# Lesson 1 | Earth Systems and Interactions

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How do Earth systems interact?

Air, rock and soil, water, and living things make up Earth systems. These systems interact with and affect one another.

Procedure

1. Read and complete a lab safety form.
2. As a group, discuss how air—represented by a balloon—interacts with rocks, water, and plants.
3. Use colored pencils to make a graphic organizer that illustrates the interactions you discussed in the Data and Observations section below.

Data and Observations

Think About This

1. Describe ways in which air, water, rocks, and plants interact.

2. Do animals and plants interact with water and air in the same ways? Explain.

3. Key Concept Infer how Earth systems might interact and create a sandy beach.
Content Vocabulary

Earth Systems and Interactions

Directions: On the line before each clue, write the letter of the term that matches it correctly. Then answer the questions that follow.

1. CO₂, for example
   A. element

2. CO₂ is part of this series of processes
   B. carbon cycle

3. C or P, for example
   C. fossil fuels

4. series of processes that does not include the atmosphere
   D. phosphorous cycle

5. increase levels of atmospheric CO₂ when burned
   E. greenhouse gas

6. What is another example of an element?

7. Some level of greenhouse gases occur naturally and keep Earth warm enough to support life. What are two human activities that add to the levels of greenhouse gases in the atmosphere?
Earth Systems and Interactions

A. Earth Systems

1. Earth has small _________________ that interact with each other:
   the _________________, the hydrosphere, the geosphere, the biosphere and
   the cryosphere.

2. The _________________ is a layer of _________________ and
   particles of matter that surround Earth.

3. Earth’s water forms the system called the _________________, most of
   which is on the planet’s surface.

4. Earth’s largest system is called the _________________, which is mainly
   solid rock covered in many places by a thin layer of _________________.

5. The _________________ is the Earth system that contains all the living
   things on the planet.

B. Interactions Among Earth Systems

1. Earth systems interact by exchanging _________________ and
   _________________, which often change in form during the interactions.

2. In the _________________ cycle, water moves in
   the _________________, changes to a(n) _________________ and
   enters the atmosphere, and transfers _________________ energy among all
   the systems.

3. The _________________ cycle is a series of processes that take place deep
   within _________________ as well as on the _________________ of
   the planet.

4. The series of processes that continuously move carbon among Earth systems is
   called the _________________ cycle.
   a. Some organisms take in CO₂ through the process of _________________
      and help cycle carbon through the _________________.
   b. Through the process of _________________, living organisms return CO₂
      to the atmosphere.

5. Earth’s carbon is stored in _________________ in each Earth system.
   a. Although only a small amount of _________________ is stored in
      the _________________, this gas affects Earth’s _________________.
Lesson Outline continued

b. Most carbon on Earth is stored in the _________________.

6. Human activities, including burning ________________ and cutting down ________________, have led to an increase in the gas ________________ in Earth’s atmosphere.
   a. Carbon dioxide is one of several ________________ gases in the atmosphere that absorb and reradiate thermal ________________ from the Sun.
   b. An increase in ________________ gases can cause ________________, possibly leading to coastal ________________ and harmful changes in habitats.

7. The series of processes that move phosphorus among Earth systems is called the ________________ cycle.
   a. ________________ take in phosphorus from the soil or from ________________, where it is dissolved.
   b. Animals get phosphorus from eating ________________ or other organisms that have eaten ________________.
   c. The decay of living things returns ________________ to the soil.

8. Earth’s phosphorus is stored in ________________ in the geosphere, the ________________, and the biosphere.

9. People disrupt the ________________ cycle.
   a. In the ________________, phosphorus is stored in plants; when people cut down the trees, the ________________ becomes less productive.
   b. ________________ from farms, homes, and factories often contains phosphorus, which can wash into bodies of ________________ and cause excess growth of ________________ that disturbs aquatic ecosystems.
How does the biosphere affect the carbon cycle?

Carbon can leave the atmosphere and enter the biosphere through the process of photosynthesis. During photosynthesis plants use the Sun’s energy, carbon dioxide, and water and make sugars. This process releases oxygen into the atmosphere.

