmaps.nsdl.org/?id=SMS-MAP-1357">Laws of Motion</a></td>
</tr>
<tr>
<td>To show evidence of meeting this CPI, students may answer the following questions:</td>
<td>• National Science Digital Library, <a href="http://nsdl.org/refreshers/science/">Science Refreshers</a></td>
</tr>
<tr>
<td>1. While hanging out in the neighborhood you overhear some adults complaining about how fast the cars are driving past the playground. The posted speed limit is 25 mph. Some of the adults plan to complain at the next city council meeting. Based on past experience with the city council you know that they want data not anecdotes before they consider taking any action. Describe a simple yet effective way to determine the speed of the cars.</td>
<td>• National Science Digital Library, Science Digital Literacy Maps The Physical Setting: <a href="http://strandmaps.nsdl.org/?id=SMS-MAP-1357">Laws of Motion</a></td>
</tr>
<tr>
<td>2. A toy car rolls at a constant speed down a straight inclined track. When the car reaches the flat surface at the base of the inclined track, the speed of the car decreases.</td>
<td>• National Science Digital Library, <a href="http://nsdl.org/refreshers/science/">Science Refreshers</a></td>
</tr>
<tr>
<td>Which statement best explains why the speed of the car decreases when it reaches the flat surface?</td>
<td></td>
</tr>
<tr>
<td>A. The force of gravity acting on the car increases.</td>
<td></td>
</tr>
<tr>
<td>B. The force of gravity acting on the car decreases.</td>
<td></td>
</tr>
</tbody>
</table>
C. The forces influencing the car are not balanced.  
D. The forces influencing the car are balanced.  

<table>
<thead>
<tr>
<th>3. The motion of a car accelerating in a straight line differs from the motion of a car moving in a straight line at a constant speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which change best describes acceleration of a car?</td>
</tr>
<tr>
<td>A. a change in the direction of the car</td>
</tr>
<tr>
<td>B. a change in the distance the car travels</td>
</tr>
<tr>
<td>C. the change in velocity divided by the time for that change</td>
</tr>
<tr>
<td>D. the change in the time for the car to travel a distance</td>
</tr>
</tbody>
</table>
**Life Science 5.3:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

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<tbody>
<tr>
<td>What do all living things have in common?</td>
<td>Living organisms have a variety of observable features that enable them to obtain food and reproduce.</td>
<td>• Compare live or digital video images of a variety of single-celled organisms to multi-cellular organisms. Consider factors such as behavior, growth, development, movement, etc. to describe the differences.</td>
</tr>
</tbody>
</table>

### Content Statements

<table>
<thead>
<tr>
<th>5.3.8.A.1</th>
<th>5.3.8.A.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.3.8.A.1</strong></td>
<td>Compare the benefits and limitations of existing as a single or multicellular organism.</td>
</tr>
<tr>
<td><strong>5.3.8.A.2</strong></td>
<td>In multicellular organisms, specialized cells perform specialized functions. Tissues, organs and organ systems are composed of cells and function to serve the needs of cells for food, air, and waste removal.</td>
</tr>
<tr>
<td><strong>5.3.8.A.1</strong></td>
<td>• Explain the division of labor among the levels of the hierarchy in multi-cellular organisms that allow these organisms to carry out necessary life processes, and how that may differ from single-celled organisms.</td>
</tr>
<tr>
<td><strong>5.3.8.A.2</strong></td>
<td>• Compare the benefits and limitations as a single celled organism and as a multi-cellular organism through a classroom debate.</td>
</tr>
</tbody>
</table>
compose the final organism.

Tissues grow through cell division.

**Desired Results**

**Sample Assessments 5.3.8.A.1**
*To show evidence of meeting this CPI, students may complete the following assessment:*

1. Students imagine that they are slime molds, which are capable of living as singular or multi-cellular organisms. They write a persuasive essay to the rest of the slime molds, asking them to either unite or separate, using the benefits and drawbacks living as a singular or multi-celled organism to guide their argument. Students make a claim about the preferred lifestyle, and support it with evidence and reasoning.

**To show evidence of meeting this CPI, students may answer the following question:**

1. How is a skin cell from a mouse similar to an amoeba?
   A. *Both need energy.*
   B. Both have cell walls.
   C. Both move with pseudopodia.
   D. Both consume carbon dioxide.

**Sample Assessments 5.3.8.A.2**
*To show evidence of meeting this CPI, students may complete the following assessment:*

- Compare prepared slides or digital images of a variety of cells from human body systems (nervous, digestive, cardiac, circulatory etc.). Consider how the shape and structure of each cell type is related to the function of the cell. Describe the differences with respect to cell functioning.

**Resources 5.3.8.A.2**
- Teachers’ Domain provides lesson plans and other multimedia resources (video clips and simulations) that support this CPI. 
1. Students answer the question *how does structure relate to function?* by creating a pictorial essay using cell images. There will be no words accompanying the essay, just images. Students select the appropriate images (and sequence the images) to demonstrate to the viewer how cellular and tissue structures determine the function of these elements.

To show evidence of meeting this CPI, students may answer the following question:

1. The numbered drawings below show the organization within a multicellular organism from simple to complex.

   ![Diagram](image)

Which of these numbered drawings represents a tissue?

A. 1  
B. 2  
C. 3  
D. 4
**Life Science 5.3:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

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<tr>
<td>How is matter transformed, and energy transferred/transformed in living systems?</td>
<td>All organisms transfer matter and convert energy from one form to another.</td>
<td>• Conduct an experiment to monitor the growth and development of an organism, tracking the changes in nutritional needs throughout an organism’s life cycle</td>
</tr>
</tbody>
</table>

**Content Statements**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Food is broken down to provide energy for the work that cells do, and is a source of the molecular building blocks from which needed materials are assembled.</td>
<td>5.3.8.B.1 Relate the energy and nutritional needs of organisms in a variety of life stages and situations, including stages of development and periods of maintenance.</td>
</tr>
<tr>
<td>All animals, including humans, are consumers that meet their energy needs by eating other organisms or their products.</td>
<td>5.3.8.B.2 Analyze the components of a consumer’s diet and trace them back to plants and plant products.</td>
</tr>
</tbody>
</table>

**Resources 5.3.8.B.1**

- Annenberg Media’s Teachers’ Resources offer short video courses covering essential science content for K-6 teachers. [http://www.learner.org/resources/series179.html](http://www.learner.org/resources/series179.html)

- Create a digital graphic organizer or model to trace the flow of energy through an ecosystem, beginning at photosynthesis.

