Lesson 2 | Interactions of Earth Systems

Name ______________________ Date ______________ Class __________

Inquiry **Launch Lab** **LESSON 2: 20 minutes**

How do some Earth systems interact?

Earth's systems constantly interact with each other. In this activity, you'll model some common interactions.

Procedure

1. Read and complete a lab safety form.
2. Place a **plastic container** on a sheet of **newspaper.** In one end of the container, mold about 5 cups of **soil** into a landform of your choice.
3. Hold a **hair dryer** about 20 cm from the model landform. Using the hair dryer set on low, blow air across the model landscape for 1 min. Be careful not to blow the soil out of the container. Record your observations in the Data and Observations section below.
4. Using a **spray bottle,** spray **water** onto your landform. Record your observations.

Data and Observations

Think About This

1. How did you use the materials in this activity to model Earth's systems?

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2. How could you improve your model? What changes would you make?

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3. **Key Concept** Describe how Earth systems interacted in your model.

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Name ______________________ Date ______________ Class ________

Content Vocabulary

LESSON 2

Interactions of Earth Systems

Directions: *Each of the sentences below is false. Make the sentence true by replacing the underlined word(s) with a term from the list below. Write your changes on the lines provided. NOTE: You may need to change a term to its plural form.*

climate	**condensation**	**evaporation**	**precipitation**
pressure	**process**	**rock cycle**	**transpiration**
water cycle	**weather**	**uplift**	

______________ **1.** Through the process of uplift, plants release water vapor from their leaves.

______________ **2.** Yesterday was warm and sunny, but the climate changed overnight; this morning, it is cold and rainy outside.

______________ **3.** Condensation produces the water vapor in our atmosphere.

______________ **4.** Rain and snow are two main forms of evaporation.

______________ **5.** The rock cycle includes many pressures that transport and continuously change rocks into different forms.

______________ **6.** The water cycle produces igneous, sedimentary, and metamorphic rocks.

______________ **7.** Clouds form due to the precipitation of water into tiny droplets.

______________ **8.** Mountains may be formed by weather, which moves large bodies of Earth materials to higher elevations.

______________ **9.** Metamorphic rocks form due to conditions of high temperatures and transpiration.

______________ **10.** The rock cycle moves water through the hydrosphere, atmosphere, geosphere, and biosphere.

______________ **11.** The average weather pattern for an area over a long period of time can best be described as process.

Lesson Outline

Interactions of Earth Systems

A. The Water Cycle

1. The continuous movement of water on, above, and below Earth's surface is called the ______________ cycle.

2. The energy to move water and allow it to change ______________, from a(n) ______________ to a gas or a solid ultimately comes from the ______________.

3. The process by which a liquid, such as water, changes into a gas is called ______________.

4. About 90% of the water vapor in Earth's atmosphere enters through ______________ from the ______________ and other bodies of water.

a. About 10% of the water enters the atmosphere through ______________, during which plants release water vapor through leaves.

b. Water vapor also enters the atmosphere through ______________, which takes place in many cells and produces water and carbon dioxide.

5. As water rises through the troposphere and cools, it changes from a(n) ______________ to a(n) ______________ through the process of condensation; when the tiny drops of water come together, they form ______________.

6. ______________ is moisture that falls to Earth's surface.

B. Changes in the Atmosphere

1. Most changes that take place in the atmosphere take place in the ______________.

2. The state of the atmosphere at a particular time and place is called the ______________.

a. The average amount of energy produced by the motion of air molecules is air ______________.

b. The force exerted by air molecules in all directions is called air ______________.

Lesson Outline continued

c. The movement of air caused by differences in air pressure is ____________________.

d. The amount of water vapor in a given volume of air is ____________________; clouds and precipitation are more likely when ____________________ is high.

3. The average weather pattern for a region over a long period of time is called ____________________.

a. ____________________ can affect the amount of precipitation an area receives by causing the ____________________ effect.

b. ____________________ blowing the ocean causes ____________________ currents in the water that flow like rivers, moving the ____________________ energy in water from place to place.

