EARTH MOTION^3

Our Changing Earth

Teacher Guide

WESTERN**RESERVE**
PUBLIC MEDIA

http://www.WesternReservePublicMedia.org/EarthMotion3

Contents

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Our Changing Earth

Unit Overview
Earth Motion^3: Our Changing Earth

Have you ever wondered how the mountains were formed or how the Grand Canyon was created? ***Earth Motion^3: Our Changing Earth*** contains three complete modules that can help to explain these phenomena.

Each module contains these components:

- A short student video (which is streamed on the address below and on D3A2, and is available on iTunes U Ohio)
- A professional development video
- A formative and a summative evaluation
- A series of lesson plans and a website that contains all of the above
- Extras features including Internet resources, activities and games, available at **http://WesternReservePubicMedia.org/EarthMotion3**

Module 1: Earth Cycles

This program deals with the water, oxygen, carbon and nitrogen cycles. Hands-on activities are given for each section. It all leads to the concept of why these cycles are important, how they work, how human activity disrupts them and what we can do to lighten our impact. The project has the students creating an educational board game or card game that incorporates the key concepts of one cycle.

Module 2: Plate Tectonics

The main focus of this module is the movement of tectonic plates, which causes changes in the earth surface. Students participate in expert groups that research an assigned topic. They then make a presentation to the class of their findings. A second approach enables students to create a model that shows the effects of the earth's movement. Finally, as a project, students create a model showing the effects of the earth's moving plates.

Module 3: Transfer of Energy

The main focus of this module is for students to understand that energy is transferred by conduction, convection and radiation. The lessons include an activity where students travel from station to station doing the experiments and keeping track of the results. Then students use the Internet to find and plot earthquakes to determine the location of the edges of the tectonic plates. The project has students creating a project about the transfer of energy.

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Teacher Guide

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EARTH MOTION^3

Our Changing Earth

Module 1: Earth Cycles

http://www.WesternReservePublicMedia.org/EarthMotion3

Overview

In this module, students do hands-on activities related to the water, oxygen, carbon and nitrogen cycles. The module begins with a formative assessment. Each section includes a resource page and PowerPoints that explain the basic concepts involved. The main goal of the module is to understand how the cycles operate and to be aware that our actions have an effect on the life of the cycles and ultimately on the earth.

In the water cycle section, students place the different parts of the cycle on a model. They also do an experiment to show the effects of acid rain on the earth.

In the oxygen cycle, students see a demonstration of the cycle and then do an experiment to see the effect of oxygen deprivation.

In the carbon cycle, students collect data and create a graph about the comparison of carbon in the air and temperature increase.

In the nitrogen cycle, students play a game that requires them to go to stations around the room and get information about nitrogen.

Finally, a project involves students creating a board game using information they learned from the activities above. They can then play their game with others in the class.

A summative assessment is included.

Standards Addressed

Grade 7, Science, Earth Science

6-8 Benchmark

C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01 / Earth Systems

01. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

Y2003.CSC.S01.G06-08.BC.L07.I02 / Earth Systems

02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Y2003.CSC.S01.G06-08.BC.L07.I03 / Earth Systems

03. Describe the water cycle and explain the transfer of energy between the atmosphere and hydrosphere.

Y2003.CSC.S01.G06-08.BC.L07.I04 / Earth Systems

04. Analyze data on the availability of fresh water that is essential for life and for most industrial and agricultural processes. Describe how rivers, lakes and groundwater can be depleted or polluted becoming less hospitable to life and even becoming unavailable or unsuitable for life.

Earth Cycles Vocabulary

General

Atmosphere: The gaseous mass or envelope surrounding a celestial body, especially the one surrounding the earth, and kept there by the body's gravitational pull.

Biogeochemical cycles: Substances involved with life on earth.

Consumer: An organism that feeds on other organisms.

Cycle: A recurring period of time in which certain events or phenomena occur and reach completion or repeat themselves in a regular sequence.

Digestion: The mechanical and chemical breaking down of food into smaller components to a form that can be absorbed.

Ecosystem: A system formed by the interaction of a community of organisms with their physical environment.

Fermentation: A process in which an agent causes an organic substance to break down into simpler substances, especially the breakdown of sugar into alcohol.

Global warming: An increase in the average temperature of the earth's atmosphere (especially a sustained increase that causes climatic changes).

Herbivore: An organism that eats plants or an organism that feeds on producers.

Lithosphere: The solid part of the earth consisting of the crust and outer mantle.

Organism: Any living thing (such as animal, plant, fungus or micro-organism).

Producer: An organism that makes its own food.

Solution: A homogeneous mixture of two or more substances, which may be solids, liquids, gases or a combination of these.

Water Cycle

Water continually cycles from the earth to the atmosphere and back.

Acid rain: Rain containing acids that form in the atmosphere when industrial gas emissions (especially sulfur dioxide and nitrogen oxides) combine with water.

Aquatic: Relating to or consisting of or being in water.

Aquifer: A pool of underground water.

Condensation: Water changes from a gas to a liquid.

Evaporation: Water changes from a liquid to a gas.

Freshwater: Water that is not salty.

Groundwater: Water filters into soil and rock until it comes to rocks it cannot pass through. Water will fill spaces in rocks and soil.

Hydrosphere: The watery layer of the earth's surface; includes water vapor.

Infiltration: Water goes into the ground. It filters through soil, rocks, etc.

Perspiration: Animals return water to the atmosphere when they sweat, pant, breathe, etc.

Precipitation: Water returns to the earth's surface in the form of rain, sleet, snow or hail.

Runoff: Some water moves along the surface of the ground, collecting in low areas.

Saltwater: Water with salt, as that of the ocean and of certain seas and lakes.

Sea level: The lowest level of ground.

Surface water: Water in rivers and lakes.

Transpiration: Plants return water to the atmosphere. Plants lose water through leaves. Plants suck in water through their roots.

Carbon Cycle

The organic circulation of carbon from the atmosphere into organisms and back again.

Carbon (C): A naturally abundant nonmetallic element that occurs in many inorganic and in all organic compounds, exists freely as graphite and diamond and as a constituent of coal, limestone and petroleum and is capable of chemical self-bonding to form an enormous number of chemically, biologically and commercially important molecules.

Carbon dioxide (CO_2): A colorless, odorless, incombustible gas formed during respiration, combustion and organic decomposition and used in food refrigeration, carbonated beverages, inert atmospheres, fire extinguishers and aerosols.

Decomposers: Organisms such as bacteria and fungi that feed on and break down dead organisms, returning constituents of organic substances to the environment.

Fossil fuel: A hydrocarbon deposit, such as petroleum, coal or natural gas, derived from living matter of a previous geologic time and used for fuel.

Methane (CH_4): An odorless, colorless, flammable gas; the major constituent of natural gas that is used as a fuel and is an important source of hydrogen and a wide variety of organic compounds.

Photosynthesis: The chemical process by which chlorophyll-containing plants use light to convert carbon dioxide and water into carbohydrates, releasing oxygen as a byproduct.

Respiration: The metabolic processes whereby certain organisms obtain energy from organic molecules; processes that take place in the cells and tissues during which energy is released and carbon dioxide is produced and absorbed by the blood to be transported to the lungs.

Oxygen Cycle

The oxygen cycle is the biogeochemical cycle that describes the movement of oxygen within and between its three main reservoirs: the atmosphere (air), the biosphere (biological matter) and the lithosphere (crust).

Atmosphere: The gaseous envelope surrounding the earth; consists of oxygen, nitrogen and other gases, extends to a height of about 40,744 km (22,000 miles) and rotates with the earth.

Biosphere: The part of the earth and its atmosphere in which living organisms exist or life is capable of being supported.

Combustion: A process in which a substance reacts with oxygen to give heat and light.

Ecosystem: An ecological community together with its environment, functioning as a unit.

Glucose ($C_6H_{12}O_6$): Simple sugar. The molecules that most living things use for energy.

Lithosphere: The solid part of the earth consisting of the crust and outer mantle.

Metabolism: The chemical processes occurring within a living cell or organism that are necessary for the maintenance of life. In metabolism, some substances are broken down to yield energy for vital processes while other substances, necessary for life, are synthesized.

Nutrient: Any substance that can be metabolized by an animal to give energy and build tissue.

Photosynthesis: Plants take in carbon dioxide and water and use them to make sugar or glucose.

Respiration: The process that breaks apart simple food molecules to release energy. It occurs inside cells.

Solution: An act or the process by which a solid, liquid or gaseous substance is homogeneously mixed with a liquid or sometimes a gas or solid.

Nitrogen Cycle

The circulation of nitrogen; nitrates from the soil are absorbed by plants that are eaten by animals that die and decay, returning the nitrogen back to the soil.

Amino acids: A group of 20 different kinds of small molecules that link together in long chains to form proteins. Often referred to as the building blocks of proteins.

Combustion: A process in which a substance reacts with oxygen to give heat and light.

Methane (CH_4): A colorless, odorless gas used as a fuel.

Nitrogen (N): A common nonmetallic element that is normally a colorless odorless tasteless inert diatomic gas; constitutes 78 percent of the atmosphere.

Proteins: Any of a group of complex organic macromolecules that contain carbon, hydrogen, oxygen, nitrogen and usually sulfur and are composed of one or more chains of amino acids. Proteins are fundamental components of all living cells and include many substances, such as enzymes, hormones and antibodies that are necessary for the proper functioning of an organism. They are essential in the diet of animals for the growth and repair of tissue and can be obtained from foods such as meat, fish, eggs, milk and legumes.

Name_____

Earth Cycles Formative Assessment

1. By what process do plants create food?
    a. Respiration
    b. Photosynthesis
    c. Digestion
    d. Chlorophyll

2. What gas is a byproduct of the process that plants use to make food?
    a. Carbon dioxide
    b. Nitrogen
    c. Ammonia
    d. Oxygen

3. Plants need nitrogen in order to grow. Nitrogen in the air is not usable by plants. What is the most common process by which nitrogen is made available to plants?
    a. Breakdown of water
    b. Lightning
    c. Photosynthesis
    d. Bacterial action

4. What is an organism that breaks down dead organisms called?
    a. Decomposer
    b. Second consumer
    c. Producer
    d. First consumer

5. In what phase of the water cycle does rain fall?
    a. Evaporation
    b. Precipitation
    c. Collection
    d. Freezing

EARTH MOTION 3
Our Changing Earth

Module 1: Earth Cycles

Water Cycle

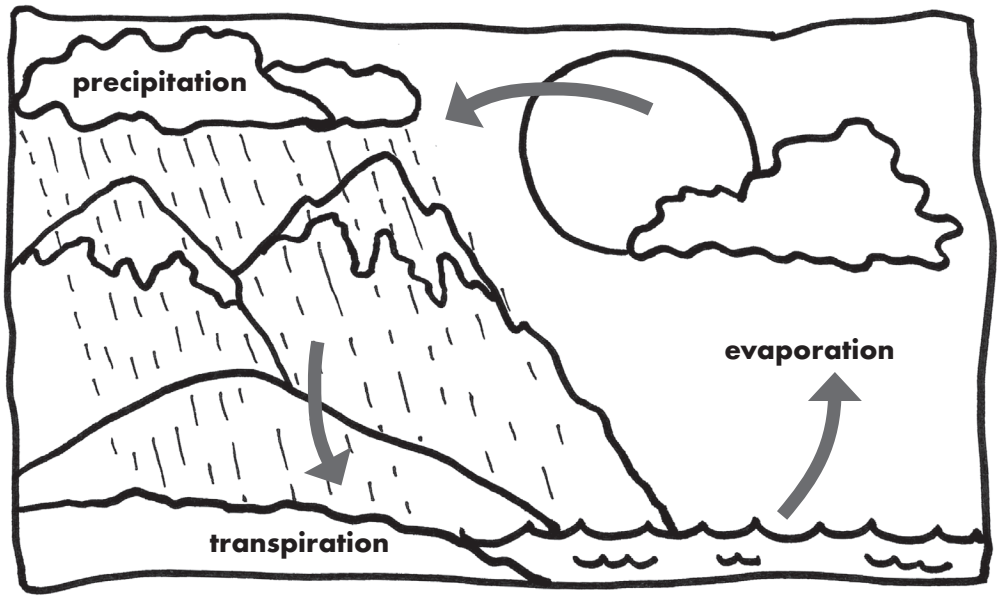
Water Cycle Overview

The water cycle describes the existence and movement of water on, in and above the earth. Earth's water is always in movement and is always changing states, from liquid to vapor to ice and back again. The water cycle has been working for billions of years and all life on earth depends on it continuing to work. Water is traveling into the air and back onto the earth again. This constant circling is called the **water cycle.**

Evaporation and Condensation

The sun heats the water found in lakes, rivers and oceans. It heats, lifts and carries tiny water drops into the air. This is called **evaporation**. When the water in the air cools down, clouds form. The water in the clouds condenses or turns to liquid and falls from the sky as **precipitation**, which can be snow, sleet, hail or rain.

Some of the precipitation that falls to the earth drops onto the land and some into the sea. Some water soaks into the soil or can be absorbed by the roots of plants. The process where plants release water into the atmosphere is called **transpiration**. The water may stay trapped for thousands of years, but eventually it will end up in a river that will take it to an ocean. It may stay in the ocean for years or evaporate the next day. This begins the cycle of evaporation, condensation and precipitation all over again.



Transpiration and Perspiration

Some water that falls to the earth is used by plants and animals. As they use water, they also give off water into the air around them. Transpiration is the process of plants releasing water into the air through their leaves. Some animals release water as well. For example, dogs pant and people release water through **perspiration**.

It Never Ends!

Water is constantly evaporating and condensing. All water has been in the air and has fallen back to the earth many times. The cycle never ends.

Introduction to the Water Cycle

Overview

Students will find out about the way the water cycle functions and how their actions impact it.

Standards Addressed

Grade 7, Science, Earth Science

6-8 Benchmark

C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01/ Earth Systems

01. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

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02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Y2003.CSC.S01.G06-08.BC.L07.I03 / Earth Systems

03. Describe the water cycle and explain the transfer of energy between the atmosphere and hydrosphere.

Y2003.CSC.S01.G06-08.BC.L07.I04 / Earth Systems

04. Analyze data on the availability of fresh water that is essential for life and for most industrial and agricultural processes. Describe how rivers, lakes and groundwater can be depleted or polluted becoming less hospitable to life and even becoming unavailable or unsuitable for life.

Materials

- Scissors and glue (if conducting cut-out activity)

Procedure

1. Distribute the Earth Cycles Formative Assessment handout. Answers can be found below.

2. Ask the students what they know about the water cycle.

3. Use the Biogeochemical Cycles PowerPoint presentation to augment students' understanding of the subject. In addition, you could have them write key words and concepts.

4. Go to the U.S. Geological Survey site **http://ga.water.usgs.gov/edu/watercyclehi.html** and review it with the students.

5. Two versions of a water cycle activity sheet are available for your use. The first, Water Cycle Diagram, asks students to match the letter with the appropriate term. The second, Water Cycle Vocabulary, involves cutting out the terms and attaching them to the picture. An answer sheet for the second version is included in this section.