- Model or simulate the flow of energy through relationships between organisms expressed in food webs, and explain how energy and matter are both acquired and used by each organism in a food web.

**Resources 5.3.8.B.2**

Sample Assessments 5.3.8.B.1
To show evidence of meeting this CPI, students may complete the following performance assessment:

1. You are an entomologist studying the relationship between nutritional needs and life cycle stages in insects. You are interested in raising the healthiest insect colony possible. Choose a model species (darkling beetle, butterfly, fruit fly, etc.) to study its life cycle course. Conduct a series of experiments that track the growth of the insect over time to determine which media or food are the best choices for each life cycle stage. Grow the same type of insect in different nutritional media (oatmeal, fruits, meats, dairy, etc.) and track the growth (length, weight) at several intervals within the life cycle. Why would growth patterns differ over the course of an insect’s lifetime? Are there different nutritional needs for different life cycles? Justify your conclusions using the growth data (length, weight) that you collect. Share and discuss your findings in a class entomology poster session.

Sample Assessments 5.3.8.B.2
To show evidence of meeting this CPI, students may complete the following performance assessment:

1. Your class has been invited to compete in a school science-fiction film festival. The theme of this year’s festival is “A World Without Light.” Using concepts related to photosynthesis and food webs, create a short film (2-8 minutes) depicting the consequences of a world without solar energy. Focus first on the effects on the plant and non-human animal world, and then explore how humans might respond. Present your film at the school’s festival for review.

Harvard-Smithsonian Center for Astrophysics’ Digital Video Library provides short video clips of a workshop covering content associated with this CPI.

Harvard-Smithsonian Center for Astrophysics’ Digital Video Library provides short video clips of an interview with a science education expert regarding student misconceptions associated with this CPI.
Life Science 5.3: Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

Interdependence: All animals and most plants depend on both other organisms and their environment to meet their basic needs.

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<tr>
<td>In what ways do organisms interact within ecosystems?</td>
<td>All animals and most plants depend on both other organisms and their environments for their basic needs.</td>
<td>• Illustrate patterns of how populations in a given area depend on each other for their basic needs.</td>
</tr>
<tr>
<td>Content Statements</td>
<td>Cumulative Progress Indicators</td>
<td></td>
</tr>
<tr>
<td>Symbiotic interactions among organisms of different species can be classified as:</td>
<td>5.3.8.C.1 Model the effect of positive and negative changes in population size on a symbiotic pairing.</td>
<td>• Illustrate patterns of how populations in a given area depend on each other for their basic needs.</td>
</tr>
<tr>
<td>• Producer/consumer</td>
<td></td>
<td>• Explain how energy resources of a community are shared through the interactions of producers, consumers, and decomposers.</td>
</tr>
<tr>
<td>• Predator/prey</td>
<td></td>
<td>• Diagram the systems, order and organizations within and between populations.</td>
</tr>
<tr>
<td>• Parasite/host</td>
<td></td>
<td>• Understand and use interrelationships between systems and equilibrium to explain the idea that each organism fills a specific role or niche in its community.</td>
</tr>
<tr>
<td>• Scavenger/prey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Decomposer/prey</td>
<td></td>
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</tbody>
</table>

**Desired Results**

**Sample Assessments 5.3.8.C.1**

*To show evidence of meeting this CPI, students may complete the following performance assessment:*

1. You are a cargo inspection agent working in Guam to prevent the introduction of non-native species to your island. People coming...
into your territory often do not understand why you must spend so much time checking their cargo. Working in small groups, develop a public service announcement and media campaign to explain to the public how devastating the introduction of non-native species can be to an island ecosystem. Research how the region has been affected by invasive species. Connect with experts in the field to further your understandings. Use video clips, podcasts, and other authentic media to help explain the impact. Focus your message on how non-native species can become invasive and affect the biodiversity of the island.

CPI.
http://www.invasivespeciesinfo.gov/
**Life Science 5.3:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**Heredity and Reproduction:** Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

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<tbody>
<tr>
<td>How do organisms change as they go through their life cycle?</td>
<td>Organisms reproduce, develop, have predictable life cycles, and pass on some traits to their offspring.</td>
<td>• Work in groups to conduct experimental crosses using fruit flies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content Statements</th>
<th>Cumulative Progress Indicators</th>
<th>Resources 5.3.8.D.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some organisms reproduce asexually. In these organisms, all genetic information comes from a single parent. Some organisms reproduce sexually through which half of the genetic information comes from each parent.</td>
<td><strong>5.3.8.D.1</strong> Defend the concept that through reproduction, genetic traits are passed from one generation to the next using evidence collected from observations of inherited traits.</td>
<td>• Annenberg Media’s Teachers’ Resources offer short video courses covering essential science content for K-6 teachers. <a href="http://www.learner.org/resources/series179.html">http://www.learner.org/resources/series179.html</a></td>
</tr>
<tr>
<td>The unique combination of genetic material from each parent in sexually reproducing organisms results in the potential for variation.</td>
<td><strong>5.3.8.D.2</strong> Explain the source of variation among siblings.</td>
<td>• Pearson’s LabBench program offers an interactive site that allows students to explore the content associated with this CPI. <a href="http://www.phschool.com/science/biology_placement/labbench/lab7/intro.html">http://www.phschool.com/science/biology_placelabbench/lab7/intro.html</a></td>
</tr>
<tr>
<td>Characteristics of organisms are influenced by heredity and/or their environment.</td>
<td><strong>5.3.8.D.3</strong> Describe the environmental conditions or factors that may lead to a change in a cell’s genotype vs. phenotype.</td>
<td>• Construct a diagram showing the combination of inherited factors that are possible among the offspring of hybrid parents.</td>
</tr>
</tbody>
</table>
environment.

| genetic information or to an organism’s development and how these changes are passed on. |

| Desired Results |

**Sample Assessments 5.3.8.D.1**

To show evidence of meeting this CPI, students may complete the following assessment:

1. Document patterns of inheritance, and draw conclusions about the patterns, citing evidence after conducting experimental crosses using fruit flies.