C. The Rock Cycle

1. The series of processes that transport and continually change rocks into different forms is called the ____________________ cycle.

2. When magma or lava cools and crystallizes, it becomes ____________________ rock.

3. The process that moves large bodies of Earth materials to higher elevations is called ____________________.

4. The process by which glaciers, wind, water, and the activities of ____________________ break down rock into sediments is called ____________________; the process by which glaciers, wind, or water carry sediments to new locations is called ____________________.

5. Due to erosion, ____________________ are deposited in layers, one on top of the other.

6. The weight of upper layers of sediments pushes down on underlying sediment ____________________. Water surrounding the sediments often contains dissolved ____________________, which crystallize, and cement the sediments together, forming ____________________ rock.

7. ____________________ rock forms when any kind of rock is subject to high temperatures and ____________________ deep below Earth's surface.

Inquiry **MiniLab** LESSON 2: 20 minutes

How do plants contribute to the water cycle?

You have learned how water moves through Earth systems. How does the biosphere contribute to the water cycle?

Procedure

1. Read and complete a lab safety form.
2. Choose a **potted plant.**
3. Carefully slide the plant into a **self-sealing plastic bag.** Close the bag tightly.
4. Place your bag on a sunny windowsill and leave it undisturbed overnight.
5. Observe the plant and the bag. Record your observations in the Data and Observations section below.

Data and Observations

Analyze and Conclude

1. **Recognize** Where did the moisture in the bag come from?

____

____

2. **Identify** What process of the water cycle did you model?

____

____

3. **Key Concept** How does your model show interactions among Earth systems?

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____

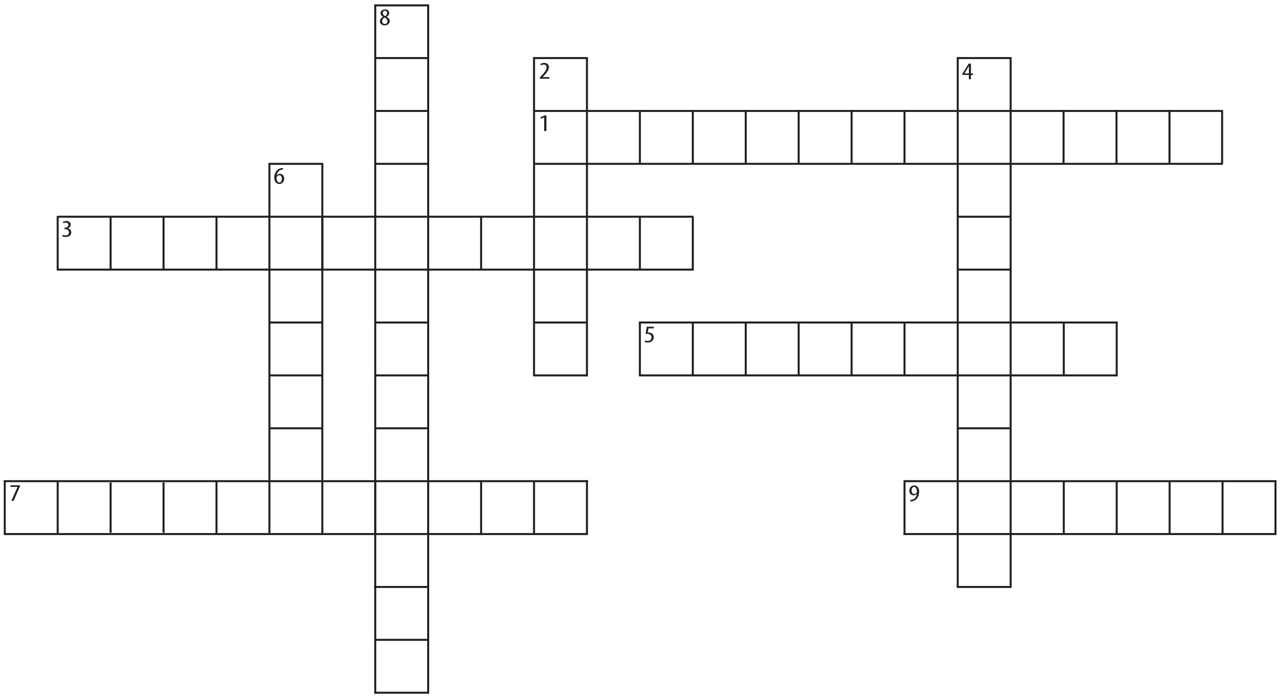
Name ______________________________ Date ______________ Class ________