Procedure

1. Read and complete a lab safety form.
2. Use a knife to cut off the bottom end of an Elodea stem at an angle. Crush the end slightly.
3. Place the Elodea in a test tube. Fill the test tube nearly to the top with water.
4. Put the test tube in a test-tube rack. Place the rack under a lamp.
5. Observe the plant for about 10 min. Record your observations in the Data and Observations section below.

Data and Observations

Analyze and Conclude

1. Describe what happened to the plant.

2. Hypothesize What likely caused the event you observed?

3. Key Concept How does photosynthesis affect the carbon cycle?
Earth Systems and Interactions

Directions: On the line before each statement, write the letter of the Earth system that matches it correctly. Some Earth systems may be used more than once.

1. The ozone layer helps protect organisms from harmful solar radiation.  
2. Organisms contribute to fossil fuel formation.  
3. Water and ice cause weathering and erosion.  
4. Plants grow in soil.  
5. Rising sea level changes habitats.  
6. Increasing global temperatures melt polar ice caps.  
7. Volcanic eruptions eject gas and debris into the air.  
8. Plants use carbon dioxide during photosynthesis.  
9. Wind causes weathering and erosion.  

A. atmosphere and biosphere  
B. atmosphere and geosphere  
C. atmosphere and hydrosphere  
D. biosphere and geosphere  
E. biosphere and hydrosphere  
F. geosphere and hydrosphere
Earth Systems and Interactions

Directions: On each line, write the term from the word bank that correctly completes each sentence. Some terms will be used more than once.

atmosphere   biosphere   carbon   geosphere   greenhouse gases   hydrosphere   phosphorus   rock   water

1. Condensation and evaporation are two processes of the ______________________ cycle.

2. The ______________________ is a mixture of gases and particles of matter.

3. The largest Earth system is the ______________________.

4. Photosynthesis and cellular respiration are two processes of the ______________________ cycle.

5. The ______________________ contains all of Earth’s water.

6. Weathering and erosion are two processes of the ______________________ cycle.

7. Humans and other living things make up the ______________________.

8. The ______________________ cycle is one natural cycle that does not exist in the atmosphere.

9. ______________________ are gases in the atmosphere that absorb and reradiate thermal energy from the Sun.

10. The ______________________ is made mainly of nitrogen and oxygen.

11. The ______________________ includes the thin layer of soil and rocks on Earth’s surface.

12. Global warming is one example of how humans can disturb the ______________________ cycle.
Use Percentages

Percentages compare a partial amount to a whole amount, much like fractions and decimals. The whole amount is equal to 100%. To change a percentage into a decimal, first write the percentage as a fraction with a denominator of 100 and then divide. For example, 25% equals \( \frac{25}{100} \), which is equal to 0.25. Another way to change a percentage to a decimal is to move the decimal point two places to the left and remove the percent symbol: 25\% = 0.25.

You can use percentages to determine the mass of nitrogen, phosphorous, and potassium in a lawn or garden fertilizer. A fertilizer labeled 20-5-10 contains 20\% nitrogen, 5\% phosphorous, and 10\% potassium. Multiply the correct percentage by the total mass of the fertilizer to find the mass of each element in the sample.

How much nitrogen is in a 15-kg bag of 20-5-10 fertilizer?

Step 1 Determine what you need to know.

The question asks for the amount of nitrogen. Nitrogen percentage is the first number in the fertilizer label, 20\%.

Step 2 Change the percentage of nitrogen to a decimal by moving the decimal point two places to the left and removing the percent symbol.

20\% = 0.20

Step 3 Multiply the total mass of the fertilizer by the decimal.

15 kg fertilizer \times 0.20 = 3 kg nitrogen

Practice

1. How much potassium is in a 32-kg bag of 20-5-10 fertilizer?

2. A 40-kg bag of 24-2-8 fertilizer contains what mass of nitrogen?

3. How much potassium is in a 16-kg bag of 24-2-8 fertilizer?

4. How many kilograms of phosphorus are in a 250-kg bag of 24-2-8 fertilizer?

5. A 10-kg bag of 24-3-12 fertilizer contains what total mass of nitrogen and potassium?

6. How much total nitrogen, potassium, and phosphorus is in a 5-kg bag of 22-2-14 fertilizer?
Earth Systems and Interactions

Directions: Use your textbook to respond to each statement.

1. Earth is a system made of four smaller systems that work together.
   Name Earth’s four systems and list one part of each.