6. Review concepts of the water cycle with the students.

7. Distribute the Water Cycle Report handout and ask students to complete it.

Answer Key

Earth Cycles Formative Assessment

1. b. Photosynthesis

2. d. Oxygen

3. d. Bacterial action

4. a. Decomposer

5. b. Precipitation

Letter-Matching Version

[I] Condensation

[H] Evaporation

[K] Evapotranspiration

[P] Freshwater storage

[E] Groundwater discharge

[F] Groundwater storage

[D] Infiltration

[B] Precipitation

[C] Snowmelt runoff to streams

[O] Spring

[M] Stream flow

[L] Sublimation

[Q] Surface runoff

[J] Water storage in the atmosphere

[A] Water storage in ice and snow

[G] Water storage in oceans

[M] Desublimation

[R] Plant uptake

Water Cycle Report

2. *The water cycle has been working for billions of years and all life on earth depends on it continuing to work.*
3. *There is a very small amount of fresh water for the entire planet. We must be careful not to waste or pollute the water.*
4. *We reduce our impact in these ways:*
    - *a. Cut down on production of greenhouse gaEarses.*
    - *b. Use clean coal that does not contain as much sulfur.*
    - *c. Use scrubber technology when burning coal to remove sulfates before smoke enters the atmosphere.*
    - *d. Use less electricity.*
    - *e. Use alternative forms of energy to generate electricity.*

Evaluation

Students can be holistically graded using this rubric, or points can be given for each part to determine the grade.

CATEGORY	4	3	2	1
Scientific Concepts	Report illustrates an accurate and thorough understanding of scientific concepts underlying the lab.	Report illustrates an accurate understanding of most scientific concepts underlying the lab.	Report illustrates a limited understanding of scientific concepts underlying the lab.	Report illustrates inaccurate understanding of scientific concepts underlying the lab.

Biogeochemical Cycles PowerPoint Presentation

BIOGEOCHEMICAL CYCLES

Slide 1

Biogeochemical

Big word; simple idea
- Bio = life
- Geo = earth
- Chemical = substance

So biogeochemical = substances involved with life on earth.

Slide 2

Water Cycle

Slide 3

Water Is Everywhere

- 75% of the earth's surface is covered with water.
- All living things contain water.
- There is water in the atmosphere.

Slide 4

Water on the Move

- Water continually cycles from the earth to the atmosphere and back again.

Slide 5

Evaporation

- Water evaporates (changes from a liquid to a gas).

Slide 6

Condensation

- Water condenses (changes from a gas to a liquid).

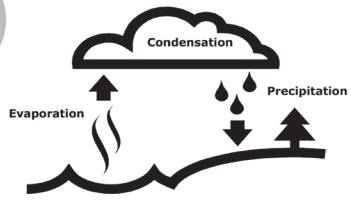
Slide 7

Precipitation

- Water returns to earth's surface in the form of rain, sleet, snow or hail.

Slide 8

The Very Simple Version



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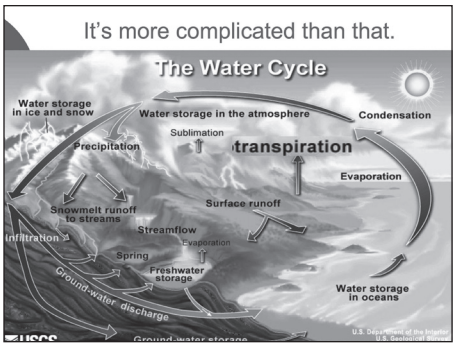

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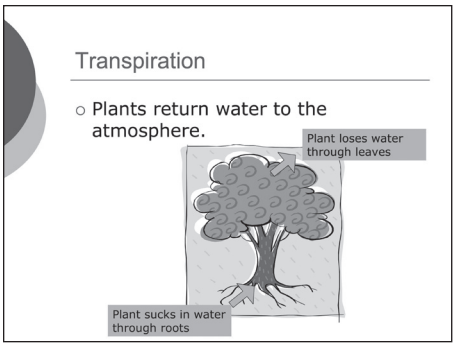

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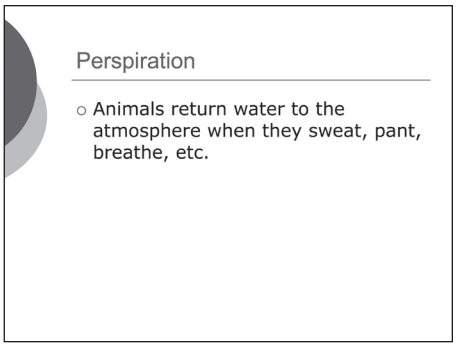

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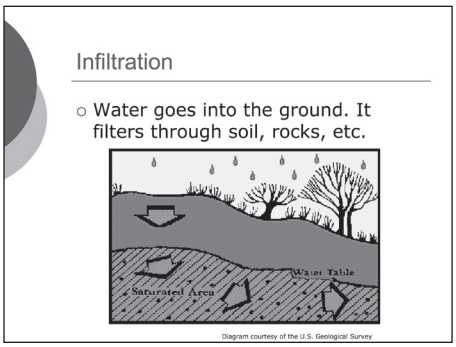

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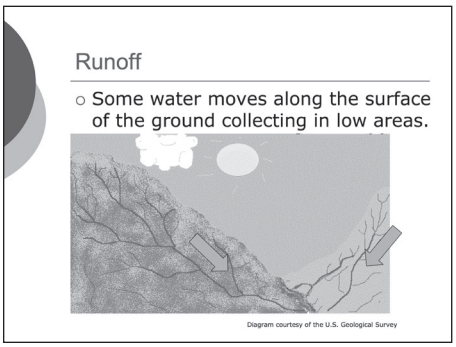

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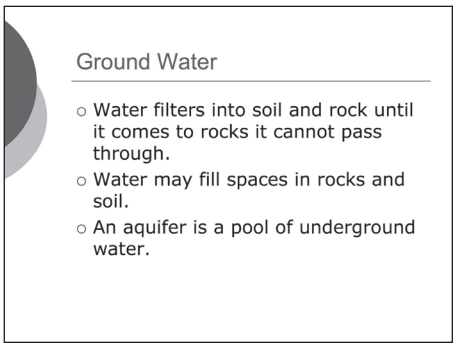

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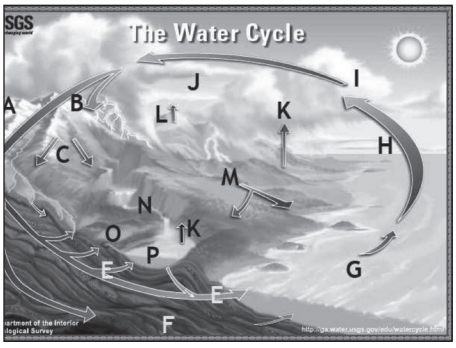
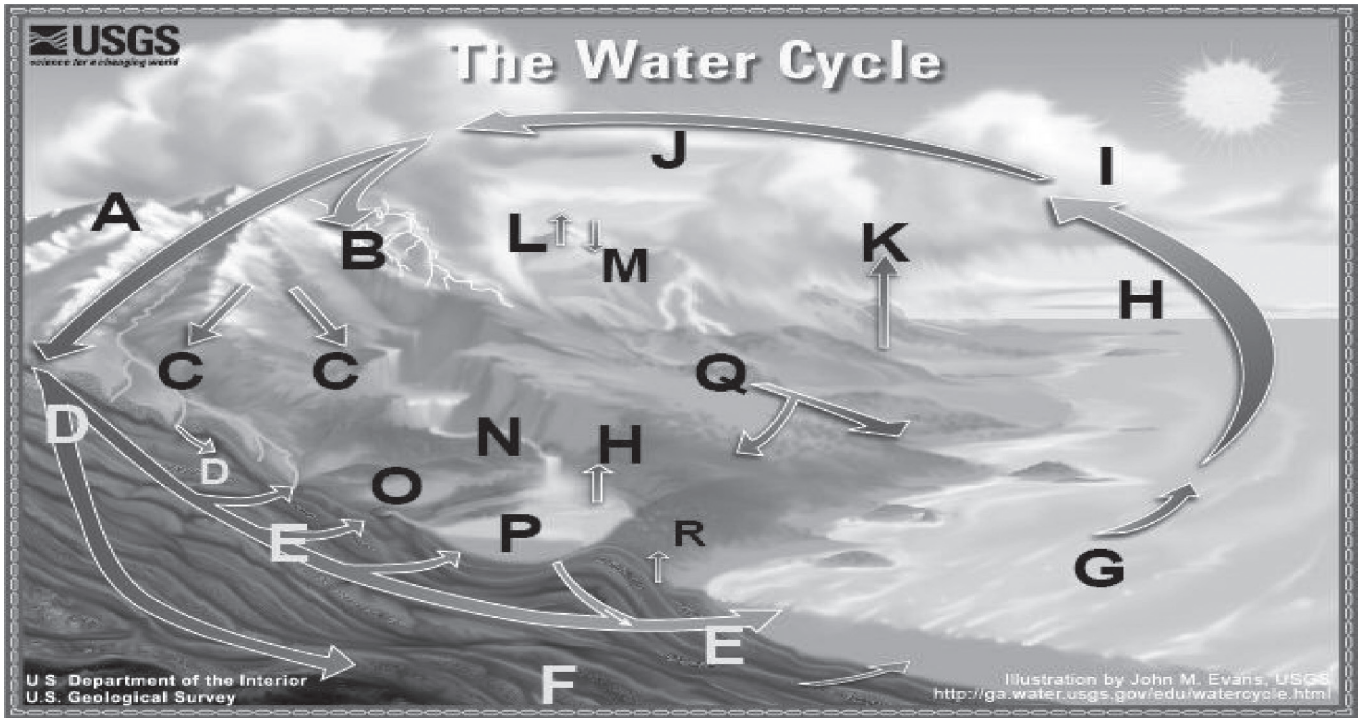


Slide 16

Name(s)_____

Water Cycle Diagram

Water continually cycles from the earth to the atmosphere and back. Here is a diagram of the natural water cycle, with the words removed. An alphabetical list of the water-cycle terms is listed below the diagram. See if you can correctly match each letter in the picture with the correct terms below.



Write the letter in the boxes next to the water-cycle terms.

[ ] Condensation

[ ] Evaporation

[ ] Evapotranspiration

[ ] Freshwater storage

[ ] Groundwater discharge

[ ] Groundwater storage

[ ] Infiltration

[ ] Precipitation

[ ] Snowmelt runoff to streams

[ ] Spring

[ ] Stream flow

[ ] Sublimation

[ ] Surface runoff

[ ] Water storage in the atmosphere

[ ] Water storage in ice and snow

[ ] Water storage in oceans

[ ] Desublimation

[ ] Plant uptake

Lesson adapted from the U.S. Geological Survey

Name: _____

Water Cycle Vocabulary

Condensation

Evaporation

Evapotranspiration

Freshwater storage

Groundwater discharge

Groundwater storage

Infiltration

Precipitation

Snowmelt runoff to streams

Spring

Stream flow

Sublimation

Surface runoff

Water storage in the atmosphere

Water storage in ice and snow

Water storage in oceans

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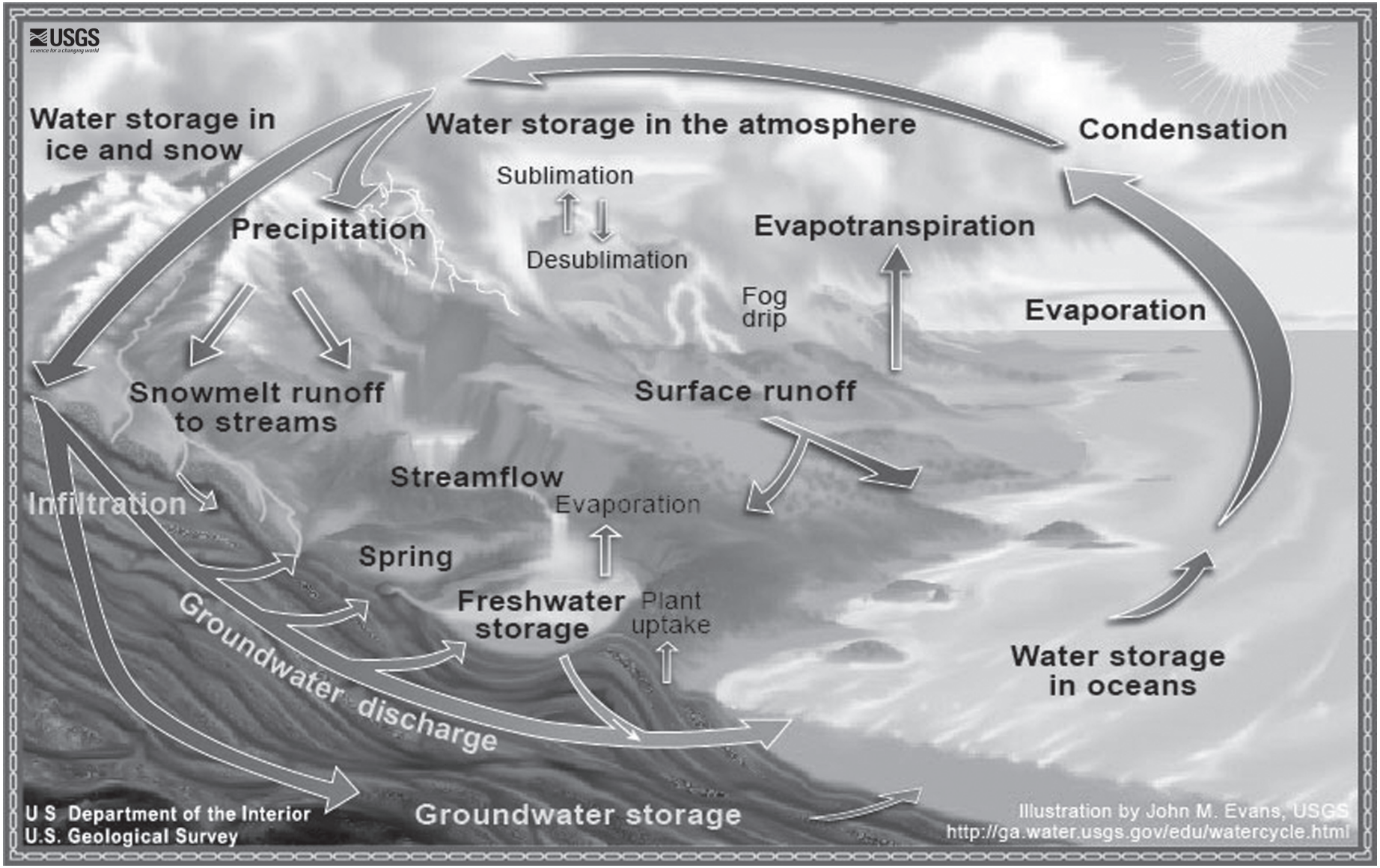
Plant uptake

Water Cycle Vocabulary Answer Sheet



Name(s)_____

Water Cycle Report

1. Sketch the cycle, including all major places the element is stored and how it moves between the lithosphere (solid earth), hydrosphere (earth's waters) and atmosphere (layer of gases that surround earth).

2. Why is this cycle important?

3. What impact do humans have on this cycle? (What do we do that affects/changes this cycle?)

4. How we can reduce our impact?

Effects of Acid Rain

Overview

Why is acid rain so damaging to buildings, ancient ruins and outdoor sculptures? Students will discover the answers to this question as they perform a simulation experiment.

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Y2003.CSC.S01.G06-08.BC.L07.I04 / Earth Systems

04. Analyze data on the availability of fresh water that is essential for life and for most industrial and agricultural processes. Describe how rivers, lakes and groundwater can be depleted or polluted becoming less hospitable to life and even becoming unavailable or unsuitable for life.

Materials

- Safety goggles
- Jumbo paper clips
- Chalk made from calcium carbonate
- Water
- Small plastic cups
- White vinegar
- Newspapers to cover work area
- Litmus paper to check pH (optional)

Procedure

Getting Ready

1. Use the PowerPoint presentation Human Impact on Water Cycle to discuss the effect that we all have on the cycle and what we can do to keep the cycle working well.