Content Practice A

Interactions of Earth Systems

Directions: *Complete the crossword puzzle with the correct terms from the word bank. If an answer has two words, do not leave any spaces.*

climate	**condensation**	**evaporation**	**precipitation**	**rock cycle**
transpiration	**uplift**	**water cycle**	**weather**	



Across

1. moisture that falls from clouds to Earth's surface
3. process by which a gas changes to a liquid
5. series of processes that transport and continually change rocks into different forms
7. process by which a liquid changes into a gas
9. average weather patterns for a region over a long period of time

Down

2. process that moves large bodies of Earth materials to higher elevations
4. continuous movement of water on, above, and below Earth's surface
6. the state of the atmosphere at a certain time and place
8. process by which plants release water vapor through their leaves

Name ______________________ Date ______________ Class ________

Content Practice B

Interactions of Earth Systems

Directions: *On each line, write the term that correctly completes each sentence.*

1. Liquid water evaporates into a gas called ____________________.

2. About 10 percent of the water that evaporates is produced by plants during ____________________.

3. A(n) ____________________ forms when millions of water droplets in the atmosphere come together.

4. Rain and snow are kinds of ____________________.

5. Igneous rocks form when magma ____________________ and ____________________.

6. The process of ____________________ breaks down rocks into sediments.

7. The process of ____________________ carries sediments to new locations.

8. ____________________ rocks form when high temperatures and pressure change rocks.

Language Arts Support **LESSON 2**

Word-Usage Activity: Adding the Suffix –tion

Many verbs can be made into nouns by adding the ending *–tion*.

Verb	**Noun**
retract	retraction

In many cases, the final *–e* of the verb is dropped. Some verbs will need another letter added before adding the ending *–tion*.

Verb	**Noun**
observe	observation
form	formation

Directions: *Read the following sentences. Change each verb in parentheses to a noun and write the correct form on the line.*

1. Some of the water in Earth's atmosphere is produced by plants through the process of (transpire) ______________________.

2. (Evaporate) ______________________ is the process that changes water into gas.

3. Because of the large amount of (precipitate) ______________________, our soccer game was cancelled.

4. Clouds form when millions of water droplets come together through (condense) ______________________.

5. On Earth's surface, many (interact) ______________________ among the hydrosphere, the geosphere, and the atmosphere take place.

6. As magma cools below the surface of Earth, (crystallize) ______________________ takes place and changes the molten material into igneous rock.

7. (Cement) ______________________ occurs when minerals dissolved in surrounding water crystallize between grains of sediment.

8. The process of uplift has the ability to move a large body of Earth material to a higher (elevate) ______________________.

Language Arts Support **LESSON 2**

Word-Usage Activity: Greek Prefixes

A prefix is a word part that is used before the main part, called the root, of a word. The prefix can change the meaning of the root word. For example, the words *atmosphere* and *hydrosphere* have the same root, but different prefixes. The prefixes give these words different meanings. Many prefixes have Greek origins. The meanings of eight prefixes with Greek origins are given in the table below.

Prefix	Greek Origin	Meaning
atmo–	*atmos*	vapor
bio–	*bios*	life
exo–	*exō*	outside
geo–	*geō*	Earth
hydro–	*hudro*	water
meso–	*mesos*	middle
meta–	*meta*	beside, after
thermo–	*thermē*	heat

Directions: *Study the Greek prefixes above and their meanings. On the line before each phrase, write the letter of the term that matches it correctly.*