2. Like any system, parts of Earth interact.
   Describe one way in which the biosphere interacts with each of the other Earth systems.

3. The carbon cycle is a series of processes that move the element carbon among Earth’s systems.
   Identify four processes that move carbon dioxide into the atmosphere and three processes that take this gas out of the atmosphere.
Earth Systems and Interactions

Key Concept How do Earth systems interact in the carbon cycle?

Directions: Use the diagram to respond to each statement on the lines provided.

1. Name three processes in the carbon cycle that are associated with natural events.

2. Name two processes in the carbon cycle that are associated with human activities.

3. Give one example of how the geosphere and atmosphere interact in the carbon cycle. Describe how carbon moves in this interaction.

4. Give one example of how the biosphere and atmosphere interact in the carbon cycle. Describe how carbon moves in this interaction.

5. Give one example of how the hydrosphere and atmosphere interact in the carbon cycle. Describe how carbon moves in this interaction.
Earth Systems and Interactions

Key Concept  How do Earth systems interact in the carbon cycle?

Directions: Complete the table with the correct terms and numbers from the word bank. Some terms and numbers may be used more than once.

<table>
<thead>
<tr>
<th>atmosphere</th>
<th>carbon dioxide gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>dissolved carbon dioxide gas</td>
<td>geosphere (crust and upper mantle)</td>
</tr>
<tr>
<td>geosphere (lower mantle)</td>
<td>hydrosphere</td>
</tr>
<tr>
<td>minerals and rocks</td>
<td>organic molecules</td>
</tr>
<tr>
<td>3,000</td>
<td>40,000</td>
</tr>
<tr>
<td>750,000+</td>
<td></td>
</tr>
</tbody>
</table>

Carbon Reservoirs

<table>
<thead>
<tr>
<th>Earth System</th>
<th>Amount of Carbon (billions of tons)</th>
<th>Form of Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>biosphere</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>750,000</td>
<td></td>
</tr>
</tbody>
</table>

Directions: Answer each question on the lines provided.

What is global warming, and what are some ways humans might be contributing to it?
Earth Systems and Interactions

Key Concept: How do Earth systems interact in the phosphorus cycle?

Directions: On the line before each statement, write the letter of the correct answer.

1. Phosphorus does not exist in the
   A. biosphere.
   B. geosphere.
   C. atmosphere.

2. Phosphates are formed when phosphorus reacts with
   A. carbon.
   B. oxygen.
   C. nitrogen.

3. Plants absorb phosphorus from soil or
   A. air.
   B. water.
   C. animals.

4. Phosphates in living things can return to soil during
   A. respiration.
   B. decomposition.
   C. photosynthesis.

5. Phosphorus that is stored in organisms
   A. never recycles.
   B. recycles slowly.
   C. recycles quickly.

6. Clearing trees in rain forests
   A. disturbs the phosphorus cycle.
   B. improves the phosphorus cycle.
   C. does not impact the phosphorus cycle.

7. Excessive algal growth can occur when phosphorus levels in ponds
   A. increase.
   B. decrease.
   C. do not change.
**Key Concept Builder**

**LESSON 1**

**Earth Systems and Interactions**

**Key Concept** How do Earth systems interact in the phosphorus cycle?

**Directions:** Use the diagram to determine if each statement is true or false. On the line before each statement, write **T** if the statement is true or **F** if the statement is false. If the statement is false, change the underlined word(s) to make it true. Write your changes on the lines provided.

1. Animal waste **removes** phosphates from soil. ____________________________

2. Phosphates **are released** when rain weathers rocks exposed at the surface. ____________________________

3. Phosphates **cannot** be dissolved by freshwater or salt water. ____________________________

4. Decomposers add phosphates to the soil when they break down **the remains** of dead plants and animals. ____________________________

5. Plants take in **phosphates** from the soil, and animals take in **phosphates** when they eat plants. ____________________________

6. Phosphates in soil **do not** interact with the hydrosphere. ____________________________
Climate and Life

According to a study published by the World Wildlife Fund in 2000, global warming could alter one-third of the world’s wildlife habitats by 2100.

Increasing temperatures are now melting the polar ice sheets of Antarctica and Greenland, resulting in a rapid acceleration of rising sea levels. One hundred glaciers have disappeared from Glacier National Park in the United States, and 2,000 Himalayan glaciers have melted in the last 100 years.