2. Make sure the chalk that you are using is made from calcium carbonate. Some are made from calcium sulfate. Prang Hygieia 95 percent calcium carbonate works well.

3. Organize materials for easy distribution. You will need enough water and vinegar to cover the chalk in the cups that you use.

Observing, Comparing and Describing

1. Begin by having the students share their knowledge of acid rain. The following questions are useful for guiding the discussion:

    a. What is acid rain? (Rain that has become more acidic than normal.)

    b. What causes acid rain? (Pollution added to the air by volcanoes and human activities such as burning fossil fuels.)

2. Explain to students that materials such as marble and limestone are often used to make buildings and sculptures. Both marble and limestone contain a mineral called calcium carbonate. The simulation that they will perform will simulate the effects of acid rain on such objects.

Creating

1. Demonstrate the procedure:

    a. Straighten one end of a jumbo paper clip.

    b. Dip a piece of chalk into a cup of water until the entire surface is wet.

    c. Use the straight end of the clip to gently and repeatedly score deep lines in the wet chalk. Too much pressure can break the chalk.

    d. Ask students what sorts of designs you could carve in the chalk by using the clip. Explain that the finished sculpture should be as detailed as possible. The entire piece of chalk should be covered with designs.

    e. When students understand the procedure, distribute chalk, record sheets, paper clips and water.

    f. Instruct students to draw a picture of their chalk that shows their carvings.

Observing, Comparing, Describing

1. Ask students to predict what will happen to their chalk when it is placed in vinegar. Have them record the predictions on their papers.

2. Demonstrate the procedure:

    a. Put on safety goggles and place your piece of chalk upright in a cup of water and observe what happens over several minutes. Write observations on the record sheet.

    b. Next, place the dry end of the chalk upright in a cup of vinegar. Observe what happens and record your observations.

3. When you are confident that students understand the procedure, distribute the safety goggles and the cups of water and vinegar. If doing the optional pH check, instruct them not to put the chalk in right away. Test the pH first with litmus paper and have students record the pH on their record sheet.

4. Circulate and offer assistance as needed.

5. Have the students answer the questions on the record sheet and share their observations.

Explaining the Phenomenon

When you place chalk in vinegar, a chemical reaction occurs between the chalk – $CaCO_3$ (calcium carbonate) – and vinegar – CH_3COOH (acetic acid). Each molecule of calcium carbonate joins with two molecules of acetic acid to form calcium acetate and carbon dioxide. The chemical equation is shown below:

$$CaCO_3 + 2\ CH_3COOH \rightarrow Ca(CH_3COO)2 + H_2O + CO_2$$

Carbon dioxide gas appears as small bubbles that form when the acetic acid is poured on the chalk. The calcium acetate appears as the light beige sludge that collects in the bottom of the plastic cup.

Tie-In to Other Standards/Topics

What signs of a chemical reaction were evident? (Production of gas and change in temperature – it drops slightly).

Even though we have some different materials, how would the relationship between the mass of everything with which we started compare to the mass of everything with which we ended? (It would be the same).

If we measure the mass at the beginning and the mass at the end, would they be the same? (Lead them into the fact that we would have to collect the gas because some carbon and oxygen atoms are leaving the system.)

Carbon cycle, global warming, etc.: Acid rain falling into oceans releases carbon dioxide stored in seashells, coral, etc. Carbon dioxide is a greenhouse gas.

Extensions

Have students generate a list of questions for further investigation. Examples of such questions include the following:

- Students leave chalk in vinegar to see how acid rain would affect materials over a longer period of time.
- How acidic is our local water? Students can collect such local samples as tap water, rain water, pond water, etc. They can test each sample with pH paper and compare results. Normal rain has a pH as high as six or even seven. If the sample has a pH lower than five, it is considered to be acid rain.
- What areas of the world are most affected by acid rain? Students can research this topic and present results to the class.
- How does acid rain affect other materials? Students can use the vinegar and water from this activity to investigate further. Some items to try include pennies, eggs, seashells and steel wool.
- How does acid rain affect living things? Set up an experiment where two sets of plants are grown – one set with acid rain and one set with regular water. Have students record their observations.
- Place one egg in vinegar and one in water and observe for 24-48 hours. The outcome is a very dramatic example of how acid rain is very damaging to living things that lay eggs. This can lead to great discussions of how this would affect an entire ecosystem.

Evaluation — Lab Activity

CATEGORY	4	3	2	1
Experimental Hypothesis	Hypothesized relationship between the variables and the predicted results is clear and reasonable based on what has been studied.	Hypothesized relationship between the variables and the predicted results is reasonable based on general knowledge and observations.	Hypothesized relationship between the variables and the predicted results has been stated, but appears to be based on flawed logic.	No hypothesis has been stated.
Scientific Concepts	Report illustrates an accurate and thorough understanding of scientific concepts underlying the lab.	Report illustrates an accurate understanding of most scientific concepts underlying the lab.	Report illustrates a limited understanding of scientific concepts underlying the lab.	Report illustrates inaccurate understanding of scientific concepts underlying the lab.
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment.	Conclusion includes what was learned from the experiment.	No conclusion was included in the report or shows little effort and reflection.

Name_____

Acid Rain Activity

Know	Want to Know
Learned	

Human Impact on Water Cycle PowerPoint Presentation

Human Impact on Water Cycle

Slide 1

Fresh Water on Earth Is Limited

- Although 75% of the earth is covered in water, only 3% of the water is freshwater.
- Most of the freshwater is in glaciers and ice caps.
- Less than 1% of the freshwater on the earth is readily available.

Slide 2

Usable Water Is Valuable

- Think about how many ways you use clean freshwater every day.
- Did you wash your face? Brush your teeth? Take a drink? Cook food? Use the toilet? Eat fresh produce? Wash your clothes?

Slide 3

Greenhouse Gases

- Certain gases in the atmosphere help keep the earth warm.
- Without these greenhouse gases, the earth would be extremely cold.
- Many human activities increase the amounts of greenhouse gases in the atmosphere.
- This is believed to be causing global warming.

Slide 4

Global Warming Affects the Water Cycle

- Warmer air causes more evaporation and warm air holds more water.
- This intensifies the water cycle.

Slide 5

Intense Water Cycle

- In areas around water, there may be more clouds and precipitation.
- In areas that are away from bodies of water, there may be few clouds and less precipitation leading to dry soil, plants dying, wells drying up, etc.

Slide 6

Acid Rain

- Combustion of fossil fuels adds sulfur and nitrogen compounds to the air.
- These compounds mix with the water vapor in the atmosphere and make it more acidic.

Slide 7

Effects of Acid Rain

- Acid precipitation causes water on the earth's surface to be more acidic.
- Many plants and animals cannot live in the more acidic conditions. They die and it affects everything in the food web.
- Acid rain deteriorates buildings, statues, etc.

Slide 8

What We Can Do:

- Cut down on production of greenhouse gases
- Use clean coal that does not contain as much sulfur
- Use scrubber technology when burning coal to remove sulfates before smoke enters the atmosphere
- Use less electricity
- Use alternative forms of energy to generate electricity (wind, solar)

Slide 9

Name(s)_____

Effects of Acid Rain Record Sheet

1. Predict what will happen in tap water:

2. Predict what will happen in vinegar:

3. Draw your carved chalk before the procedure:

4. Describe what happens when you dip the chalk in water.

5. Describe what happens when you dip the chalk in vinegar.

6. Draw your chalk after the procedure. Label one end water and the other vinegar.

7. How did this activity simulate the negative effects of acid rain?

8. How does acid rain affect buildings, statues, etc., that contain calcium carbonate?

9. What can we do to help cut back on the acidity of rain in our area?

Effects of Acid Rain Answer Sheet

1. Predict what will happen in tap water:

   Any reasonable answer.

2. Predict what will happen in vinegar:

   Any reasonable answer.

3. Draw your carved chalk before the procedure:

4. Describe what happens when you dip the chalk in water.

   Not much – it may bubble slightly as gas is replaced by water in the pores of the material.

5. Describe what happens when you dip the chalk in vinegar.

   It bubbles or fizzes. A light-beige sludge forms in the cup and the design on the chalk becomes less visible or is gone.

6. Draw your chalk after the procedure. Label one end "water" and the other "vinegar."

7. How did activity simulate the negative effects of acid rain?

   (The pH of vinegar is similar to that of some acid rain. Chalk contains the same material that many statues, buildings, etc., are made of.)

8. How does acid rain affect buildings, statues, etc., that contain calcium carbonate?

   (Calcium carbonate reacts with acid rain, so acid rain breaks down the statues' and buildings' surfaces.)

9. What can we do to help cut back on the acidity of rain in our area?

   (Less pollution, especially burning fossil fuels, cut back on use of electricity, find alternative forms to generate electricity, use clean coal, scrubber technology. etc. Answers will depend on student level of knowledge and class activities leading up to this.)

EARTH MOTION 3
Our Changing Earth

Module 1: Earth Cycles

Oxygen Cycle

Oxygen Cycle Overview

Oxygen (O) cycles through the ecosystem and the biosphere in the same way that other elements do. The earth has a fixed supply of oxygen, even though it is found everywhere – in the atmosphere, oceans, rocks and all living things. Oxygen is one of the major components found in the atmosphere. Two oxygen molecules can be joined together. If three are joined, it is called **ozone**. Oxygen can also join with most other elements. Hydrogen and oxygen (H_20) make water. Carbon and oxygen join to make carbon dioxide (CO_2).

There is a large amount of oxygen dissolved in water. As water moves, it is forced into solutions. The creatures that live in the ocean filter these solutions and take oxygen from them. Over the years of our geologic history, oxygen has also bonded to rocks and land. Oxygen bonds with silicon (silicates), iron and carbon (carbonates) to form many of the compounds of rocks. Over the years, the rocks break down and release nutrients into the soil.

The organisms of the world (including you) use oxygen in many ways. They use oxygen from the atmosphere. Plants use carbon dioxide combined with water and make sugars. Animals use the sugars for energy. Through respiration, the sugars are broken down into water and carbon dioxide and the cycle begins again.

Introduction to the Oxygen Cycle

Overview

Students will gain a better understanding about oxygen in the atmosphere.

Standards Addressed

Grade 7, Science, Life Science

6-8 Benchmark C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01 / Earth Systems

01. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

Y2003.CSC.S01.G06-08.BC.L07.I02 / Earth Systems

02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Procedure

1. Ask students what they know about oxygen. This could be noted on a chalkboard or white board.

2. Use the Oxygen Cycle PowerPoint presentation to discuss the principles of oxygen.

3. Allow students to work with a partner or in groups of three.

4. Instruct the students to fill out the Oxygen Cycle Report handout.

Answers to Oxygen Cycle Report

2. *All organisms of the world use oxygen to live. They use oxygen in the atmosphere and breathe out carbon dioxide. This combines with water in plants and makes sugar. Animals use the sugar for energy.*

3. *What we are doing:*

    a. *Destroying natural areas with plants and replacing them with buildings, parking lots, lawns, etc.*

    b. *Burning things adds more carbon dioxide to the atmosphere.*

4. *What we need to do:*

    a. *Stop destroying and promote regrowth of natural areas, especially forests.*

    b. *Burn less (fossil fuels, forest fires, etc.).*

Oxygen Cycle PowerPoint Presentation

Oxygen Cycle

Slide 1

Required for Life

- All living things use oxygen or depend on organisms that use oxygen in some way.



Slide 2

All Animals and Other Consumers Use Oxygen

- We use oxygen to break down simple sugar and release energy.
- This can be done through respiration or fermentation.
- Animals mainly use respiration.

Slide 3

Respiration

- The process that breaks apart simple food molecules to release energy.
- It occurs inside cells.
- What YOU do with the oxygen you take in.

Slide 4

Simple Sugar — Glucose

The molecule most living things use for energy — including us!

- We break down food into smaller molecules during digestion. One of the small molecules is glucose.
- Glucose leaves your intestines, goes into your blood and is taken to every cell in your body.

Slide 5

Respiration in Cells

- In your cells, oxygen is used to split glucose apart — releasing energy, water and carbon dioxide.

Slide 6

Photosynthesis

- Plants take in carbon dioxide and water and use them to make food. Their food is simple sugar — glucose.

Slide 7

Photosynthesis (continued)

- Plants pull the carbon off CO_2 and use the carbon in glucose. (They do not need the oxygen for this. They get that from water, H_2O.)
- Plants release the oxygen (O_2) back into the atmosphere.
- Other organisms use the free oxygen for respiration.

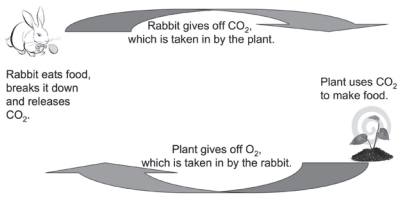
Slide 8

How are photosynthesis and cellular respiration similar?

- Photosynthesis:
  - $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$
- Cellular Respiration:
  - $6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + \text{energy}$
- Photosynthesis uses carbon dioxide and produces oxygen.
- Cellular respiration uses oxygen and produces carbon dioxide.

Slide 9

Basic idea

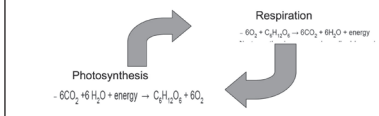


Slide 10

Everywhere

- This happens on land and in the water.
- Algae and aquatic plants produce food underwater through photosynthesis.
- They use CO_2 dissolved in the water.
- Other aquatic organisms use the dissolved oxygen these plants release into the water.

Slide 11



Slide 12

Kind of a C-on/C-off Cycle

- Plants take the carbon off the CO_2, freeing the oxygen so it can be used for respiration.
- During respiration, organisms attach a carbon to the O_2 and release CO_2 so it can be used for photosynthesis.
- One big cycle — all living things depend on each other for it to work!

Slide 13

Human Impact

- We keep destroying natural areas, especially forested areas with many plants and replacing them with buildings, parking lots, lawns, etc.
- Fewer plants mean less oxygen and more carbon dioxide.
- This disturbs the balance of the natural cycle.

Slide 14

More Human Impact

- Every time something burns (combustion), more carbon dioxide is released into the atmosphere.
- We add more and more CO_2 and destroy more and more of the plants that clean the air for us.

Slide 15

What We Need to Do

- Stop destroying and promote regrowth of natural areas — especially forests.
- Burn less (fossil fuels, forest fires, etc.)

Slide 16

Name(s)_____

Oxygen Cycle Report

1. Sketch the cycle, including all major places the element is stored and how it moves between the lithosphere (solid earth), hydrosphere (earth's waters) and atmosphere (layer of gases that surround earth).

2. Why is this cycle important?

3. What impact do humans have on this cycle? (What do we do that affects/changes this cycle?)

4. How we can reduce our impact?

The Oxygen Cycle and Aquatic Organisms

Overview

Students will conduct an experiment to help them better understand the atmospheric portion of the carbon cycle.

Standards Addressed

Grade 7, Science, Life Science

6-8 Benchmark

C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01 / Earth Systems

01. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

Y2003.CSC.S01.G06-08.BC.L07.I02 / Earth Systems

02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Materials

- Baby food jars with tight-fitting lids
- Bromthymol blue (BTB) indicator
- Dechlorinated water
- Straw
- Aquatic snails
- Pieces of the pond plant elodea
- Labeling tape
- Markers
- Tank for used water

Procedure

Part A: Teacher Demo

1. Fill a small beaker less than half full with water and add about seven drops of BTB indicator.
2. Show students the liquid and discuss the color of it.
3. Put a straw into the liquid and blow into it (or have a student volunteer to do this).
4. Stop when the color is green.
5. Discuss the color of the water.
6. Blow into the straw again until the liquid is yellow.
7. Ask students what they think caused the color to change. They should understand that we exhale carbon dioxide.
8. Review (or introduce) the chemical equations for respiration and photosynthesis.