_______ **1.** all of Earth's water

_______ **2.** air that surrounds Earth

_______ **3.** the last atmospheric layer before outer space

_______ **4.** temperature increases in this atmospheric layer

_______ **5.** all living things

_______ **6.** existing rock changed into new rock

_______ **7.** the solid part of Earth

_______ **8.** between the stratosphere and the thermosphere

A. mesosphere
B. hydrosphere
C. thermosphere
D. metamorphic
E. exosphere
F. atmosphere
G. biosphere
H. geosphere

Math Skills **LESSON 2**

Use a Formula

Vapor density, measured in g/m^3, is the amount of water vapor in air. The maximum amount of water vapor that air can hold depends on temperature. Relative humidity (RH) compares the actual vapor density to the maximum vapor density. RH is calculated using the formula:

$$RH = \left(\frac{\text{actual vapor density}}{\text{maximum vapor density}}\right) \times 100\%$$

At 30°C, air can contain a maximum of **30.4** g/m^3 of water vapor. If the air contains **22.8** g/m^3 of water vapor, what is the RH?

Step 1 Identify the values given in the problem.
actual vapor density = **22.8** g/m^3
maximum vapor density = **30.4** g/m^3

Step 2 Put the values into the formula and solve.

$$RH = \left(\frac{\text{actual vapor density}}{\text{maximum vapor density}}\right) \times 100\%$$

$$RH = \left(\frac{\mathbf{22.8}\ g/m^3}{\mathbf{30.4}\ g\ m^3}\right) \times 100\%$$

$$RH = \mathbf{0.75} \times 100\%$$

$$RH = \mathbf{75\%}$$

Practice

1. At 30°C, air can contain a maximum of 30.4 g/m^3 of water vapor. If the air contains 9.12 g/m^3 of water vapor, what is the RH?

2. At 24°C, air has a maximum vapor density of 23 g/m^3. If the air contains 4.14 g/m^3 of water vapor, what is the RH?

3. At 10°C, a sample of air contains 4.7 g/m^3 of water vapor. If air can contain a maximum of 9.4 g/m^3 of water vapor at that temperature, what is the RH?

4. At 0°C, air can contain a maximum of 4.85 g/m^3 of water vapor. If the air has an actual vapor density of 4.51 g/m^3, what is the RH?

School to Home

LESSON 2

Interactions of Earth Systems

Directions: *Use your textbook to answer each question or respond to each statement.*

1. **Earth's biosphere includes all living things. Earth's hydrosphere includes all of the water on Earth.**

   Name two ways in which parts of the biosphere interact with the hydrosphere.

   ____

   ____

   ____

2. **Earth's atmosphere is the mix of gases that surrounds the planet.**

   How do plants and animals interact with the atmosphere?

   ____

   ____

   ____

3. **Earth's geosphere is the solid part of the planet. The geosphere includes rocks, soil, and minerals.**

   Explain how interactions among the geosphere, atmosphere, and hydrosphere affect weather and climate.

   ____

   ____

   ____

4. **Earth's geosphere also interacts with the water on Earth.**

   How do interactions between the geosphere and hydrosphere produce sedimentary rocks?