To show evidence of meeting this CPI, students may answer the following question:

1. The figures below represent two chromosomes from an animal.

   ![Chromosomes](image)

   Using the table below that describes the traits carried on Chromosome #6, which trait can the animal inherit only from its mother?

<table>
<thead>
<tr>
<th>Genes on Chromosome #6</th>
<th>Trait</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Resources 5.3.8.D.2**

- Construct Family Trees
- List the advantages and disadvantages of genetic engineering: Cloning
- Identify and list dominant and recessive traits within a population
- Work in groups to conduct experimental crosses using fruit flies.
- Record the specific traits that appear in each generation (eye color, body color, wing type, etc) to determine the degree of variation between siblings of the same generation.
- Explain how this variation occurs, justifying their claim using evidence.

- Annenberg Media’s Teachers’ Resources offer short video courses covering essential science content for K-6 teachers. [http://www.learner.org/resources/series179.html](http://www.learner.org/resources/series179.html)
- Pearson’s LabBench program offers an interactive site that allows students to explore the content associated with this CPI. [http://www.phschool.com/science/biology_place/labbench/lab7/intro.html](http://www.phschool.com/science/biology_place/labbench/lab7/intro.html)
- Compare the development of identical and fraternal twins
<table>
<thead>
<tr>
<th>H</th>
<th>long hair</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>short hair</td>
</tr>
<tr>
<td>B</td>
<td>black hair</td>
</tr>
<tr>
<td>b</td>
<td>white hair</td>
</tr>
</tbody>
</table>

A. short hair  
B. long hair  
C. white hair  
D. black hair

**Sample Assessments 5.3.8.D.2**  
To show evidence of meeting this CPI, students may complete the following assessment:

1. Determine which individuals are parents, which are siblings, etc.  
   from a group of related individuals (plants, animals, etc.) with images provided. Present their ideas of relatedness, justifying their claim with reasoning based on the physical evidence.

**Sample Assessments 5.3.8.D.3**  
To show evidence of meeting this CPI, students may complete the following assessment:

1. The pictures below represent forms of reproduction. In which form of reproduction will the offspring differ most from the parent?
   
   A.  
   B.  
   C.  
   D.  

**Resources 5.3.8.D.3**

- Annenberg Media’s Teachers’ Resources offer short video courses covering essential science content for K-6 teachers.  
  http://www.learner.org/resources/series179.html

- Pearson’s LabBench program offers an interactive site that allows students to explore the content associated with this CPI.  
1. Explain why DDT (dichlorodiphenyltrichloroethane) was banned from use in the United States, and how it affected certain wildlife species.

*To show evidence of meeting this CPI, students may answer the following question:*

1. Widespread use of chemical pesticides has been linked to harmful mutations in many wild frog populations. For a mutation to affect the next generation of frogs, it must have altered the genetic code in the frog’s:

A. skin cells  
B. cardiac cells  
C. muscle cells  
D. reproductive cells
**Life Science 5.3:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**Evolution and Diversity:** Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

<table>
<thead>
<tr>
<th>Essential Questions</th>
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<th>Labs, Investigation, and Student Experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>In what ways are organisms of the same kind different from each other?</td>
<td>Sometimes differences between organisms of the same kind give advantages in surviving and reproducing in different environments.</td>
<td>• Use current news and journal articles to locate scientific evidence to explain current extinctions due to changing environmental conditions.</td>
</tr>
<tr>
<td>How does this help them reproduce and survive?</td>
<td></td>
<td>• Explain why the species is at risk, clarifying the concept that evolution occurs at the level of the species, not at the level of the individual</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Resources 5.3.8.E.1</th>
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</thead>
<tbody>
<tr>
<td>Individual organisms with certain traits are more likely than others to survive and have offspring in particular environments. The advantages or disadvantages of specific characteristics can change when the environment in which they exist changes. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival.</td>
<td><strong>5.3.8.E.1</strong> Organize and present evidence to show how the extinction of a species is related to an inability to adapt to changing environmental conditions using quantitative and qualitative data.</td>
<td>• Contrast Darwin and Lamarck’s theories of evolution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Observe Darwin’s Finches and their beak structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Explain to peers the evolution of a species based on anatomical evidence in a digital or video representation</td>
</tr>
</tbody>
</table>

**Labs, Investigation, and Student Experiences**

- Use current news and journal articles to locate scientific evidence to explain current extinctions due to changing environmental conditions.
- Explain why the species is at risk, clarifying the concept that evolution occurs at the level of the species, not at the level of the individual.

**Resources 5.3.8.E.1**

Anatomical evidence supports evolution and provides additional detail about the sequence of branching of various lines of descent.

| **5.3.8.E.2** | Compare the anatomical structures of a living species with fossil records to derive a line of descent. |

**Desired Results**

**Sample Assessments 5.3.8.E.1**

*To show evidence of meeting this CPI, students may complete the following performance assessment:*

1. You are a US Fish and Wildlife officer in a Midwestern state. Conservation biologists Josh Donlan and Harry Greene have asked to speak to you regarding their “Pleistocene Rewilding Project” which proposes to reintroduce giant tortoises, wild horses, lions and elephants to the Midwest, where their distant relatives once roamed. They argue that these introductions would contribute biological, economic, and cultural benefits to North America. Before you decide to speak with Donlan and Green, research the proposed reasons for the ancestral extinction of the megafauna. As a class, use scientific evidence found in journal articles and primary sources to debate if the plan will have any ecological or cultural benefit, and decide if your state should consider their reintroduction plan.