Part B: Student Activity

1. Divide the class into four groups.
2. Each group will set up two baby food jars with water and BTB.
3. Instruct the groups to put masking tape on the jar lids and write their group number and class period on the tape.
    a. Group 1 will not add anything to their jars.
    b. Group 2 will add a sprig or two of elodea.
    c. Group 3 will add two snails.
    d. Group 4 will add elodea and snails.
4. Have them cover one of their baby food jars completely with foil and leave the other jar uncovered. Instruct the group members to make certain the covered jar's lid is on tightly. Place jars in bright light.
5. Instruct the groups to record the starting color of the liquid in each jar and make a prediction about what the results will show. What color do they think each jar will be and why?

Part C: Day Two

1. Remind students of yesterday's lesson and how they set up the baby food jars.
2. Have students get their own jars to examine and record the data in the table provided. Students need to examine and record the results for all the jars.
3. Have students discuss the results with their classmates as they share information and fill in the data tables.
4. Instruct them to answer the questions on the lab paper.
5. Once all data is recoded, have students clean up as follows:
    a. To clean up the tubes, pour the BTB water and its contents into the tank provided.
    b. Remove the labels from the baby food jars and wash and rinse them.
    c. Return the clean jars and lids.

Evaluation

Rubric for Experiment

CATEGORY	4	3	2	1
Data	Professional looking and accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Accurate representation of the data in written form, but no graphs or tables are presented.	Data are not shown or are inaccurate.
Analysis	The relationship between the variables is discussed and trends/ patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/ patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship between the variables is not discussed.
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error and what was learned from the experiment.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment.	Conclusion includes what was learned from the experiment.	No conclusion was included in the report, or report shows little effort and reflection.
Scientific Concepts	Report illustrates an accurate and thorough understanding of scientific concepts underlying the lab.	Report illustrates an accurate understanding of most scientific concepts underlying the lab.	Report illustrates a limited understanding of scientific concepts underlying the lab.	Report illustrates inaccurate understanding of scientific concepts underlying the lab.

Name(s)_____

Color My World

Part A: Teacher Demo Questions

1. What color is the bromthymol blue indicator when carbon dioxide is present in a solution?

   When bromthymol blue is blue, it means _____ .

   When bromthymol blue is green, it means _____ .

   When bromthymol blue is yellow, it means_____ .

2. Write the chemical equation for photosynthesis.

3. What happens to the concentration of CO_2 during photosynthesis?

4. Write the chemical equation for respiration.

5. What happens to the concentration of CO_2 during respiration?

Parts B and C: Oxygen Cycle Data Table

Jar	What was added to jar	Color I expect it to be	Why	Color it was	Why
1 covered	nothing				
1 uncovered	nothing				
2 covered	elodea				
2 uncovered	elodea				
3 covered	snails				
3 uncovered	snails				
4 covered	elodea and snails				
4 covered	elodea and snails				

Post-Lab Follow-Up (Please answer these after the conclusion.)

1. How do the results indicate that snails take in or release CO_2?

2. Do the results indicate that sunlight is necessary for the snail to release CO_2? Use data from the lab to explain your answer.

3. Do your results indicate that elodea plants take in or release CO_2?

4. Do the results indicate that sunlight is necessary for the elodea to remove CO_2? Use data from the lab to explain your answer.

5. In what process does elodea use CO_2?

6. In what process does elodea produce CO_2?

7. What is the contribution of light in these processes? How did the experiment demonstrate the contribution of light?

8. Based on what you know about photosynthesis and respiration, why do plants and animals need each other in order to survive?

Color My World Answer Sheet

Part A: Teacher Demo Questions

1. What color is the bromthymol blue indicator when carbon dioxide is present in a solution?

   When bromthymol blue is blue, it means ***the carbon dioxide concentration is low***.

   When bromthymol blue is green, it means ***the carbon dioxide concentration is medium***.

   When bromthymol blue is yellow, it means ***the carbon dioxide concentration is high***.

2. Write the chemical equation for photosynthesis.

   $6CO_2 + 6H_2O + \text{Energy} \rightarrow C_6H_{12}O_6 + 6O_2$

3. What happens to the concentration of CO_2 during photosynthesis?

   It goes down – it is taken out of the water by the plants.

4. Write the chemical equation for respiration.

   $C_6H_{12}O_6 + 6O_2 = 6H_2O + 6CO_2 + \text{energy}$

5. What happens to the concentration of CO_2 during respiration?

   It goes up – added to the water during respiration.

Parts B and C: Oxygen Cycle Data Table

Jar	What was added to jar	Color I expect it to be	Why	Color it was	Why
1 covered	nothing	Student answers should show thought, but will vary.		Blue	No measurable addition of carbon dioxide.
1 uncovered	nothing			Blue	No measurable addition of carbon dioxide.
2 covered	elodea			Green to Yellow	No sunlight = little photosynthesis. Use own stored food = respiration. So more carbon dioxide added to water than removed.
2 uncovered	elodea			Blue	Elodea remove carbon dioxide from water during photosynthesis so carbon dioxide concentration is lower.
3 covered	snails			Green to Yellow	Snails add carbon dioxide to the water during respiration, so carbon dioxide levels higher – no sunlight needed.
3 uncovered	snails			Green to Yellow	Snails add carbon dioxide to the water during respiration, so carbon dioxide levels higher – no sunlight needed.
4 covered	elodea and snails			Green to Yellow	No sunlight = little photosynthesis. Use own stored food = respiration. So more carbon dioxide added to water than removed and snails add carbon dioxide to the water during respiration.
4 covered	elodea and snails			Blue Possibly Blue-Green	Snails add carbon dioxide, but elodea remove it for photosynthesis. Should balance out if equal; may be a little greenish if elodea not keeping up with snails/not enough sunlight, etc.

Post-Lab Follow-Up (Please answer these after the conclusion.)

1. How do the results indicate that snails take in or release CO_2?

   Solution was green/yellow, showing Co_2 was added to the solution.

2. Do the results indicate that sunlight is necessary for the snail to release CO_2? Use data from the lab to explain your answer.

   No. Both the covered and uncovered jar were the same color.

3. Do your results indicate that elodea plants take in or release CO_2?

   Yes. The covered jar with just elodea was a bit greenish, which shows elodea added CO_2 to the water. Jars with both snails and elodea should indicate that elodea can remove CO_2.

4. Do the results indicate that sunlight is necessary for the elodea to remove CO_2? Use data from the lab to explain your answer.

   Yes. The covered jars were greenish or yellow, indicating that sunlight is needed for the plants to remove CO_2.

5. In what process does elodea use CO_2?

   Photosynthesis.

6. In what process does elodea produce CO_2?

   Respiration.

7. What is the contribution of light in these processes? How did the experiment demonstrate the contribution of light?

   The containers with elodea both with light and without showed that plants only remove a lot of CO_2 in the presence of sunlight.

8. Based on what you know about photosynthesis and respiration, why do plants and animals need each other in order to survive?

   The plants release oxygen; the animals use oxygen. The animals release CO_2; the plants use CO_2.

EARTH MOTION 3
Our Changing Earth

Module 1: Earth Cycles

Carbon Cycle

Carbon Cycle Overview

Carbon (C) is the basis of life on earth. All living things are carbon based and need this element to survive. Carbon is also part of the ocean, air and even rocks and is always on the move. Unlike energy, carbon is continuously cycled and reused. The earth has only a fixed amount of the element.

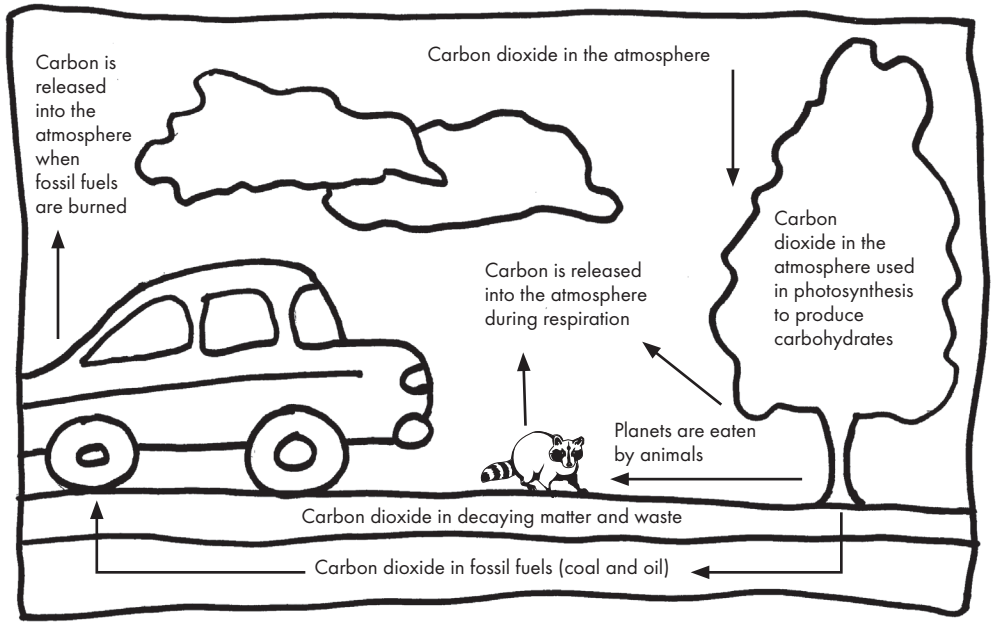
The Cycle

Plants have a process called **photosynthesis** that allows them to take carbon dioxide from the atmosphere and combine it with water. Then, using the energy of the sun, plants make sugars and oxygen molecules. Almost every creature on earth uses the sugars and starches created by plants.

Animals are non-photosynthetic creatures and are unable to create their own food. Rather, they eat plants or other animals. In humans and animals, the sugars and starches they eat are broken down by a process called **respiration**. This gives them energy, water and carbon dioxide molecules. The carbon dioxide then returns to the atmosphere where the plants use it again.

The organisms that break down dead animals, feces, dropped leaves, etc., are examples of **decomposers**. They break down organic material by separating the chemical compounds inside the body. They break down complex molecules that contain carbon into smaller molecules. Decomposers return carbon dioxide and simple carbon compounds (like carbon dioxide (CO_2) and methane (CH_4) to the atmosphere and soil so they can be reused by other organisms.

Sometimes the decomposers don't break down organic material. There are oil fields under the surface that are made up of plants that did not decompose millions of years ago. One day this carbon will return to the carbon cycle. This is a geologic process and is slow to work.



Balance of the Cycle

For many years, this cycle worked in perfect balance. This is changing, however, due to the use by man of fossil fuels (such as oil and coal) to produce energy. We also are cutting down forests and paving over areas where plants once grew, so there are fewer plants to recapture the CO_2 that we are releasing. We need to be careful that we don't release more carbon into the atmosphere than is being locked up. This could cause harm to the delicate carbon cycle.

The Carbon Cycle PowerPoint Presentation

THE CARBON CYCLE

Slide 1

What Is Carbon?

- An element
- The basis of life of earth
- Found in rocks, oceans, atmosphere

Slide 2

Carbon Cycle

- The same carbon atoms are used repeatedly on earth. They cycle between the earth and the atmosphere.

Slide 3

Plants Use Carbon Dioxide

- Plants pull carbon dioxide from the atmosphere and use it to make food — photosynthesis.
- The carbon becomes part of the plant (stored food).

Slide 4

Animals Eat Plants

- When organisms eat plants, they take in the carbon and some of it becomes part of their own bodies.

Slide 5

Plants and Animal Die

- When plants and animals die, most of their bodies are decomposed and carbon atoms are returned to the atmosphere.
- Some are not decomposed fully and end up in deposits underground (oil, coal, etc.).

Slide 6

Carbon Slowly Returns to Atmosphere

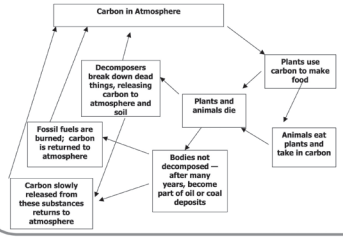
- Carbon in rocks and underground deposits is released very slowly into the atmosphere.
- This process takes many years.

Slide 7

Cycle – Repeats Over and Over and Over and Over …

Slide 8

Carbon Cycle Diagram



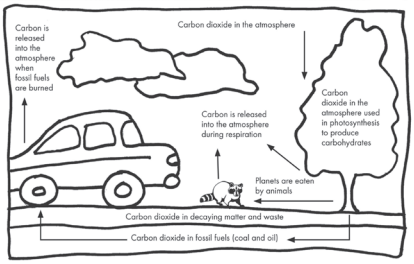
Slide 9

Carbon in Oceans

- Additional carbon is stored in the ocean.
- Many animals pull carbon from water to use in shells, etc.
- Animals die and carbon substances are deposited at the bottom of the ocean.
- Oceans contain earth's largest store of carbon.

Slide 10

The Carbon Cycle



Slide 11

Human Impact

- Fossil fuels release carbon stores very slowly
- Burning anything releases more carbon into atmosphere — especially fossil fuels
- Increased carbon dioxide in atmosphere increases global warming
- Fewer plants mean less CO_2 removed from atmosphere

Slide 12

What We Need to Do

- Burn less, especially fossil fuels
- Promote plant life, especially trees

Slide 13

Name(s)_____

Carbon Cycle Report

1. Sketch the cycle, including all major places the element is stored and how it moves between the lithosphere (solid earth), hydrosphere (earth's waters) and atmosphere (layer of gases that surround earth).

2. Why is this cycle important?

3. What impact do humans have on this cycle? (What do we do that affects/changes this cycle?)

4. How we can reduce our impact?

Carbon Cycle Report Answer Sheet

2. *Carbon is the basis of life on earth. All living things are carbon based and need carbon to survive. Carbon is always on the move. Animals, including humans, eat plants that provide sugar for energy. They use respiration to return carbon dioxide (CO_2) to the air. Organisms break down or decompose, which also provides carbon.*

3. *Burning anything releases more carbon into the atmosphere – especially fossil fuels. Increased carbon dioxide in atmosphere increases global warming. Fewer plants means less carbon dioxide removed from the atmosphere.*

4. *Burn less – especially fossil fuels. Promote plant life, especially trees.*

Carbon Cycle

Overview

Students will learn about the carbon cycle and why it is so important that it maintain its balance.

Standards Addressed

Grade 7, Science, Life Science

6-8 Benchmark

C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01 / Earth Systems

01. Explain the biogeochemical cycles that move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

Y2003.CSC.S01.G06-08.BC.L07.I02 / Earth Systems

02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Materials

- Candle
- Lighter
- Tall glass
- Graph paper

Background

All energy comes from the sun. Photosynthesis uses carbon dioxide (CO_2) from the air to build carbon-based plant matter. Plant and animal carbon material that is stored underground for millions of years turns into fossil fuels such as oil and coal. This reservoir of stored carbon is released back to the atmosphere when it is burned. Carbon dioxide is a greenhouse gas that traps heat from sunlight.

Procedure

Part 1

1. Ask the students if they have an idea of what the relationship is among the carbon cycle, fossil fuels and the atmospheric carbon dioxide level.