   ____

   ____

   ____

Name ______________________ Date ____________ Class ________

Key Concept Builder

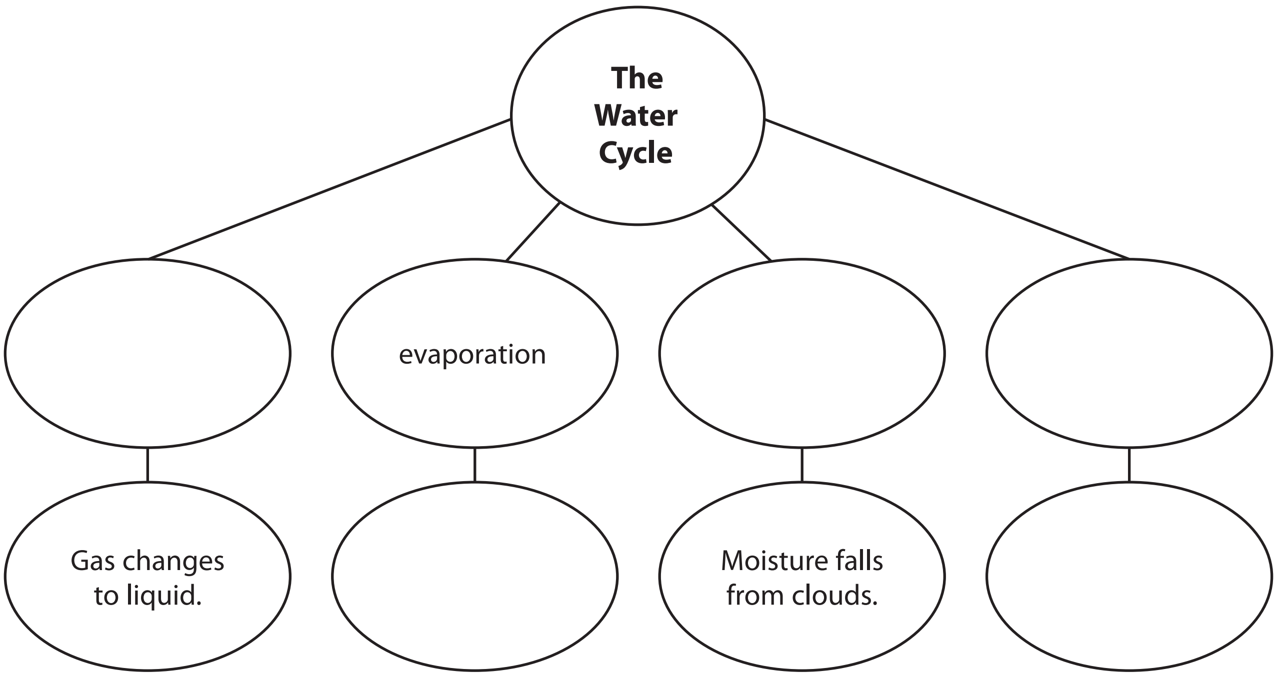
LESSON 2

Interactions of Earth Systems

Key Concept How does the water cycle show interactions of Earth systems?

Directions: *Complete the concept map by writing the correct term or phrase from the word bank in the space provided. Each term is used only once.*

condensation
Plants release water vapor through their leaves.
transpiration
Liquid changes into gas.
precipitation



Directions: *Respond to each statement on the lines provided.*

1. Use the concepts of transpiration and respiration to show interactions between the atmosphere and the biosphere.

____

____

2. Use the concept of precipitation to show interactions between the atmosphere and the geosphere.

____

____

Name ______________________________ Date ______________ Class ________

Key Concept Builder

LESSON 2

Interactions of Earth Systems

Key Concept How does weather show interactions of Earth systems?

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

_______ **1.** The state of the atmosphere at a given time and place is called
A. climate.
B. erosion.
C. weather.

_______ **2.** The measure of the average amount of energy produced by the motion of air molecules is
A. wind.
B. pressure.
C. air temperature.

_______ **3.** The force exerted by air molecules in all directions is
A. wind.
B. humidity.
C. air pressure.

_______ **4.** Wind is the movement of air caused by differences in
A. humidity.
B. air pressure.
C. temperature.

_______ **5.** The amount of water vapor in a given amount of air is
A. wind.
B. humidity.
C. temperature.

_______ **6.** Clouds are more likely to form when
A. humidity is high.
B. air pressure is high.
C. air temperature is high.

Key Concept Builder **LESSON 2**

Interactions of Earth Systems

Key Concept How does weather show interactions of Earth systems?

Directions: *Answer each question on the lines provided.*

1. What is climate?

____

____

2. What is one reason that climates differ?

____

____

3. How can mountains affect climate?

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4. How can ocean currents affect climate?

____

____

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Directions: *Draw a rain-shadow effect in the space provided. Be sure to label your drawing. Use arrows to show the direction of the wind.*

Name ______________________ Date ______________ Class ________

Key Concept Builder — **LESSON 2**

Interactions of Earth Systems

Key Concept How does the rock cycle show interactions of Earth systems?