Polar Bear Habitat Loss

The ideal habitat for polar bears is floating slabs of ice, where there are plentiful fish and the bears’ favorite food, seals. As global warming shrinks the area of Arctic sea ice, however, the habitat of the polar bear is melting.

In 2004, an aerial survey of the northern Alaskan coast documented dead bears floating in the sea. Some scientists concluded that the bears drowned because of the shrinking sea ice, which means that they have to swim longer distances between ice slabs.

According to a 2007 U.S. Geological Survey report, the polar bear population in Canada’s West Hudson Bay declined 22 percent between 1987 and 2004.

These effects of global warming and the observation that the survival rate for polar bear cubs in Alaska has dropped significantly in recent years have contributed to some scientists’ predictions that two-thirds of the world’s polar bears will disappear by the middle of this century.

Rising Seas and Inuit Villages

More than 300,000 Inuits live in an area stretching from Alaska through the Siberian tundra and into northern Scandinavia, Greenland, and Canada’s eastern Arctic islands.

Since 1970, temperatures have risen more than 2.5ºC (4.5ºF) in this area. In a village on the Beaufort Sea, people are saying that the winters are warmer, the mosquitoes are bigger, killer whales are in the harbor for the first time ever. They also say that 30 years ago, the ocean ice in June was still solid, but now in the first week of June, there is no ice at all. Elsewhere in the region, homes have been lost to the rising sea, and villages are being relocated to higher ground. In one village, the sea has moved 300 feet inland since 2000.

Applying Critical-Thinking Skills

Directions: Answer each question or respond to each statement.

1. Evaluate the following statement: “We don’t have to worry about the glaciers that are disappearing in the United States and the Himalayas because they are in the mountains and don’t contribute to rising sea levels.” Explain your answer.

2. Explain why scientists are concerned about recent den surveys that have shown that more polar bears are spending summers on land. Why are they saying that land isn’t the best place for the bears?
**Migration Patterns**

The ruby-throated hummingbird spends winters in Mexico or Central America and migrates to North America for summers. The locations of the first birds spotted in the spring of 1999 and spring of 2009 are listed in the table below.

<table>
<thead>
<tr>
<th>Month</th>
<th>First-Bird Reports</th>
<th>Month</th>
<th>First-Bird Reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>southern tip of TX; southern borders of LA, MS</td>
<td>February</td>
<td>southern borders of TX, southeast TX, LA, MS, AL; coast of west-central FL</td>
</tr>
<tr>
<td>March</td>
<td>central TX; northeast TX; southeast OK; southeast AR; mid-central MS; northwest AL; northern GA; western NC; northeast NC</td>
<td>March</td>
<td>north-central TX; northeast OK; central MO; southern IL; central IN; southern VA; southeast PA</td>
</tr>
<tr>
<td>April</td>
<td>west-central TX; western OK; north-central OK; southeast KS; northern MO; southeast IA; northern IL; southeast WI; central-western MI; southeast MI; northeast OH; east-central KY; central MA; southeast ME</td>
<td>April</td>
<td>southwest KS; north-central and northeast KY; southeast NE; north-central and northeast IA; north-central MN; northern WI; north-central Upper Peninsula eastern MI; western NY; NY/Canadian border</td>
</tr>
<tr>
<td>May</td>
<td>ND (1 bird); central KS; central NE; western ME; MN, WI, MI, NY, VT, NH, ME at the Canadian border</td>
<td>May</td>
<td>north-central/northeast MT and into central Canadian provinces; northern ND, WI, MI, NY, VT, NH, ME, into the central parts of the Canadian provinces (Alberta, Saskatchewan, Manitoba, Ontario, Quebec)</td>
</tr>
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**Map Migration Patterns**

1. Obtain two maps or outlines of North America. On each map, plot the locations of the first birds spotted from February to May of each year for which data is listed in the table (1999 and 2009).

2. Fill in the areas on each map representing the locations of the birds for each month with a different color.

3. Analyze the maps. Describe the differences between the 1999 and the 2009 maps with respect to the following: (a) the arrival at the first locations, (b) the distances traveled by the birds, and (c) the range of their summer locations.

4. Hypothesize about the Earth system interactions that are influencing the behavior of the ruby-throated hummingbird.