**Sample Assessments 5.3.8.E.2**

*To show evidence of meeting this CPI, students may answer the following question:*

1. A fisherman in coastal New Jersey found the carcass of a whale.
The man reported that the stomach contained the bones of a mermaid. He described the bones for the tabloid news artist, who drew the picture below. The artist left out the skull because the fisherman was unable to find it.

1. Based on the image above, the fisherman probably found bones of a large

A. mollusk, like a giant squid
B. mammal, like a sea lion
C. fish, like a sea bass
D. crustacean, like a king crab
**Standard 5.4 Earth System Science:** The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all encompassing system of the Universe. (5.4)

**Strand A. Objects in the Universe:** Our Universe has been expanding and evolving for 13.7 billion years under the influence of gravitational and nuclear forces. As gravity governs its expansion, organizational patterns, and the movement of celestial bodies, nuclear forces within stars govern its evolution through the processes of stellar birth and death. These processes also governed the formation of our Solar System 4.6 billion years ago. (5.4.A)

<table>
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</table>
| What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? | Observable, predictable patterns of movement in the Sun, Earth, Moon system occur because of gravitational interaction and energy from the Sun. | **Instructional Guidance**  
*To assist in meeting this CPI, students may:* |
| What causes these patterns? | | - Create their own diagrams to illustrate explanations for tidal anomalies. See NOVA on Teachers Domain: [Tidal Curiosities](http://www.teachersdomain.org/resource/phy03.sci.phys.matter.curiosities) |

### Labs, Investigation, and Student Experiences

#### Content Statements

**Content**

The relative positions and motions of the Sun, Earth, and Moon result in the phases of the moon, eclipses, and the daily and monthly cycle of tides.

**CPI**

Analyze moon phase, eclipse and tidal data to construct models that explain how the relative positions and motions of the Sun, Earth, and Moon cause these three phenomena. **5.4.8.A.1**

**Content**

Gravitation is a universal attractive force by which

**CPI**

Predict how the gravitational force between two bodies would differ

- Engage in Catch A Wave, an educational project for students that uses online real time data, to guide student discovery of the causes and effects of ocean waves and tides. See [Catch A Wave](http://www.ciese.org/curriculum/tideproj/index.shtml) at:
- Participate in a kinesthetic classroom activity designed to help better understand moon phases and eclipses. See NASA Educator's Guide to Moon Phases at: [http://www.solarviews.com/eng/edu/moonphas.htm](http://www.solarviews.com/eng/edu/moonphas.htm)
- Generate scale models of the Earth, Moon and Sun both in size and distances, when given data tables.
- Model how moon phases, eclipses, and tides occur while using materials such as lamps and Styrofoam spheres to
objects with mass attract one another. The gravitational force between two objects is proportional to their masses and inversely proportional to the square of the distance between the objects.

<table>
<thead>
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<th>CPI</th>
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<tbody>
<tr>
<td>The regular and predictable motion of objects in the solar system (Kepler’s Laws) is explained by gravitational forces.</td>
<td>Analyze data regarding the motion of comets, planets and moons to find general patterns of orbital motion 5.4.8.A.4</td>
</tr>
</tbody>
</table>

For bodies of different masses or different distances apart. 5.4.8.A.3

effectively show the relationships among the 3 bodies.

**Resources**

- National Science Digital Library, Science Digital Literacy Maps
- NSDL Collection K-12 Short Cuts: Middle School
  [http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)

**Instructional Guidance**

To assist in meeting this CPI, students may:

- Engage in a globally collaborative project, such as The Noon Day Project, where students from around the world collect and share data that will be used to measure the circumference of the earth using a method that was the first by Eratosthenes over 2000 years ago. See [The Noon Day Project](http://www.ciese.org/curriculum/noonday/)
- Explore the questions Why is there day and night? See NASA’s [Starchild](http://starchild.gsfc.nasa.gov/docs/StarChild/questions/question31.html) for background information and a short activity describing why there are nights and days.
- Utilize activities, background information, books and

**Sample Assessments**

To show evidence of meeting this CPI, students may answer the following questions:

1. The search for a planet that was causing Uranus to move in unexplained directions led to the discovery of Pluto. Which of the following MOST LIKELY explains why another planet could cause Uranus to move in unexplained directions?
A. Uranus has moons with active interiors.  
B. Uranus has no atmosphere to change its direction.  
C. Another planet could move Uranus with its gravity.  
D. Another planet would keep Uranus from drifting away. (MS)

2. Sometimes the Moon looks like a full circle, sometimes it looks like a half circle, and sometimes it looks like a crescent. Explain why the Moon appears to be different shapes at different times. You may use labeled drawings in your explanation.

Audio/Visual resources to develop an understanding of the mechanics of seasons. See NASA’s Seasons at: http://www.lpi.usra.edu/education/skytellers/seasons/activities/sequences.shtml

- Model how the Earth rotates on its tilted axis as it revolves around the Sun.
- Explain how the concept of time is derived from Earth’s rotation around the Sun.
- Identify the relationship between Sun angle and shadows on the Earth and annual variations in temperature in the mid-latitudes.

Resources

- National Science Digital Library, Science Digital Literacy Maps  
The Physical Setting: Weather and Climate  
http://strandmaps.nsdl.org/?id=SMS-MAP-1698

- NSDL Collection K-12 Short Cuts: Middle School  
http://nsdl.org/resources_for/k12_teachers/middle-school.php

Instructional Guidance

To assist in meeting this CPI, students may:

- Compare the experiences of gravity on Earth with that of the astronauts’ perceived weightlessness in space. See Teachers Domain, Gravity on Earth and in Space at: http://www.teachersdomain.org/resource/phy03.sci.phys.mfe.gravity/
• Model the relationships (basic Newtonian mechanics) between the orbiting motion of the planets around the Sun, the moons around the planets.
• Apply the components of Newton’s formula for his Law of Universal Gravitation to explain how the force of gravity depends on how much mass the objects has and how far apart they are.