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Each term is used only once.*

cemented	**compacted**	**deposited**	**erode**
igneous	**lava**	**metamorphic**	**rock cycle**
sedimentary	**uplift**	**weather**	

The **(1.)** ______________________ is the series of processes that transport and continually change rocks into different forms. Magma located inside the geosphere can flow onto Earth's surface, where it is called **(2.)** ______________________. When magma cools and crystallizes, it forms **(3.)** ______________________ rock.

(4.) ______________________ is the process that moves large bodies of Earth materials to higher elevations. Rocks that are deep below Earth's surface can move up to the surface. There, wind and water can **(5.)** ______________________ and **(6.)** ______________________ the rocks. These processes change the rocks into sediments. Over time, the sediments are **(7.)** ______________________ in new places. The weight of overlying sediments pushes down on underlying layers. The sediments are **(8.)** ______________________ and **(9.)** ______________________ together. These processes form **(10.)** ______________________ rocks. Rocks can be buried deep within Earth where pressures and temperatures are extreme. The high pressure and temperatures change the rocks into **(11.)** ______________________ rocks.

Name ______________________________ Date ______________ Class ________

Enrichment **LESSON 2**

Snowball Earth

Recently, researchers have hypothesized that, between 800 and 550 mya, ice sheets covered all continents, and the world's oceans froze over, encasing the globe in a 1-km-thick shell of ice. Researchers call this ice age Snowball Earth.

The main evidence for this Precambrian glaciation is based on a rock called tillite. The glacial till of the Pleistocene (our most recent ice age) is an unsorted mixture of boulders, silt, and clay that looks like loose gravel. Tillite is made of the same materials as till, but it was deposited by glaciers so long ago that it has become cemented into hard rock. Two thick layers of tillite between 750 and 580 million years old have been found on almost every continent. In some localities, the glacial deposits were found on top of limestone layers.

Researchers hypothesize that these ancient till deposits resulted from fluctuations of carbon dioxide concentrations in the atmosphere. Carbon dioxide absorbs heat in the atmosphere and warms the Earth; if carbon dioxide is removed from the atmosphere, the atmosphere and Earth cool. Two groups of researchers offer different explanations about the formation of Snowball Earth.

Ridgewell and Team's Explanation, 2003

Part A. Carbonate ions in seawater combined with atmospheric carbon dioxide, removing the carbon dioxide from the atmosphere. As atmospheric carbon dioxide decreased, the atmosphere cooled.

Part B. Primitive organisms in the shallow waters of continental shelves combined carbonate ions with dissolved calcium and formed limestone deposits. Minor glaciers lowered sea level by about 100 meters, and most of the continental shelves became exposed above water. This reduced the amount of carbonate ions used to form limestone, leaving more ions to extract carbon dioxide from the atmosphere. This led to global atmospheric cooling, the growth of glaciers, and an increase in the amount of sunlight and heat reflected back into space, cooling Earth more, and resulting in the glaciers of Snowball Earth.

Donnadieu's Explanation, 2004

Part A. Weathering of continental silicate removed carbon dioxide from the atmosphere and formed limestone in the ocean. The decrease in atmospheric carbon dioxide resulted in global cooling.

Part B. Between 800 and 700 mya, the supercontinent Rodinia broke apart, exposing more coastline to the ocean. Coastal rainfall and runoff increased weathering, which decreased atmospheric carbon dioxide, cooling Earth. Glaciers expanded, the ice and snow reflected more sunlight back into space, and the glaciers grew larger until they covered all continents, and the sea froze over, resulting in Snowball Earth.

Applying Critical-Thinking Skills

Directions: *Respond to each statement.*

1. **Define** *Snowball Earth.*

2. **Compare** the mechanisms provided by the two explanations for the formation of Snowball Earth.

Earth System Interactions: Then and Now

All of Earth might have been a harsh environment 800 to 600 million years ago. According to the Snowball Earth hypothesis, the entire planet might have been covered with ice during the late Proterozoic eon. Ice is thought to have formed at Earth's poles and spread all the way to its equator. The Snowball Earth hypothesis suggests that changes in the atmosphere caused the surface of Earth to completely freeze over. The Snowball Earth hypothesis involves interactions between all four of Earth's systems: the geosphere, hydrosphere, atmosphere, and biosphere.