2. Light a candle and ask the students the following questions:

    a. What is burning when a candle is lit? *The candle wax, which comes from petroleum or beeswax, is burning.*

    b. What is needed for combustion to occur? *A fuel, oxygen and heat are needed for combustion to occur.*

    c. What will happen when the burning candle is covered? *Combustion of the candle wax uses O_2 and produces CO_2. When the CO_2 replaces enough O_2, the flame will go out.*

3. Cover the candle with a tall glass. Have students estimate how long the candle will burn.

4. Ask the students to name other materials that burn and list them on the blackboard. *Almost everything that burns originally came from a plant source.*

5. Review the list of materials and trace them back to their original living source. *Objects will quickly trace back to plants or fossil fuels such as petroleum.*

6. Following are discussion points for the class:

    a. Sunlight and photosynthesis are responsible for all the carbon-based burnable material on Earth.

    b. Fossil fuels such as oil and coal come from animal and plant material that died, was buried and was put under pressure for millions of years. These fuels are considered nonrenewable because they take so long to create.

    c. The first plants changed ancient atmospheric carbon dioxide (CO_2) and water (H_2O) into carbon-based material (burnable plant material) and oxygen (O_2). Earth had very little free oxygen before plants evolved. Increased plant life increased free oxygen and hydrocarbons until there were enough to support animal life and fire.

    d. Respiration and combustion consume hydrocarbons and oxygen and give off carbon to the air in the form of CO_2. The use of fossil fuels to meet the world's energy demands moves carbon from the ground into the air and has contributed to increased concentrations of carbon dioxide in the atmosphere. Atmospheric CO_2, a greenhouse gas, traps heat like the windows of a car on a sunny day.

    e. Climate change is quite complicated and continues to be studied. Yet, according to the Intergovernmental Panel on Climate Change, which represents more than 2,000 of the worlds leading climate scientists, "Human activity is influencing the global climate." Because of this, many countries in the world are trying to reduce their production of CO_2.

Part 2

1. Have students work with a partner.

2. Distribute graph paper and the data sheet to students. Have each pair of students determine the X-axis (years) together so that they have the same scale. One student will make a graph of average yearly temperature in Celsius. The other will make a graph of carbon dioxide levels in parts per million by volume.

3. This graphing could also be done using a spreadsheet program such as Excel.

4. Have the students use the data they have gathered to complete the Interpreting the Carbon Cycle Graph handout.

5. After the interpretations are made, have a class discussion about the answers.

Answers to Interpreting the Carbon Cycle Graph

1. *Yes, there has been in increase in temperatures over the years.*

2. *Yes, there has been an increase in CO_2 levels over the years.*

3. *Yes. The data given shows that as the amount of carbon dioxide increases, so does the temperature.*

4. *It appears that the amount of carbon dioxide is the independent variable. That being the case, the temperature is affected by the amount of carbon dioxide.*

Answers to Carbon Cycle Review

1. How could people in the United States produce less CO_2?

   For the average American, driving produces sizably more CO_2 than any other consumer behavior. This is followed by heating and cooling our homes and using electricity for appliances and lighting.

2. What sources of energy don't produce CO_2?

   Hydro, wind and solar power are some examples.

3. What sources of carbon-based energy can be quickly replenished?

   Fuels derived from plants.

4. What is the earth's major source of energy?

   The sun. Its energy creates wind for windmills, drives the water cycle for hydropower and provides energy to build plants.

5. How is that energy stored?

   The energy of the sun is captured by plants, which take carbon dioxide (CO2) from the air to build carbon-based plants. There is energy bound up in the new form of carbon that makes the plant.

6. What happens when that energy is used?

   When the carbon-based fuel is burned, it releases energy. This releases the carbon back to the air in the form of CO2.

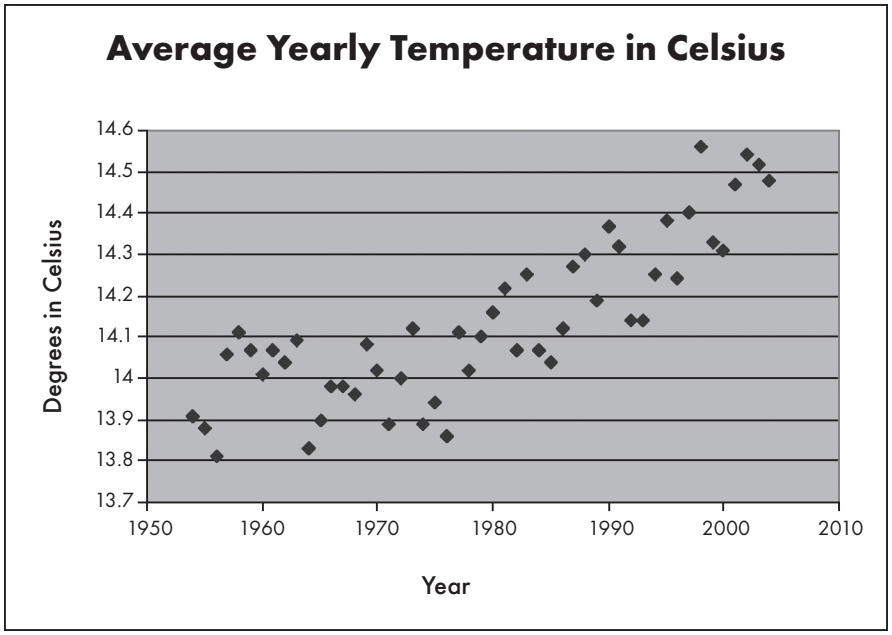
7. Why are climate scientists concerned about our use of fossil fuels for energy?

   Use of fossil fuels for energy contributes to increased amounts of CO_2 in the atmosphere, which most scientists believe is causing global warming.

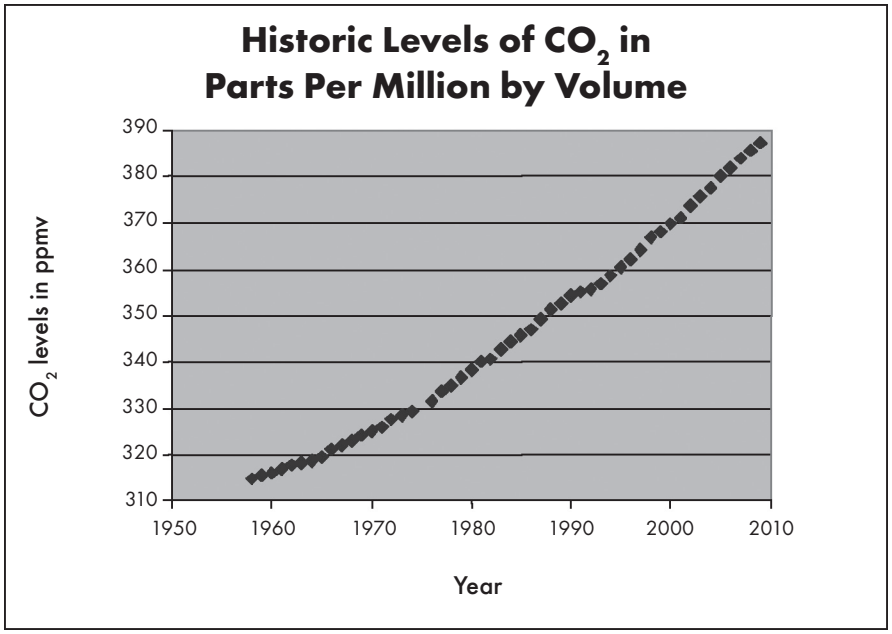
Concluding Comments

Increased reliance on renewable energy sources is an excellent solution that requires development of a new infrastructure. Conservation of the resources we already use is a more immediate solution.

Sample Graph of Yearly Temperatures



Sample Graph of Carbon Dioxide Levels



Carbon Cycle Data Sheet

December Historical Co_2 Levels in ppmv

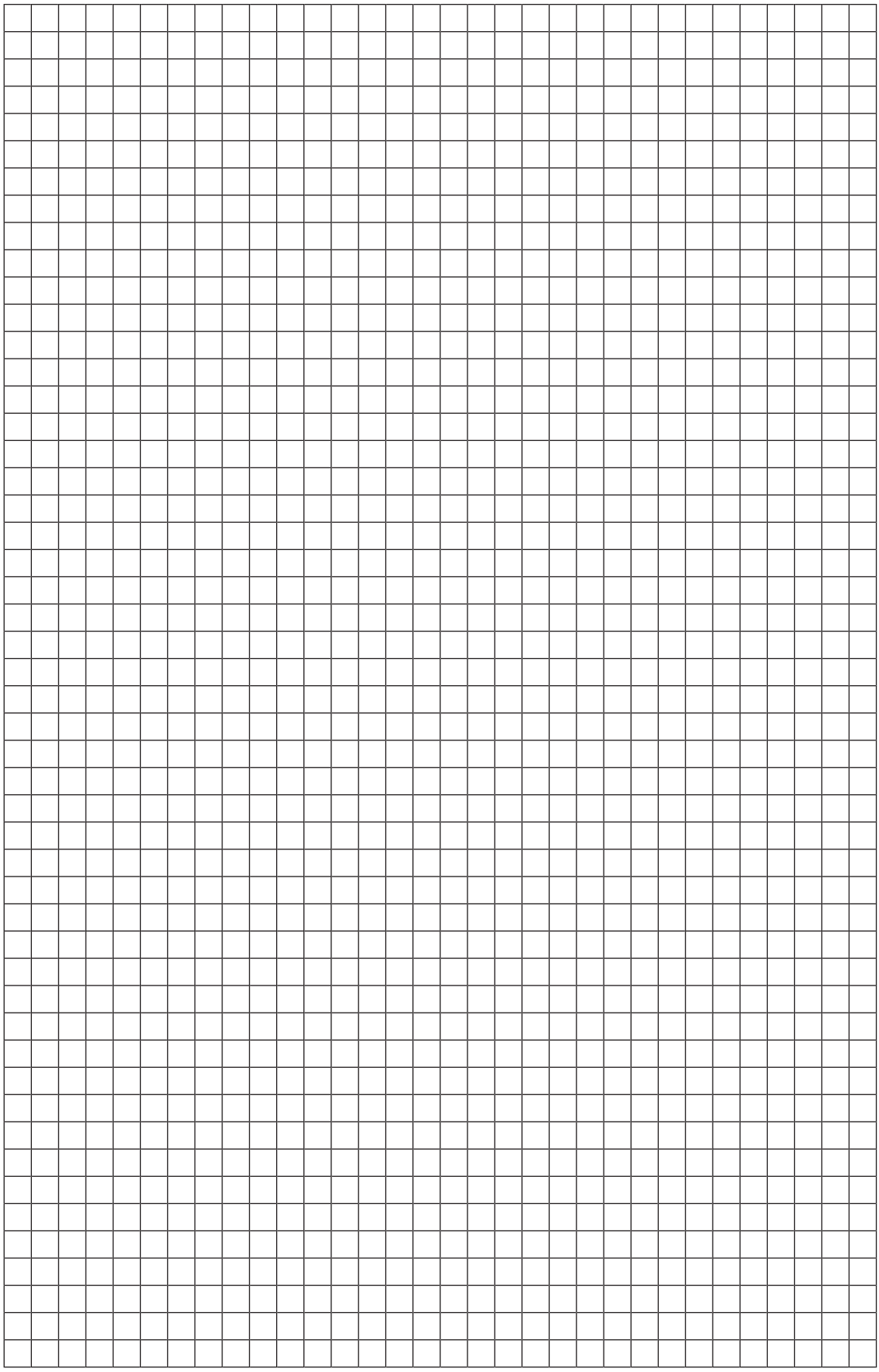
1958 - 314.67
1959 - 315.59
1960 - 316.19
1961 - 317.01
1962 - 317.7
1963 - 318.31
1964 - 318.71
1965 - 319.42
1966 - 321.08
1967 - 321.96
1968 - 322.84
1969 - 324.12
1970 - 325.13
1971 - 326.01
1972 - 327.55
1973 - 328.64
1974 - 329.5
1975 - 301.49
1976 - 331.65
1977 - 333.47
1978 - 334.83
1979 - 336.78
1980 - 338.29
1981 - 339.91
1982 - 340.67
1983 - 342.89
1984 - 344.36
1985 - 345.61
1986 - 346.89
1987 - 349.03
1988 - 351.29
1989 - 352.66
1990 - 354.21
1991 - 354.98
1992 - 355.39
1993 - 356.7
1994 - 358.74
1995 - 360.42
1996 - 361.96
1997 - 364.12
1998 - 366.87
1999 - 367.85
2000 - 369.62
2001 - 371.11
2002 - 373.71
2003 - 375.97
2004 - 377.51
2005 - 380.07
2006 - 381.85
2007 - 383.84
2008 - 385.54
2009 - 387.27

Table data source: Dr. Pieter Tans, NOAA/ESRL

ppmv = parts per million by volume

Year	Average Temp Celsius	Year	Average Temp Celsius
1954	13.91	1980	14.16
1955	13.88	1981	14.22
1956	13.81	1982	14.07
1957	14.06	1983	14.25
1958	14.11	1984	14.07
1959	14.07	1985	14.04
1960	14.01	1986	14.12
1961	14.07	1987	14.27
1962	14.04	1988	14.30
1963	14.09	1989	14.19
1964	13.83	1990	14.37
1965	13.90	1991	14.32
1966	13.98	1992	14.14
1967	13.98	1993	14.14
1968	13.96	1994	14.25
1969	14.08	1995	14.38
1970	14.02	1996	14.24
1971	13.89	1997	14.40
1972	14.00	1998	14.56
1973	14.12	1999	14.33
1974	13.89	2000	14.31
1975	13.94	2001	14.47
1976	13.86	2002	14.54
1977	14.11	2003	14.52
1978	14.02	2004	14.48
1979	14.10		

Atmosphere CO_2 in PPMV



Year

Average Yearly Temperatures in Degrees Celsius

Name(s)_____

Interpreting the Carbon Cycle Graph

1. Does there seem to be a trend to the global temperature in the last 50 years? If so, what is the trend?

2. Does there seem to be a trend to the amount of CO_2 in the atmosphere in the last 50 years? If so, what is the trend?

3. Do you think there is a relationship between the amount of CO_2 in the atmosphere and the global temperature? Explain.

4. Can you tell, based on this data, whether temperature is affected by carbon dioxide levels or carbon dioxide levels are affected by temperature?

Name(s)_____

Carbon Cycle Review

Countries around the world are concerned with the increase of carbons into the atmosphere and are working to reduce the amount of CO_2 produced.

1. How could people in the United States produce less CO_2?

2. What sources of energy do not produce CO_2?

3. What sources of carbon-based energy can be quickly replenished?

4. What is the earth's major source of energy?

5. How is that energy stored?

6. What happens when that energy is used?

7. Why are climate scientists concerned about our use of fossil fuels for energy?

EARTH MOTION 3
Our Changing Earth

Module 1: Earth Cycles

Nitrogen Cycle

Nitrogen Cycle Overview

Nitrogen is the most abundant element on our planet. Seventy-eight percent of our atmosphere is made up of nitrogen. The nitrogen cycle is the process by which nitrogen in all of its forms cycles through the earth (like the water, oxygen and carbon cycles.) Nitrogen is crucial for any life on Earth. It is in all amino acids and proteins and is the basis for nucleic acids such as DNA.

Nitrogen in its gaseous form has to be converted into a usable form. This process is called **fixation**. There are bacteria whose only job is to fix nitrogen so that it can be used by plants. The job of other types of bacteria is to return nitrogen to a gaseous state.

The process of nitrogen being fixed, used by plants and animals and returned to the atmosphere is referred to as the nitrogen cycle.

Nitrogen Cycle PowerPoint Presentation

The Nitrogen Cycle

Slide 1

Nitrogen

- The most abundant element in earth's atmosphere = approximately 78%.
- Used to carry out many life functions.
- Especially important for plant life.

Slide 2

Nitrogen Fixation

- Almost completely unusable for living things in its gaseous form (atmosphere).
- Gaseous nitrogen must be converted, or fixed, by bacteria before it can be used.
- The process bacteria use to fix nitrogen is called **nitrogen fixation**.