✓ **Note:** Students at this level should be focusing on conceptual understandings. Quantitative exploration of Kepler’s Laws and Gravity will take place in a later grade band cluster.

**Resources**

• National Science Digital Library, Science Digital Literacy Maps
  The Physical Setting: Gravity
  [http://strandmaps.nsdl.org/?id=SMS-MAP-1372](http://strandmaps.nsdl.org/?id=SMS-MAP-1372)

• NSDL Collection K-12 Short Cuts: Middle School
  [http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)

**Instructional Guidance**

*To assist in meeting this CPI, students may:*

• Create a model of the Solar System that illustrates that relative motions and positions of bodies in the Solar System. Work together as a class to create a human powered model to mimic the movements of the four

**Note:** The name comes from Charles Boyle, the 4th Earl of Orrery, for whom one of these models was made. The first orreries were mechanical, but a computer model of the Solar System is also called an orrery. See GEMS located at: [http://kepler.nasa.gov/ed/activities/gems.html](http://kepler.nasa.gov/ed/activities/gems.html) for a detailed lesson plans and resources.

- Observe the orrery in motion, and then form conclusions about the orbital periods of the inner planets. Afterwards, predict as a class, the orbital periods of the outer planets using the mapped scale model.

- Investigate and debate how Galileo’s observations of the planets of Venus persuade him of the true nature of the solar system.

- **Extension:** Do some research on the public's reaction to Galileo's "Dialogue Concerning the Two Chief World Systems." What were the dominant political structures in place at the time of publication and what repercussions did he face?

**Note:** Students at this level should be focusing on conceptual understandings. Quantitative exploration
of Kepler’s Laws and Gravity will take place at a later grade band.

**Resources**

- National Science Digital Library, Science Digital Literacy Maps
  Historical Perspectives: [Copernican Revolution](http://strandmaps.nsdl.org/?id=SMS-MAP-2312)

- NSDL Collection K-12 Short Cuts: Middle School
  [http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)
**Standard 5.4 Earth System Science:** The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all encompassing system of the Universe. (5.4)

**Strand B. History of Earth:** From the time that the earth formed from a nebula 4.6 billion years ago, it has been evolving as a result of geologic, biological, physical and chemical processes. (5.4.B)

<table>
<thead>
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</tr>
</thead>
</table>
| How do geologic events occurring today provide insight Earth’s past? | Earth’s components form systems. These systems continually interact at different rates of time, affecting the shape of the Earth’s surface regionally and globally. | Instructional Guidance  
To assist in meeting this CPI, students may:  
- Use the [Deep Time](http://www.teachersdomain.org/resource/tdc02.sci.ess.eartsys.deeptime/) interactive timeline to find out:  
  ✓ When fish, reptiles, birds, mammals, and humans appeared in geologic time.  
  ✓ What geological changes were occurring at the time of their appearance.  
  ✓ How has the complexity of life changed over time.  
- Observe fossil evidence of bacteria as it existed over geologic time and compare it to bacteria as it exists today.  

<table>
<thead>
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<tbody>
<tr>
<td><strong>Content</strong></td>
<td></td>
</tr>
</tbody>
</table>
Today’s planet is very different than early Earth.  
Evidence for one-celled forms of life, bacteria, extends back more than 3.5 billion years. |
| CPI |  
5.4.8.B.1  
Correlate the evolution of organisms and the environmental conditions on Earth as they changed throughout geologic time |
| **Content** |  
Fossils provide evidence of how life and environmental conditions have changed.  
The principle of Uniformitarianism makes |
| CPI |  
5.4.8.B.2  
Evaluate the appropriateness of increasing the human population in a region (e.g., barrier islands, pacific northwest, Midwest United States) based on the region’s history of catastrophic |

**Sample Assessments**  
To show evidence of meeting this CPI, students may answer the following questions:
Possible the interpretation of Earth’s history. The same Earth processes that have occurred in the past occur today.

| Possible the interpretation of Earth’s history. The same Earth processes that have occurred in the past occur today. | events such as volcanic eruptions, earthquakes, and floods. | 1. How has the complexity of life changed over time?  
2. How is looking for primitive life forms in hot vents like a time capsule of Earth's history? |

**Desired Results**

**Sample Assessments**

*To show evidence of meeting this CPI, students may answer the following questions:*

- Intelligently discuss the earth’s past using geological examples from the world today
- Explain the mechanisms for how changes in Earth's atmosphere affected the kinds and distribution of life forms

**Resources**

- National Science Digital Library, Science Digital Literacy Maps  
The Living Environment: Biological Evolution  
[http://strandmaps.nsdl.org/?id=SMS-MAP-1430](http://strandmaps.nsdl.org/?id=SMS-MAP-1430)
- NSDL Collection K-12 Short Cuts: Middle School  
[http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)
### 5.4 Earth System Science

The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all-encompassing system of the Universe. (5.4)

### Strand C. Properties of Earth Materials

The Earth’s composition is unique, related to the origin of our solar system, and provides us with the raw resources needed to sustain life. (5.4.C)

<table>
<thead>
<tr>
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</thead>
</table>
| How do changes in one part of an Earth system affect other parts of the system? | How do changes in one part of an Earth system affect other parts of the system? | **Instructional Guidance**  
**To assist in meeting this CPI, students may:**  
- Design and conduct experiments to evaluate the chemical and physical properties of the soil near their school.  
- Use the physical and chemical properties of local soil to uncover the story of the formation of the soil.  
- Construct and operate a composting system and use the products to amend the soil of a community garden. |