Draw and Compare Graphic Organizers

1. Draw a flow chart that shows the carbon interactions between Earth's four systems during the development and formation of Snowball Earth.

2. Draw a parallel flow chart that shows the carbon interactions between Earth's four systems as they are happening today.

3. Identify three major differences between the chart describing interactions in the time of Snowball Earth and the chart describing the interactions occurring on Earth today.

Name ______________________ Date ______________ Class __________

Inquiry **Lab A** **1 hour**

How do Earth's systems interact?

You've learned about the rock cycle and the water cycle. These are just two examples of how Earth systems work together. Each system interacts with the others to help maintain an ecological balance on Earth. What happens if one system is disrupted?

Ask a Question

How does a change in one system affect other systems? How can you model interactions among Earth systems?

Materials

beaker water lamp terrarium small fan sand

Safety

Make Observations

❑ **1.** Read and complete a lab safety form.

❑ **2.** Think about Earth's four systems and how they interact with each other.

❑ Describe a real-world scenario that shows these interactions. The photos in your textbook show examples of real-world scenarios.

____

____

____

❑ **3.** Use the materials listed, or make a list of your own materials. Then, design a model of your scenario.

❑ Think about the following as you plan your model:

- How can you represent each of Earth's systems?

____

____

- How will you show the systems interacting?

____

____

- Will your model be self-contained or open to the air?

____

Lab A continued

Form a Hypothesis

- ❑ **4.** After your teacher approves your design, build your model according to your design plans.
- ❑ **5.** After building your model, formulate a hypothesis on how a change in one system might affect the other systems.

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____

____

Test Your Hypothesis

- ❑ **6.** Add or take away something in your model to cause one system to change.
  - ❑ Is the change realistic? Could this happen in real life?

____

____

- ❑ **7.** Observe and record the results immediately after the change occurs.
  - ❑ Examine your model again on the following day. Be sure to record the results.

Time of Change to System	Results
Immediate Change	
Day After Change	

Name ______________________ Date ______________ Class __________

Lab A continued

Analyze and Conclude

❑ **8. Identify** Which parts of your model represent each system?

___

___

___

❑ **9. Summarize** how the change you made to one system affected the others.

___

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❑ **10. Interpret** Was the change you modeled helpful or harmful?

___

❑ Was it caused by human activities or natural events? Explain.

___

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___

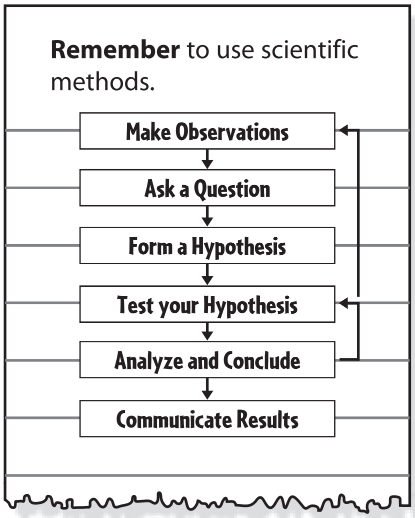
❑ **11. The Big Idea** Earth is sometimes described as a rocky planet. Based on what you observed in this lab, does that statement accurately describe Earth?

___

❑ Why or why not?

___

___



Communicate Your Results

Take your classmates on a "tour" of your model. Point out each Earth system, explain your hypothesis, recreate the change you introduced, and describe your results. Invite your classmates to ask questions and offer suggestions about improving your model.

Name ______________________ Date ______________ Class ________

Inquiry **Lab B** **1 hour**

How do Earth's systems interact?

You've learned about the rock cycle and the water cycle. These are just two examples of how Earth systems work together. Each system interacts with the others to help maintain an ecological balance on Earth. What happens if one system is disrupted?

Ask a Question

How does a change in one system affect other systems? How can you model interactions among Earth systems?

Materials

beaker water lamp terrarium small fan sand

Safety

Make Observations

1. Read and complete a lab safety form.
2. Think about Earth's four systems and how they interact with each other. Describe a real-world scenario that shows these interactions. The photos in your textbook show examples of real-world scenarios.