Slide 3

Nitrogen Fixing Bacteria

- Special bacteria fix the nitrogen in the air so plants and other producers can use it.
- Many of these bacteria live in the soil.
- Some plants, especially legumes (beans), have special bumps or nodes on their roots where these bacteria can live.

Slide 4

Nitrogen for Other Organisms

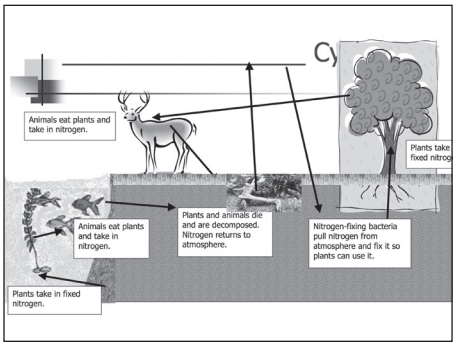
- Once the nitrogen is fixed by bacteria, plants use it and it becomes part of the plant.
- Other organisms that feed on the plants take in nitrogen and use it.
- Nitrogen is passed through the food chain.

Slide 5

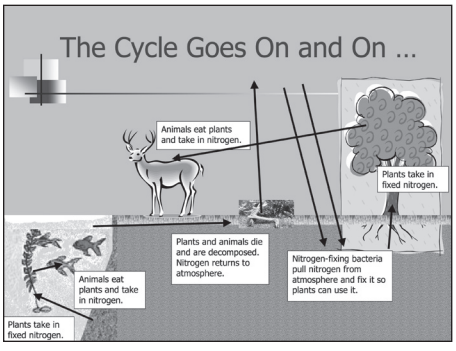
Decomposers

- When an organism dies, decomposers break down the body.
- Nitrogen from the body is returned to the atmosphere.
- The bacteria that decompose bodies are a different type of bacteria than the ones that fix nitrogen.

Slide 6



Slide 7

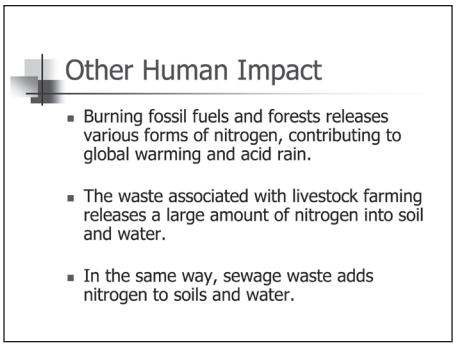


Slide 8

Human Impact — Fertilizers

- We overuse nitrogen-rich fertilizers, which dissolve in surface runoff and ground water.
- Fertilizers end up in waterways as they wash into streams and ponds.
- Increased nitrate levels cause plants to grow rapidly, filling the water until the plants use up the nitrate supply and die.
- The number of herbivores increase when the plant supply increases. When the plants die, the herbivores are left without a food source. In this way, changes in nutrient supply affect the entire food chain.

Slide 9



Slide 10

Slide 11

Nitrogen Cycle

Overview

Students will play the role of nitrogen atoms traveling through the nitrogen cycle to gain an understanding of the varied pathways through the cycle and the relevance of nitrogen to living things.

Standard Addressed

Grade 7, Science, Earth Science

6-8 Benchmark

C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01 / Earth Systems

01. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

Y2003.CSC.S01.G06-08.BC.L07.I02 / Earth Systems

02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Materials

- Eleven dice

Procedure

1. Before class begins, use the provided full-page signs to set up 11 stations for surface water, atmosphere, soils, fertilizer, groundwater, rainwater, live plants, animal wastes, dead plants and animals, live animals and ocean.

2. Cut apart the dice codes and put each at its appropriate station, along with one die.

3. Copy the passport stamps onto sticker paper and cut them apart into individual stickers. Plain paper and glue may also be used.

4. Discuss with the class what nitrogen is. Show the Nitrogen Cycle PowerPoint presentation.

5. Divide students so that there are a few at each station.

6. Give each student a traveling nitrogen passport and tell them that they are going to play a game in which they will simulate the cycle of a nitrogen atom. They will travel through the nitrogen cycle (following directions at the different stations around the room) based on rolling dice. Tell students that they will each carry a the passport with them and stamp it each time they get to a station.

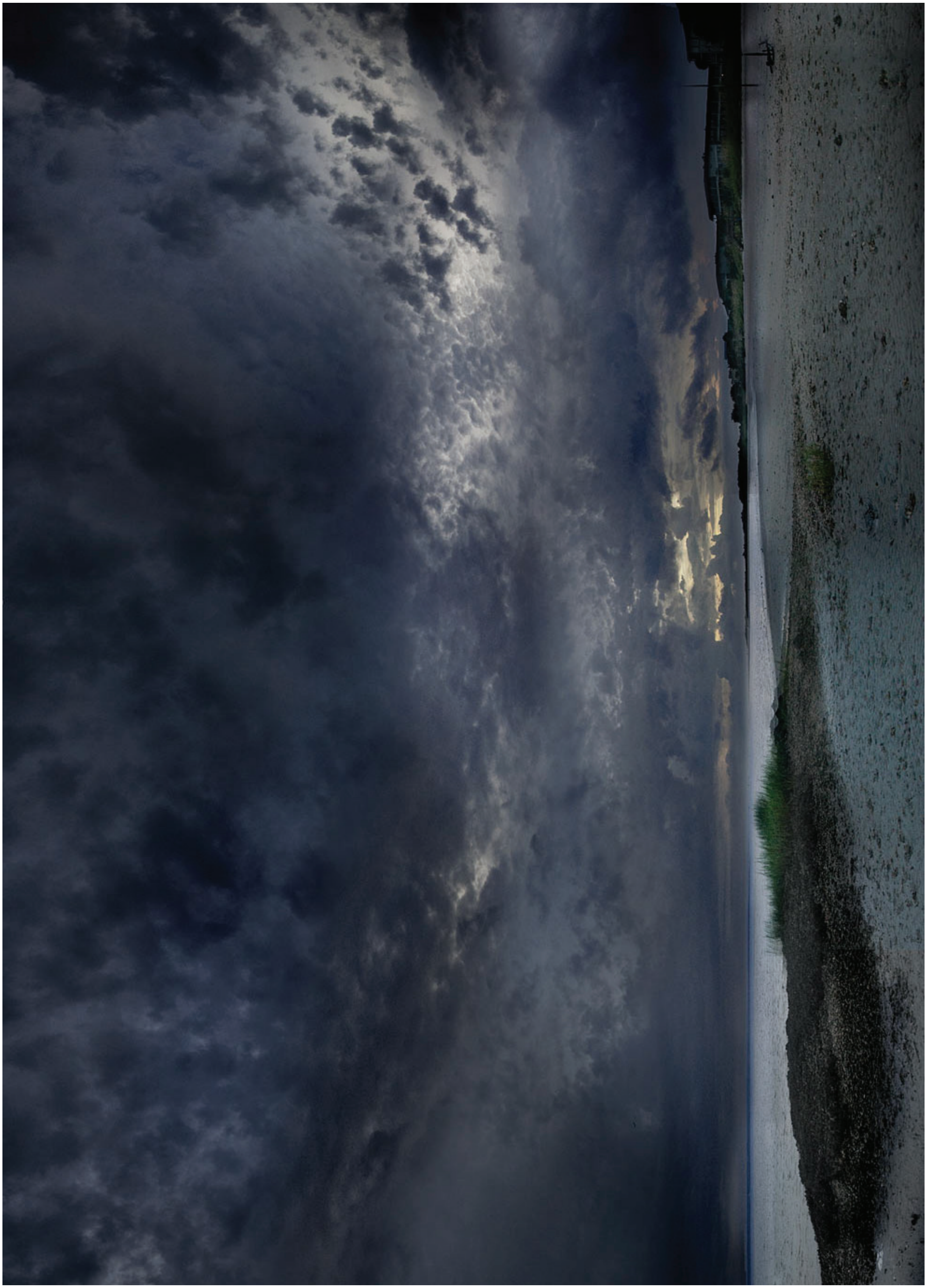
Evaluation

Successful completion of the traveling nitrogen passport.

Atmosphere Station

Surface Water Station

Rainwater Station



Groundwater Station

Fertilizer Station

Soils Station

Ocean Station

Live Animals Station

Animal Wastes Station

Dead Plants and Animals Station

Live Plants Station

Dice Codes

Instructions:

- Print the following dice code pages.
- Cut each reservoir apart.
- Place dice codes at each reservoir station.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Atmosphere** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1 or 2</u> Lightning strikes! Nitrogen gas is made into a solid and travels to the **soil**. <u>If you roll a 3</u> Blue-green algae and bacteria convert you into a solid, bringing you to the soil. <u>If you roll a 4</u> Bean plants extract you from the air and bring you to the soil. <u>If you roll a 5 or 6</u> Some nitrogen can get into the water in clouds and then fall as rain.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Surface Water** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1 or 2</u> You are just the sort of nitrogen that plants need to live. You are now within a live plant. <u>If you roll a 3 or 4</u> You travel through the rivers and streams to the ocean. <u>If you roll a 5 or 6</u> You percolate deep underground in the groundwater.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Rainwater** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1</u> You fall into a lake or stream so now you are part of surface water. <u>If you roll a 2 or 3</u> You fall on the land and become part of the soil. <u>If you roll a 4</u> You percolate deep underground in the groundwater. <u>If you roll a 5 or 6</u> You rain into the ocean.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Groundwater** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll an odd number</u> The groundwater you are dissolved within travels and you become part of the surface water. <u>If you roll an even number</u> The groundwater you are dissolved within travels and you become part of the ocean.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Fertilizers** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1 or 2</u> You dissolve and wash into the surface water. <u>If you roll a 3 or 4</u> You become part of the soil. <u>If you roll a 5 or 6</u> You are just the sort of nitrogen that plants need to live. You are now within a live plant.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Soils** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1</u> You dissolve and wash into the groundwater. <u>If you roll a 2</u> You dissolve and wash into the surface water. <u>If you roll a 3 or 4</u> You are just the sort of nitrogen that plants need to live. You are now within a live plant. <u>If you roll a 5 or 6</u> Bacteria have transformed you into nitrogen gas and you are now part of the atmosphere.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Ocean** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1</u> Look out! Water is on the move. You have washed into the groundwater. <u>If you roll a 2 or 3</u> You are just the sort of nitrogen that plants need to live. You are now within a live plant! <u>If you roll a 4, 5 or 6</u> Bacteria have transformed you into nitrogen gas and you are now part of the atmosphere.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Live Animals** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll an odd number</u> The animal that you are within has died. Go to dead plants and animals. <u>If you roll an even number</u> Congratulations! The animal that you were within has excreted and you are in its waste. Go to animal waste.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Animal Waste** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1or 2</u> Look out before someone steps in you! Now you are decomposing in the soil. <u>If you roll a 3 or 4</u> A farm supply company has picked you up and made you into fertilizer. <u>If you roll a 5 or 6</u> What's that in the water? You have dissolved into surface water.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Dead Plants and Animals** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll a 1 or 2</u> You are decomposed and have become part of the soil. <u>If you roll a 3</u> You are decomposed and become dissolved in surface water. <u>If you roll a 4</u> You are decomposed and become dissolved in the ocean. <u>If you roll a 5 or 6</u> Forest fire! The wood you are within has burnt and you have been released into the atmosphere.

RESERVOIR	POTENTIAL ROUTES
You have arrived at **Live Plants** *Stamp your passport and then roll the die to see where you will travel next!*	<u>If you roll an odd number</u> The plant that you are within has died. Go to dead plants and animals. <u>If you roll an even number</u> An animal has eaten the plant that you are within! Go to live animals.

Traveling Nitrogen Passport

You are about to become a nitrogen atom! In this activity, you will travel as a nitrogen atom, stopping in locations where a nitrogen atom may be found. For each stop along your way, you need to record where you went and how you got there. You will do this by gluing the sticker for that stop in the correct spot and writing down what the station sign told you happened to get you there. See the example below.

Place the stamp for your starting location here.