<table>
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<td><strong>Content</strong></td>
<td><strong>CPI</strong></td>
</tr>
<tr>
<td>Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, each having a different chemical composition.</td>
<td>CPI</td>
</tr>
<tr>
<td>Physical and chemical changes take place in the Earth materials when Earth features are modified through weathering and erosion.</td>
<td>CPI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Resources</strong></th>
</tr>
</thead>
</table>
| - National Science Digital Library, Science Digital Literacy Maps  
The Physical Setting: Changes in the Earth's Surface [http://strandmaps.nsdl.org/?id=SMS-MAP-0048](http://strandmaps.nsdl.org/?id=SMS-MAP-0048)  
- NSDL Collection K-12 Short Cuts: Middle School [http://nsdl.org/resources_for/k12Teachers/middle-school.php](http://nsdl.org/resources_for/k12Teachers/middle-school.php)  
- *Science Curriculum Topic Study*: Soil, p.186 |

**Instructional Guidance**  
**To assist in meeting this CPI, students may:**  
- Use existing data sets to compare the:
### Content

Earth’s atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has a different physical and chemical composition at different elevations.

### CPI

Model the vertical structure of the atmosphere using information from active and passive remote sensing tools (e.g., satellites, balloons, and/or ground based sensors) in the analysis.

### Desired Results

- Rate of disintegration of igneous, metamorphic, and sedimentary rocks to the composition of the rock
- Surface area exposed to mechanical and chemical environments in which the weathering takes place.
- Create a model of the rock cycle that integrates the various forms of mechanical and chemical weathering.

Observe landforms, such as river valleys and geologically old and young mountains ranges, and infer the process that took place to form the landform.

### Resources

- National Science Digital Library, Science Digital Literacy Maps
  The Physical Setting: Changes in the Earth's Surface
  http://strandmaps.nsdl.org/?id=SMS-MAP-0048
- NSDL Collection K-12 Short Cuts: Middle School
  http://nsdl.org/resources_for/k12_teachers/middle-school.php

### Sample Assessments

*To show evidence of meeting this CPI, students may answer the following questions:*

1. Compare and contrast large scale commercial farming practices with those implemented by organic farmers.

2. On steep slopes along the sides of new roads, highway department workers often grow plants to prevent soil from being eroded. Describe two ways that these plants keep the soil from eroding.

### Instructional Guidance

*To assist in meeting this CPI, students may:*

- Identify the gases in the atmosphere, and explain why there is variation in some of the gases (water vapor, carbon dioxide) at different locations around the globe and at different altitudes.
- Relate the location and construction of active and passive remote sensing satellites to the data collected.
- Apply the date collected by satellites to create a scale model of the vertical (physical and chemical) structure of the Earth’s atmosphere that describes how the chemical and physical properties of each layer effect the existence of life on Earth.
### Sample Assessments

To show evidence of meeting this CPI, students may answer the following questions:

1. Which of the following best explains why the pressure inside a high-flying airplane must be controlled?
   
   A. At high altitudes there is greater atmospheric pressure than on the surface of the Earth.
   B. At high altitudes there is lower atmospheric pressure than on the surface of the Earth.
   C. If the cabin is not pressurized, ozone and other upper atmospheric gases will enter the airplane.
   D. If the cabin is not pressurized, carbon dioxide will escape from the airplane.

   (NAEP)

2. Recent studies indicate that ozone in the upper layers of Earth's atmosphere is being depleted. What effect does the depletion of ozone have, and how is this effect harmful to humans?

   (NAEP)

### Sample Assessments

To show evidence of meeting this CPI, students may answer the following questions:

1. All of the following are examples of erosion EXCEPT:
   
   A. The wind in the desert blows sand against a rock.
   B. A glacier picks up boulders as it moves.
   C. A flood washes over a riverbank, and the water carries small soil particles downstream.
   D. An icy winter causes the pavement in a road to crack.

### Resources

- National Science Digital Library, Science Digital Literacy Maps
  The Physical Setting: Weather and Climate
  [http://strandmaps.nsdl.org/?id=SMS-MAP-1698](http://strandmaps.nsdl.org/?id=SMS-MAP-1698)
- NSDL Collection K-12 Short Cuts: Middle School
  [http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)
The picture below can be used to show how sandstone can form along the edge of a large lake.

2. Draw and write on the picture to show and explain the two main processes of sandstone formation.
**5.4 Earth System Science**: The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all encompassing system of the Universe. (5.4)

**Strand D. Tectonics**: The theory of Plate Tectonics provides a framework for understanding the dynamic processes within and on the Earth. (5.4.D)

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</table>
| To what extent does the exchange of energy within the Earth drive geologic events on the surface? | Energy flow and movement of material from the Earth’s interior causes geologic events on the Earth’s surface. | **Instructional Guidance**

*To assist in meeting this CPI, students may:*

- Describe and compare the characteristics of each layer of the Earth.
- Describe how technology has influenced what we know about the internal structure of Earth.
- Investigate the role of the transfer of energy in geophysical processes that create unique landforms.

**Content Statements**

**CPI**

5.4.8.D.1
Model the interactions between the layers of the Earth.

**CPI**

5.4.8.D.2
Present evidence to support arguments for the theory of plate motion.

**Resources**

- National Science Digital Library, Science Digital Literacy Maps
  The Physical Setting: Plate Tectonics [http://strandmaps.nsdl.org/?id=SMS-MAP-0049](http://strandmaps.nsdl.org/?id=SMS-MAP-0049)
- NSDL Collection K-12 Short Cuts: Middle School [http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)
Mapping of the Mid-Atlantic Ridge, revealing sea floor spreading, and subduction zones are evidence for the theory of plate tectonics.