____

____

____

3. Use the materials listed, or make a list of your own materials. Then, design a model of your scenario. Think about the following as you plan your model:
   - How can you represent each of Earth's systems?
   - How will you show the systems interacting?
   - Will your model be self-contained or open to the air?

____

____

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____

____

Lab B continued

4. After your teacher approves your design, build your model according to your design plans.

Form a Hypothesis

5. After building your model, formulate a hypothesis on how a change in one system might affect the other systems.

___

___

___

Test Your Hypothesis

6. Add or take away something in your model to cause one system to change. Is the change realistic? Could this happen in real life?

___

___

7. Observe and record the results immediately after the change occurs. Examine your model again on the following day. Be sure to record the results.

Analyze and Conclude

8. **Identify** Which parts of your model represent each system?

___

___

___

Name ______________________ Date ______________ Class ________

Lab B continued

9. Summarize how the change you made to one system affected the others.

____

____

____

10. Interpret Was the change you modeled helpful or harmful? Was it caused by human activities or natural events? Explain.

____

____

____

11. The Big Idea Earth is sometimes described as a rocky planet. Based on what you observed in this lab, does that statement accurately describe Earth? Why or why not?

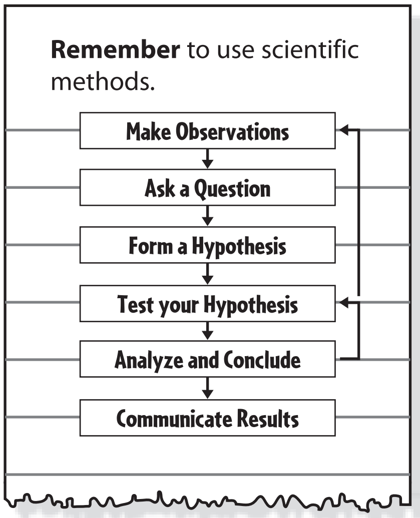
____

____

____

Communicate Your Results

Take your classmates on a "tour" of your model. Point out each Earth system, explain your hypothesis, recreate the change you introduced, and describe your results. Invite your classmates to ask questions and offer suggestions about improving your model.



Inquiry Extension

Conduct research to locate a place where the change you observed in your model has occurred. Find out what impact it had on the living things in the area. Determine if the change is still impacting life in the area.

Inquiry **Lab C**

How do seasonal changes affect Earth's systems?

Directions: *Use the information and data from the Lab* How do Earth's systems interact? *to perform this lab.*

You have learned that Earth's four systems interact and that a change to one system can affect all of the systems. In Lab B you investigated this interaction by making a model of Earth's systems and then making a change to your model. Now consider how the changes that occur during Earth's four seasons might affect your system, each one in turn. Depending upon your model, you might want to consider seasonal severe weather as well as the typical temperatures and precipitation of the different seasons.

Please note that you must complete Lab B before beginning Lab C. Also, have your teacher approve your design and safety procedures before beginning your experiment.

Name ______________________________ Date ______________ Class ________

Chapter Key Concepts Builder

Our Planet—Earth

End-of-Chapter Practice

Directions: *Work with your class to create a display showing interactions among Earth systems in your area.*

- Your class should divide into four groups. Each group should select a different Earth system to investigate. Answer the following questions about the system:

Earth System:
• What is the composition of the system?
• What is the structure of the system?
• What are some unique properties of the system in our area?

- As a class, decide which interactions among Earth systems you would like to display. Select interactions that are relevant to your area. Try to choose interactions that include input from all groups. Discuss the following questions as you make your decision.

How many interactions should we display?	Which interactions should we display?	What format should we use to display the interactions?	What materials will we need?	Who will accomplish each ask?

- Create your display. Obtain permission from the school administration to display your work in a hallway. Arrange for members of your class to be available to answer questions from other students on the first day that your work is displayed.

Display Requirements:

- scientifically accurate
- visually pleasing
- includes labels and captions explaining Earth system interactions
- includes contributions from all class members