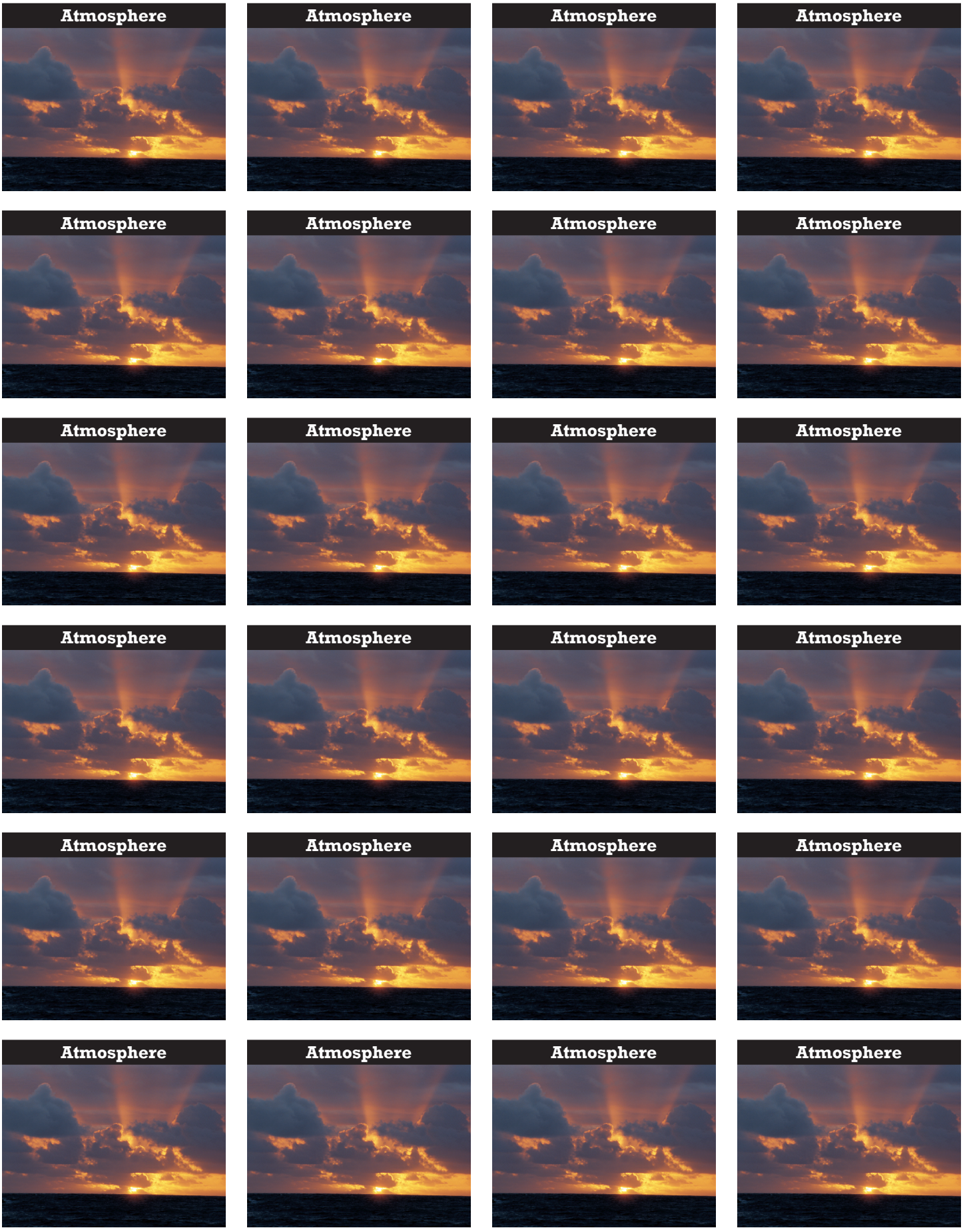
Place starting location sticker here

Example

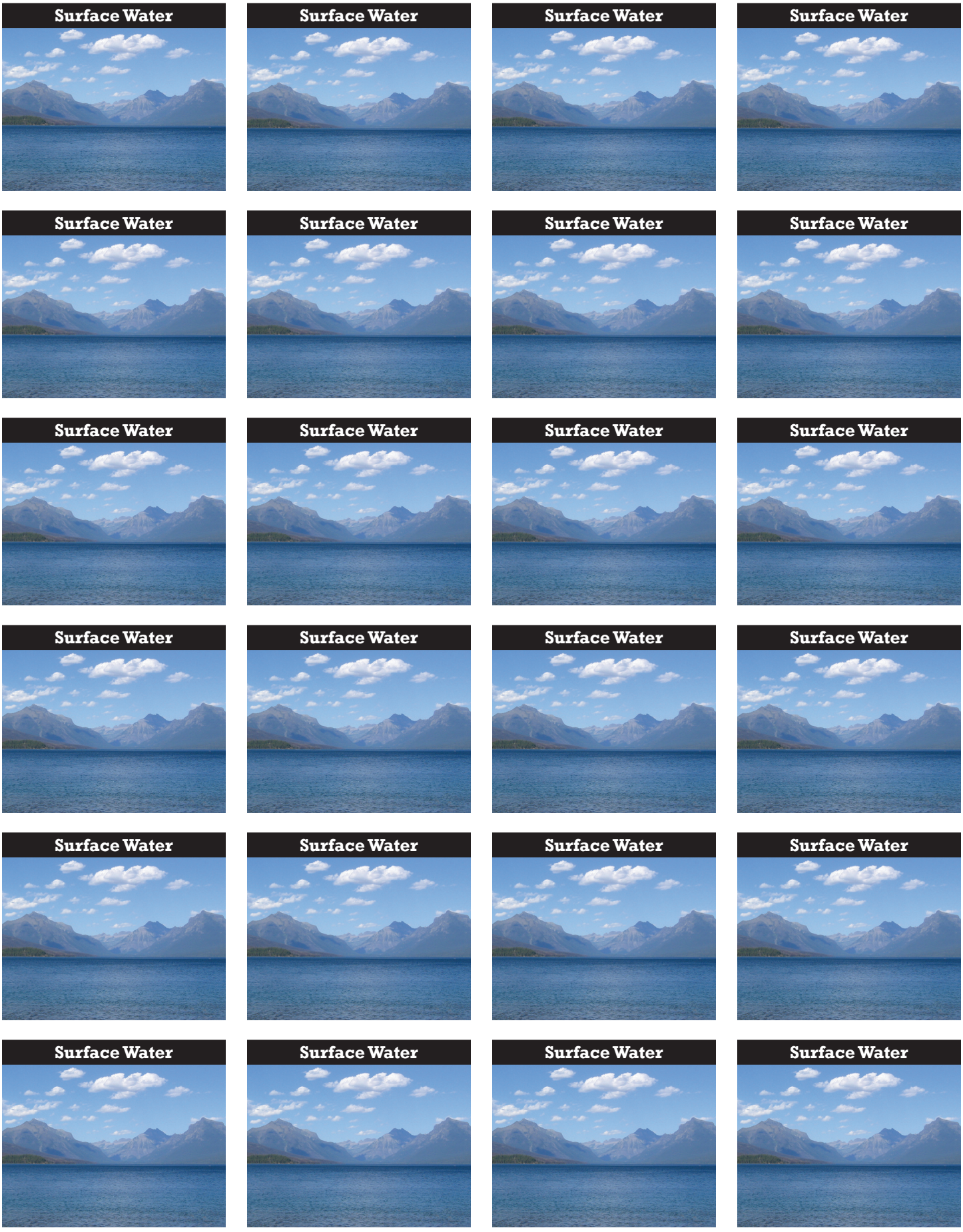
An animal has eaten the plant that you are within. Go to Live Animals.	**Live Plants** 

Trip #1: How I got here:	Where I went. (Glue stamp here.)
Trip #2: How I got here:	Where I went. (Glue stamp here.)
Trip #3: How I got here:	Where I went. (Glue stamp here.)
Trip #4: How I got here:	Where I went. (Glue stamp here.)
Trip #5: How I got here.	Where I went. (Glue stamp here.)
Trip #6: How I got here:	Where I went. (Glue stamp here.)
Trip #7: How I got here:	Where I went. (Glue stamp here.)
Trip #8: How I got here:	Where I went. (Glue stamp here.)