<table>
<thead>
<tr>
<th><strong>Content</strong></th>
<th><strong>CPI</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth’s magnetic field has north and south poles and lines of force that are used for navigation.</td>
<td>5.4.8.D.3 Explain why geomagnetic north and geographic north are at different locations.</td>
</tr>
</tbody>
</table>

**Sample Assessments**

*To show evidence of meeting this CPI, students may answer the following question:*

1. Seafloor spreading provides evidence of which of the following Earth processes?
   
   A. erosion of coastlines
   
   B. weathering of mountains

**Instructional Guidance**

*To assist in meeting this CPI, students may:*

- Locate and map current evidence and data, such as volcanism, earthquakes, and ocean features (e.g., mid-ocean ridges, and trenches), to reveal the location of plate margins.
- Apply historical field evidence, such as the location of fossils, glacial moraines, and rock structures, to the theory of plate tectonics.
- Create explanations for the evidence of plate tectonics that include our current understanding of the Earth’s interior.

**Resources**

- National Science Digital Library, Science Digital Literacy Maps
  The Physical Setting: Plate Tectonics
  http://strandmaps.nsdl.org/?id=SMS-MAP-0049
- NSDL Collection K-12 Short Cuts: Middle School
  http://nsdl.org/resources_for/k12_teachers/middle-school.php

**Instructional Guidance**

*To assist in meeting this CPI, students may:*

- Experiment with a topographic map and a corrected and uncorrected compass to locate places on Earth utilizing the compass rose in the map legend.
- Analyze models of the interior of the Earth that show the conducting, fluid outer core to conceptualize the changing geomagnetic poles.

**Resources**

- National Science Digital Library, Science Digital Literacy Maps
|   | C. movement of crustal plates  
D. formation of sedimentary rocks  
(NAEP) |

**Sample Assessments**  
*To show evidence of meeting this CPI, students may answer the following question:*

1. You are a captain of a commercial offshore fishing boat based in Manasquan, NJ. After cruising for three hours on a heading of 45° northeast from the harbor you discover that you are 12° and 55” west of your intended fishing spot. Explain to your first mate why it is necessary to adjust his compass from true north to magnetic north when traveling over long distances.

The Physical Setting: Electricity and Magnetism  
[http://strandmaps.nsdl.org/?id=SMS-MAP-2085](http://strandmaps.nsdl.org/?id=SMS-MAP-2085)  
- NSDL Collection K-12 Short Cuts: Middle School  
[http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)
### 5.4 Earth System Science
The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all encompassing system of the Universe. (5.4)

### Strand E. Energy in Earth Systems
Internal and external sources of energy drive the Earth system. (5.4.E)

<table>
<thead>
<tr>
<th>Essential Questions</th>
<th>Enduring Understandings</th>
<th>Labs, Investigation, and Student Experiences</th>
</tr>
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</table>
| What is the role of the sun in energy transfer in the atmosphere and in the oceans? | The energy from the sun is transferred throughout the oceans and atmosphere. | **Instructional Guidance**  
*To assist in meeting this CPI, students may:* |
| **Content** | | |
| **The Sun provides energy for plants to grow and drives convection within the atmosphere and oceans, producing winds, ocean currents, and the water cycle.** | **CPI**  
*5.4.8.E.1 Explain how energy from the Sun is transformed or transferred in global wind circulation, ocean circulation, and the water cycle.* | |

### Content Statements

**5.4.8.E.1**  
Explain how energy from the Sun is transformed or transferred in global wind circulation, ocean circulation, and the water cycle.

### Desired Results

**Sample Assessments**

*To show evidence of meeting this CPI, students may answer the following question:*

The dwarf planet Pluto takes much longer to revolve around the Sun than do other planets. This is because Pluto


- Observe the orrery in motion, and then form conclusions about the orbital periods of the inner planets. Afterwards, predict as a class, the orbital periods of the outer planets using the mapped scale model.

**Note:** The name comes from Charles Boyle, the 4th Earl of Orrery, for whom one of these models was made. The first orreries were mechanical, but a computer model of the Solar System is also called an orrery. See GEMS located at: [http://kepler.nasa.gov/ed/activities/gems.html](http://kepler.nasa.gov/ed/activities/gems.html) for a detailed lesson plans and resources.
A. is farther from the Sun than other planets.
B. is smaller than other planets.
C. has fewer satellites than other planets.
D. has a very slow rotation as compared to other planets.

- Investigate and debate how Galileo's observations of the phases of Venus persuade him of the true nature of the solar system.

✓ Extension: Do some research on the public's reaction to Galileo’s "Dialogue Concerning the Two Chief World Systems." What were the dominant political structures in place at the time of publication and what repercussions did he face?

✓ Note: Students at this level should be focusing on conceptual understandings. Quantitative exploration of Kepler’s Laws and Gravity will take place at a later grade band.

Resources
- National Science Digital Library, Science Digital Literacy Maps
  Historical Perspectives: Copernican Revolution
  http://strandmaps.nsdl.org/?id=SMS-MAP-2312
- NSDL Collection K-12 Short Cuts: Middle School
  http://nsdl.org/resources_for/k12_teachers/middle-school.php
### 5.4 Earth System Science:

The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all encompassing system of the Universe. (5.4)

### Strand F. Weather and Climate:

Earth’s weather and climate system are the result of complex interactions between land, ocean, ice and atmosphere. (5.4.F)

<table>
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</table>
| How do changes in one part of an Earth system affect other parts of the system? | Earth’s components form systems. These systems continually interact at different rates of time, affecting the Earth regionally and globally. | **Instructional Guidance**

*To assist in meeting this CPI, students may:*

- Monitor the weather environment and make predictions about the weather up to 48 hours before special outdoor events. See Exploring the Environment, *Weather or Not?* at: [http://www.cotf.edu/ete/modules/weathernot/weathernot.htm](http://www.cotf.edu/ete/modules/weathernot/weathernot.htm)


- Generate graphs of multiple weather parameters to establish relationships among weather variables.

- Apply knowledge of weather patterns to analyze case studies of when weather impacted a historical event.

### Content Statements

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<tbody>
<tr>
<td><strong>Global patterns of atmospheric movement influence local weather.</strong></td>
<td><strong>5.4.8.F.1</strong> Determine the origin of local weather by exploring national and international weather maps.</td>
</tr>
</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Climate is influenced locally and globally by atmospheric interactions with land masses and bodies of water.</strong></td>
<td><strong>5.4.8.F.2</strong> Explain the mechanisms that cause varying daily temperature ranges between a coastal community and a community located in the interior of the country.</td>
</tr>
</tbody>
</table>

### Resources

- National Science Digital Library, Science Digital Literacy Maps
- The Physical Setting: Weather and Climate
<table>
<thead>
<tr>
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<th>CPI</th>
<th>Resources</th>
</tr>
</thead>
</table>
| Weather (in the short term) and climate (in the long term) involve the transfer of energy and water in and out of the atmosphere. | **5.4.8.F.3** Create a model of the hydrologic cycle that focuses on the transfer of water in and out of the atmosphere. Apply the model to different climates around the world. | http://strandmaps.nsdl.org/?id=SMS-MAP-1698  
- NSDL Collection K-12 Short Cuts: Middle School http://nsdl.org/resources_for/k12Teachers/middle-school.php |

**Desired Results**

**Sample Assessments**

*To show evidence of meeting this CPI, students may answer the following question:*

1. Which zones in the map above are most likely to have a temperate climate (warm summers and cold winters)?

A. 1 and 6
B. 2 and 5
C. 3 and 4
D. 1, 2, and 3

(NAEP)

**Instructional Guidance**

*To assist in meeting this CPI, students may:*


- Conduct an investigation on local and world weather and climate. To complete the investigation, students will have at their disposal detailed instructions that describe how to create weather instruments, and how to access the Internet to locate real-time weather information from around the world. See **Weather Scope** at: [http://www.ciese.org/curriculum/weatherproj2/en/index.shtml](http://www.ciese.org/curriculum/weatherproj2/en/index.shtml)

- Observe and identify patterns in a map of climate regions of the world.

- Relate the proximity of large bodies of water, and location within global wind belts to the creation of the climate of a region.

**Resources**

- National Science Digital Library, Science Digital Literacy Maps
  The Physical Setting: Weather and Climate
  [http://strandmaps.nsdl.org/?id=SMS-MAP-1698](http://strandmaps.nsdl.org/?id=SMS-MAP-1698)

- NSDL Collection K-12 Short Cuts: Middle School
  [http://nsdl.org/resources_for/k12_teachers/middle-school.php](http://nsdl.org/resources_for/k12_teachers/middle-school.php)
### 5.4 Earth System Science: The Earth operates as a set of complex and dynamic interconnected systems, and is a part of the all encompassing system of the Universe. (5.4)

**Strand G. Biogeochemical Cycles:** The biogeochemical cycles in the Earth System include the flow of microscopic and macroscopic resources from one reservoir in hydrosphere, geosphere, atmosphere, or biosphere to another, are driven by the Earth's internal and external sources of energy, and are impacted by human activity. (5.4.F)

<table>
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</tr>
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</table>
| How do changes in one part of the Earth system affect other parts of the system and in what ways can Earth processes be explained as interactions among spheres? | Earth’s components form systems that have cycles and patterns that allow us to make predictions. These systems continually interact at different rates of time, affecting the Earth locally and globally. | **Instructional Guidance**
*To assist in meeting this CPI, students may:*
- Conduct an experiment, collecting data, and graphing data that show the temperature change of water over time when heated from ice to water vapor.
- Compare this data to the global water cycle and how water moves in and out of different locations of the water cycle at different rates (residence time).
- Identify patterns in coastal sea surface temperature by making observations of temperature changes over a period of a year.
- Compare average daily temperatures for a coastal community versus a community located 30 miles inland to identify a relationship between proximity to the ocean and daily temperature. |

<table>
<thead>
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<th>Content Statements</th>
<th>Cumulative Progress Indicators</th>
<th>CPI</th>
</tr>
</thead>
</table>
| **Content**
Water in the oceans holds a large amount of heat, and therefore significantly affects the global climate system. | **CPI**
5.4.8.G.1 Represent and explain how ocean currents impact the climate of coastal communities using sea surface temperature maps | |

<table>
<thead>
<tr>
<th>Content</th>
<th>CPI</th>
</tr>
</thead>
</table>
| **Content**
Investigations of environmental issues address underlying scientific causes and may | **CPI**
5.4.8.G.2 Investigate a local or global environmental issue by defining the problem, researching possible |

**Resources**
- National Science Digital Library, Science Digital Literacy Maps
- NSDL Collection K-12 Short Cuts: Middle School
inform possible solutions. causative factors, understanding the underlying science, and evaluating the benefits and risks of alternative solutions.

Desired Results

Sample Assessments
To show evidence of meeting this CPI, students may answer the following questions:

1. While packing for your senior trip to London England you notice something unexpected in the packing list provided by your teacher. Your teacher recommends sweaters and raincoats but not winter coats and gloves. Has your teacher sent you the wrong packing list? Explain your claim.

Use the map below to answer the following question.

Springfield, Missouri, and San Francisco, California, are at similar latitudes, but they have very different climates. Springfield has very hot summers and cold winters, while San Francisco has about the same temperatures all year.

http://nsdl.org/resources_for/k12_teachers/middle-school.php

Instructional Guidance
To assist in meeting this CPI, students may:

- Design an experiment that determines if the precipitation in their area is acidic. Graph amounts of precipitation, pH levels, and general weather conditions for the course of the experiment. On the basis of their findings, provide an analysis of the problem. If they can identify the source of acid rain, they may name them, but they must be able to substantiate their allegation. See Acid and Its Effect found at http://pals.sri.com/tasks/5-8/AcidRain/


Resources

- The Living Environment: Interdependence of Life http://strandmaps.nsdl.org/?id=SMS-MAP-2122
- NSDL Collection K-12 Short Cuts: Middle School http://nsdl.org/resources_for/k12_teachers/middle-school.php
2. What is the most likely reason the two cities have such different climates?

A. the amount of sunlight on each city  
B. *the distance of each city from an ocean*  
C. the elevation above sea level of each city  
D. the distance of each city from the equator  

(LA)