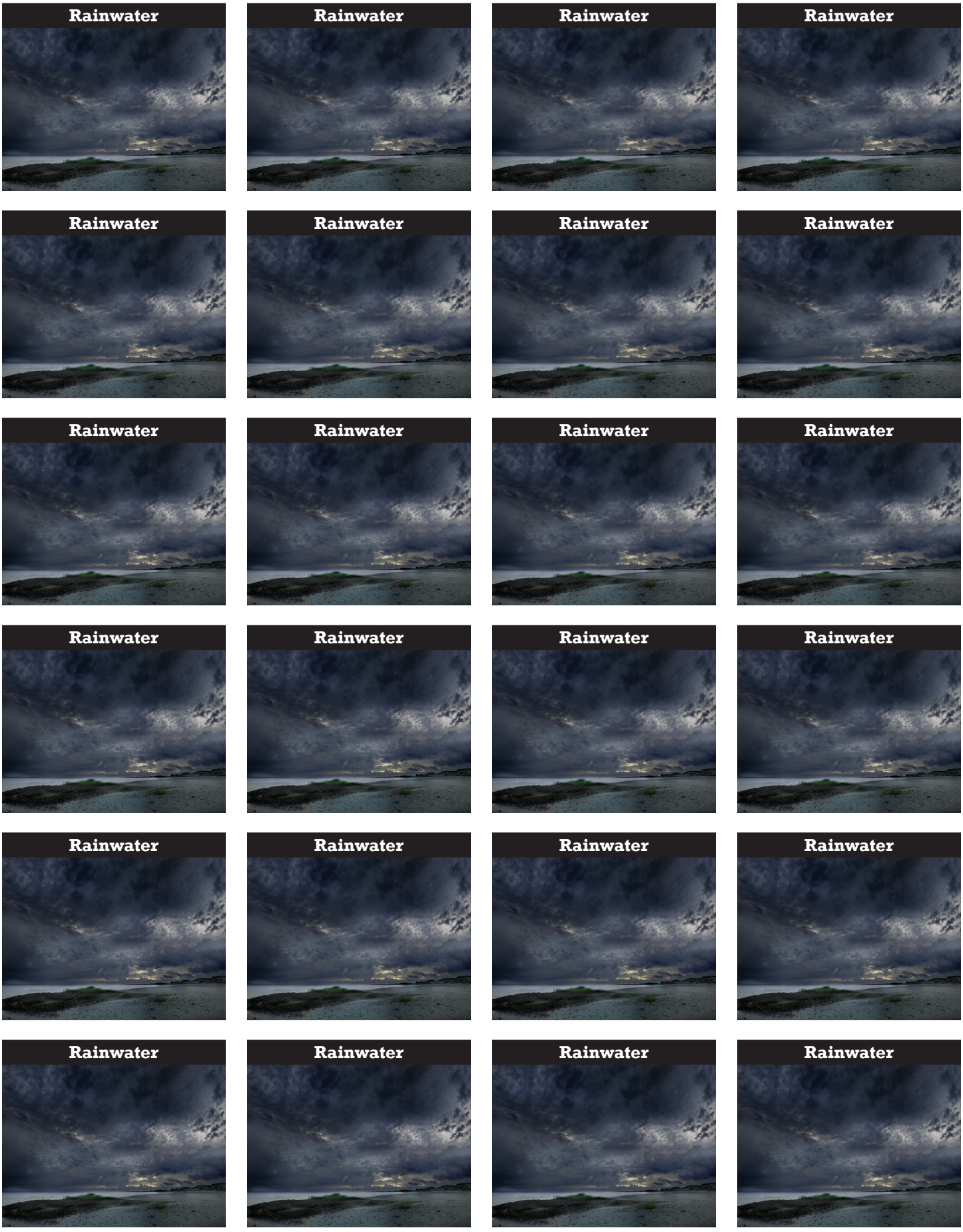
Passport Stamps



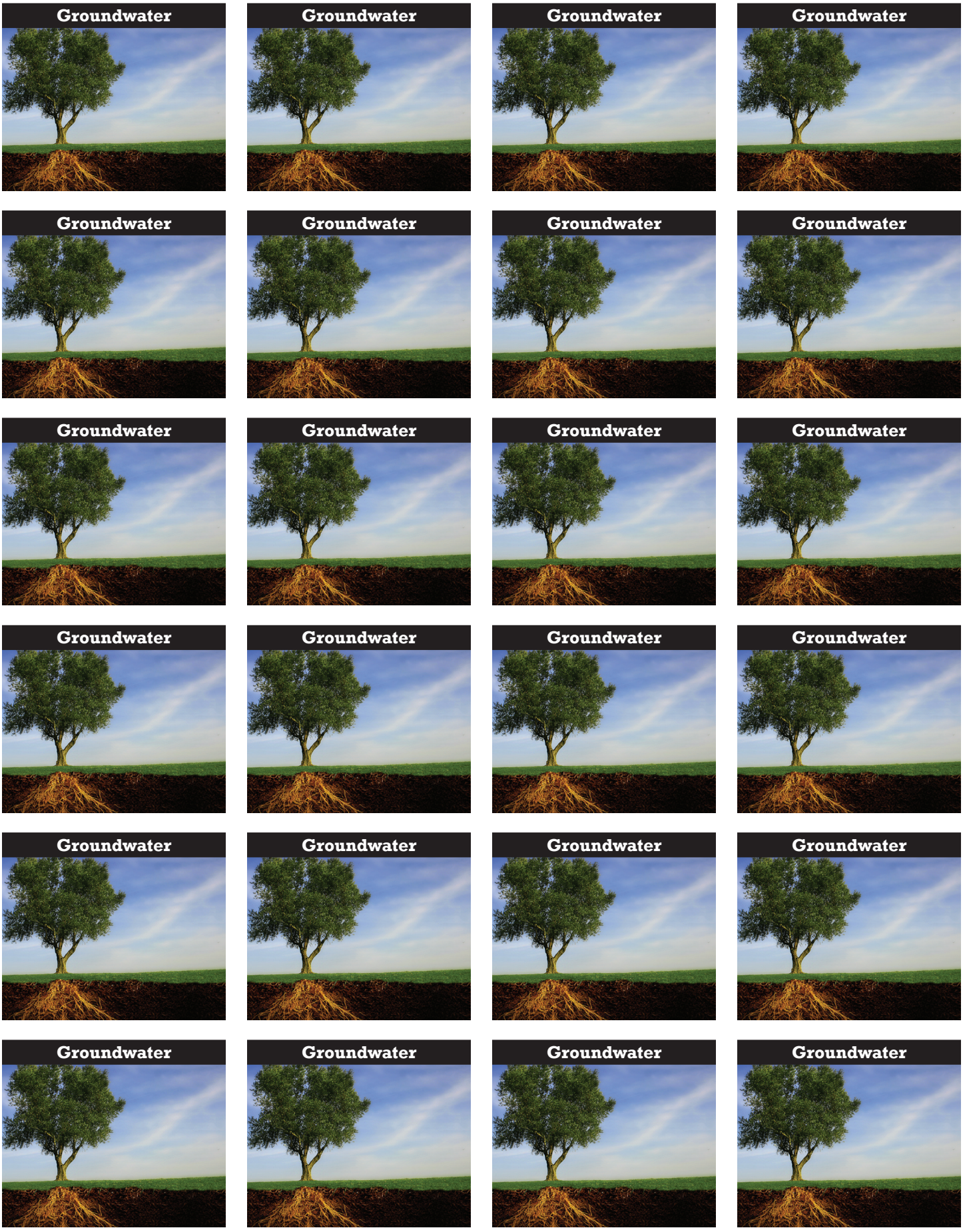
Passport Stamps



Passport Stamps

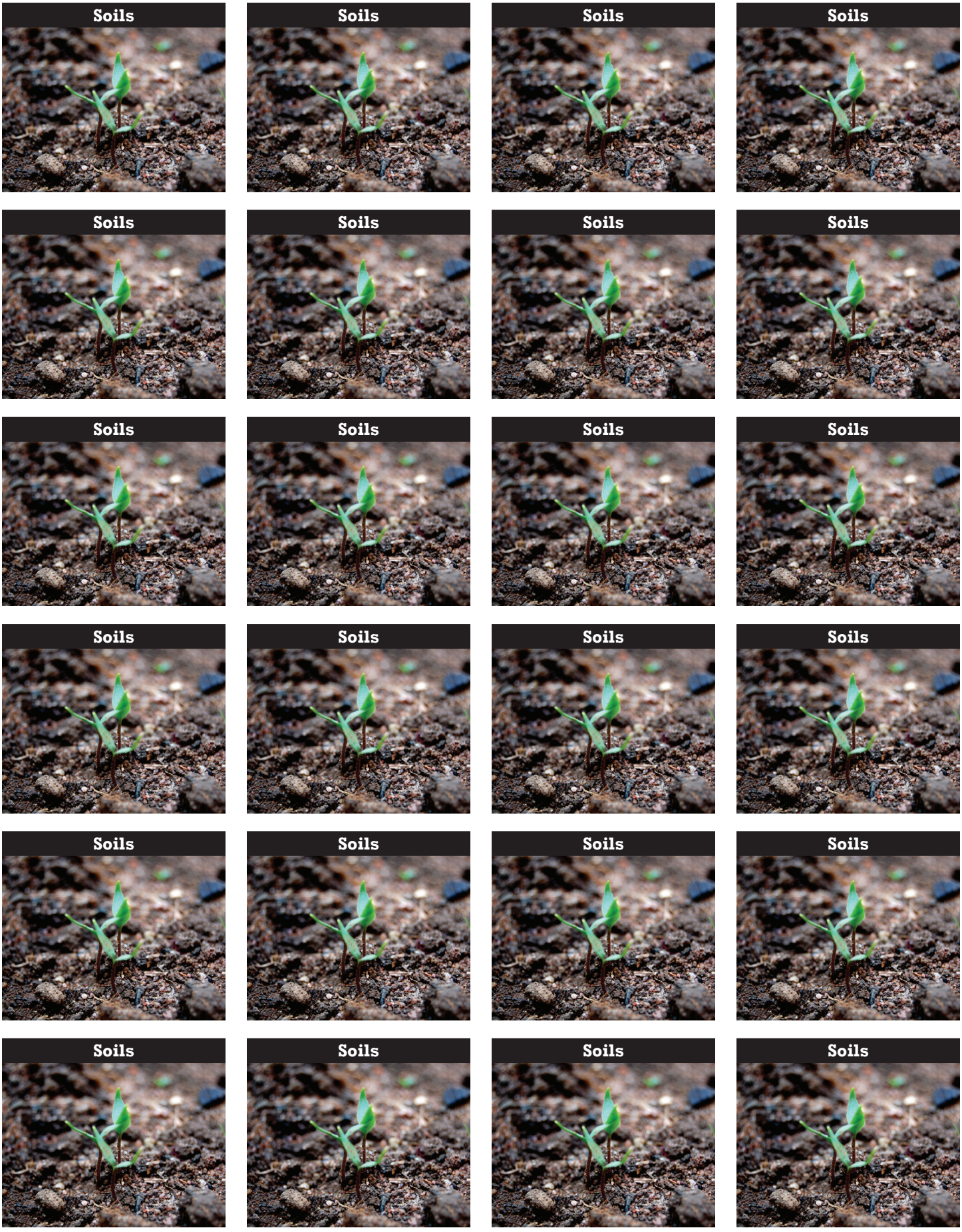


Passport Stamps

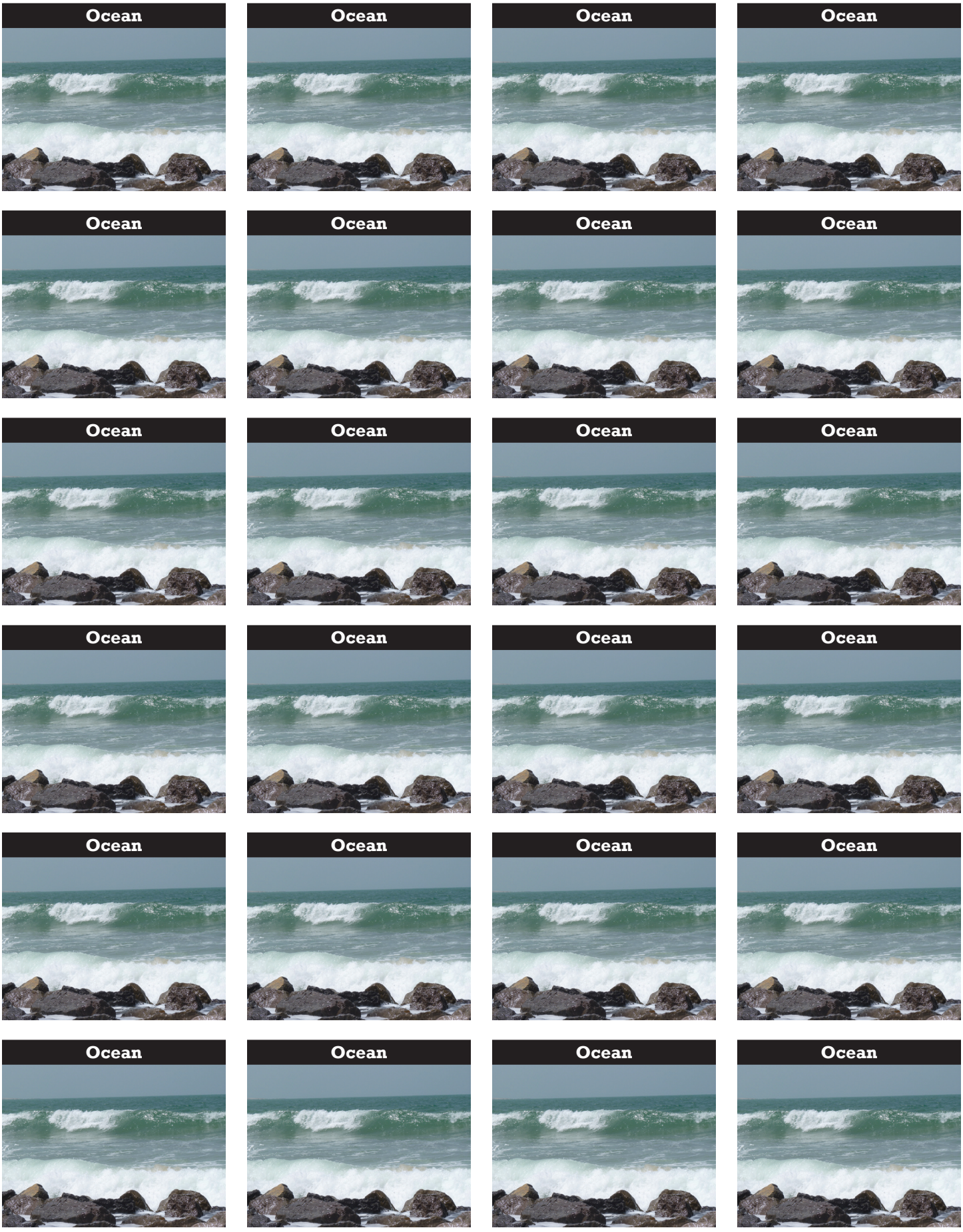


Passport Stamps

Passport Stamps



Passport Stamps



Passport Stamps

Passport Stamps

Passport Stamps

Passport Stamps

EARTH MOTION 3
Our Changing Earth

Module 1: Earth Cycles

Cycles Project

Project: Create a Game

Overview

In this lesson, the students will use creativity to design a game that employs the knowledge they have gained about the earth's cycles.

Standards Addressed

Grade 7, Science, Life Science

6-8 Benchmark

C. *Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution).*

Y2003.CSC.S01.G06-08.BC.L07.I01 / Earth Systems

01. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

Y2003.CSC.S01.G06-08.BC.L07.I02 / Earth Systems

02. Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Y2003.CSC.S01.G06-08.BC.L07.I03 / Earth Systems

03. Describe the water cycle and explain the transfer of energy between the atmosphere and hydrosphere.

Y2003.CSC.S01.G06-08.BC.L07.I04 / Earth Systems

04. Analyze data on the availability of fresh water that is essential for life and for most industrial and agricultural processes. Describe how rivers, lakes and groundwater can be depleted or polluted becoming less hospitable to life and even becoming unavailable or unsuitable for life.

Materials

- File folders
- Markers
- Papers for cards
- Computers (optional)

Procedure

1. Review all of the cycles with the students. Encourage them to consult the cycles handouts they have been given, their textbook and the Internet as needed for this project.

2. Students work in groups of two, three or four for this project.

3. Assign each group one of the earth cycles.

4. Review the Create a Game handout with the students. A game card template has been included for use, if needed.

Evaluation

Rubric for Cycles Board Game

Game Board

10 Points	8 Points	6 Points	4 Points	2 Points
Everything is neatly created and directions were followed completely.	Game board is excellent but some parts are sloppy.	Game board is complete but one or two elements are missing and it could be neater.	Most of the directions were ignored and the board is sloppy.	There is a game board but it is not colored and no extra efforts were made at creativity.

Questions

10 Points	8 Points	6 Points	4 Points	2 Points
There are 25 questions and answers and they are well incorporated into the game. Several must be answered correctly to win the game.	A couple of questions or answers are missing or incorrect.	Some questions are missing or one could play game without answering most questions.	Half of the questions are missing or questions are hardly used in the game.	Many questions are incorrect or missing and very few are required to play the game.

Directions

10 Points	8 Points	6 Points	4 Points	2 Points
All information is incorporated into game play (storage and movement of the element through the cycle and human impact).	Most of the information is included in game play (storage and movement of the element through the cycle and human impact).	Information of the cycle is good but missing some crucial point; is incomplete, incorrect or not incorporated into game play.	There is some information but major content is missing, incorrect or not crucial to game play.	There is little correct information about the cycle incorporated into game play.

Summary Information

10 Points	8 Points	6 Points	4 Points	2 Points
Clearly explains how cycle works, importance and human impact.	Most of the information is clearly explained.	Information on the cycle is good but missing some crucial points, is incomplete or incorrect.	There is some information but major content is missing or incorrect.	There is little correct information.

Appeal

10 Points	8 Points	6 Points	4 Points	2 Points
Game looks and sounds as if it would be fun to play. Directions are clear and easy to follow.	Game looks and sounds fun but has minor issues with playability.	Game looks attractive but sounds somewhat complicated and/or boring.	Some issues with the appearance/description of game. Game directions are vague or too complicated.	Game is poorly constructed, boring and/or difficult to play.

Group Members' Names _____

Cycle _____

Name of your game _____

Create a Game

Your Task: You work for a board game manufacturer and have been assigned the task of creating a fun, interesting board game or card game that will help students review everything they need to know about a specific earth cycle.

1. Using a file folder, colored paper, colored pencils and markers, create a game board. Put the name of your game on the tab of the folder and design the game board on the inside. Make sure that your game design is neat, colorful, interesting and creative. If you wish, you can create a card game rather than a board game.

2. Create at least 25 questions and answers for your game that relate to your assigned cycle. The questions must be incorporated into the game play so that the game cannot be won without answering the questions correctly.

3. Design your game so that all the information that students need to know about the assigned cycle (including where it is stored, how it cycles through the lithosphere, hydrosphere and atmosphere and how humans impact it) is included in the game.

4. Write a summary of your game that will appear on the game "box" and in advertisements for the game. People reading your summary should be informed and want to play the game. The summary must include this information:

    a. An overview of how the cycle works

    b. An explanation of why this cycle is important and how human activities impact this cycle

    c. Information about the game that makes it sound fun to play

Game Card Template

Summative Assessment

Part 1

1. Consumers use oxygen to break down _____ and release energy.

2. The process most consumers use to release energy is called _____.

3. _____ is a gas produced during respiration.

4. _____ is a gas produced during photosynthesis.

5. To perform photosynthesis, plants take in carbon dioxide and _____.

6. Explain how photosynthesis and respiration are related.

7. Explain why burning forests is an especially bad idea.

Part 2

8. By what process do plants create food?
    a. Respiration
    b. Photosynthesis
    c. Digestion
    d. Chlorophyll

9. What gas is a byproduct of the process that plants use to make food?
    a. Carbon dioxide
    b. Nitrogen
    c. Ammonia
    d. Oxygen

10. Plants need nitrogen in order to grow. Nitrogen in the air is not usable by plants. What is the most common process by which nitrogen is made available to plants?
    a. Breakdown of water
    b. Lightning
    c. Photosynthesis
    d. Bacterial action

11. What is an organism that breaks down dead organisms called?
    a. Decomposer
    b. Second consumer
    c. Producer
    d. First consumer

12. In what phase of the water cycle does rain fall?
    a. Evaporation
    b. Precipitation
    c. Collection
    d. Freezing

Summative Assessment Cycles Answer Sheet

1. *Sugar*
2. *Respiration*
3. *Carbon dioxide (CO_2)*
4. *Oxygen*
5. *Water*
6. *People give off CO_2 when they breathe. Plants take in the CO_2. They use carbon to make glucose (sugar) and the oxygen goes back into the atmosphere and we breathe it in. The cycle starts again.*
7. *Fewer plants mean less oxygen and more carbon dioxide. This disturbs the balance of the nature cycle.*
8. *b. Photosynthesis*
9. *d. Oxygen*
10. *d. Bacterial action*
11. *a. Decomposer*
12. *b. Precipitation*

EARTH MOTION^3

Our Changing Earth

Module 2: Plate Tectonics

http://www.WesternReservePublicMedia.org/EarthMotion3

Plate Tectonics

In ***Plate Tectonics***, students begin with a formative assessment. The goal of the module is to help students to understand that the earth is constantly changing.

There are two approaches to gaining that understanding. The first is to place the students into specialty groups. Each group is given a topic about which they are to become experts. They may use their text, the library or the links provided to gather information. They must find five important facts about their topic and have those facts approved by the teacher. They then will make a presentation to the class about the facts that they have learned. The topics include the earth's internal structure, plate tectonics, earthquakes, volcanoes, Ring of Fire and vocabulary.

The second approach is more hands-on. Students create a model to show the effects of plate movement – the folding, faulting and uplifting of the earth. The project requires student to come up with their own model of one or more aspects of plate tectonics. A summative assessment follows.

Also available are a resource page that gives information about the changing earth, a vocabulary list and a resources hotlist.

Standards Addressed

Grade 8, Science, Earth Science

6-8 Benchmark

E. Describe the processes that contribute to the continuous changing of earth's surface (e.g., earthquakes, volcanic eruptions, erosion, mountain building and lithospheric plate movements).

Y2003.CSC.S01.G06-08.BE.L08.I09 / Earth Systems

09. Describe the interior structure of Earth and Earth's crust as divided into tectonic plates riding on top of the slow moving currents of magma in the mantle.

Y2003.CSC.S01.G06-08.BE.L08.I10 / Earth Systems

10. Explain that most major geological events (e.g., earthquakes, volcanic eruptions, hot spots and mountain building) result from plate motion.

Y2003.CSC.S01.G06-08.BE.L08.I13 / Earth Systems

13. Describe how landforms are created through a combination of destructive (e.g., weathering and erosion) and constructive processes (e.g., crustal deformation, volcanic eruptions and deposition of sediment).

Y2003.CSC.S01.G06-08.BE.L08.I14 / Earth Systems

14. Explain that folding, faulting and uplifting can rearrange the rock layers so the youngest is not always found on top.

Plate Tectonics Vocabulary

Asthenosphere: A hot, semisolid part of the mantle that makes up the lower portion of the earth's upper mantle.

Continental crust: The land crust of the earth.

Core of the earth: There are two parts to the core: an inner core that is solid and is about 4300 degrees Celsius and an outer core that is liquid around the inner core. The core parts are composed mostly of iron, with about 10 percent sulfur. There is some new information that uranium may be in the core in quantity and may be responsible for some of the earth's inner heat.

Convergence: The act of moving toward each other and colliding.

Continental drift: A theory that the continents moved across the earth's surface.

Crust: The outermost shell of the earth.

Divergence: The act of moving away. Where plates diverge, hot molten rock rises and cools, adding new material to the edges of the mid-oceanic plates. This process is known as sea-floor spreading.

Earthquake: A sudden movement of the earth's crust caused by the release of stress accumulated along geologic faults or by volcanic activity.

Erosion: The mechanical process of wearing or grinding something down (as by particles washing over it).

Fault: An area of stress in the earth where broken rocks slide past each other, causing a crack in the earth's surface.

Geologic fault: A planar fracture in rock in which the rock on one side of the fracture has moved with respect to the rock on the other side.

Geologic fold: When one or a stack of originally flat and planar surfaces, such as sedimentary strata, are bent or curved as a result of plastic deformation.

Gondwanaland: An early landmass that broke up to form India, Australia, Antarctica, Africa and South America.

Laurasia: An early landmass that broke up to form Asia, Europe, Greenland and North America.

Lithosphere: The solid part of the earth consisting of the crust and outer mantle.

Magma: A pasty mixture of crude mineral or organic matter; liquid or molten rock deep in the earth, which on cooling solidifies to produce igneous rock.

Mantle: The mantle goes around the core and is solid. It comprises most of the earth's mass. The temperature is about 1000 degrees Celsius.

Oceanic crust: The crust underlying the ocean basin. This layer is much thinner than the earth's continental crust and is young.

Ocean trenches: Long but narrow topographic depressions of the sea floor. They are also the deepest parts of the ocean.

Pangea: A supercontinent that existed 250 million years ago which included most of the earth's continental landmasses.

Plates: The earth's surface is broken into seven large and many small moving plates, each about 50 miles thick. They move relative to one another an average of a few inches a year or about as fast as fingernails grow.

Plate tectonics: The term for the field of study of large scale motions of the earth's lithosphere.

Rift: A trough or valley formed where two blocks of crust move apart**.**

Rock cycle: A fundamental concept in geology that describes the dynamic transitions through geologic time among the three main rock types (igneous, sedimentary and metamorphic).

Satellite images: Photographs of earth or other planets made by means of artificial satellites.

Subduction: When one plate is forced beneath another into the mantle and eventually undergoes partial melting.

Topographic map: A map depicting terrain relief showing ground elevation, usually through either contour lines or spot elevations.

Transform fault: Plates moving horizontally against each other.

Types of plate boundaries

- **Transform plates:** A boundary at which one lithosphere plate slips laterally past another (which causes earthquakes).
- **Divergent plates:** A tectonic boundary where two plates are moving away from each other and new crust is forming from magma that rises to the earth's surface between the two.
- **Convergent plates:** A tectonic boundary where two plates are moving toward each other, which causes mounts to develop.

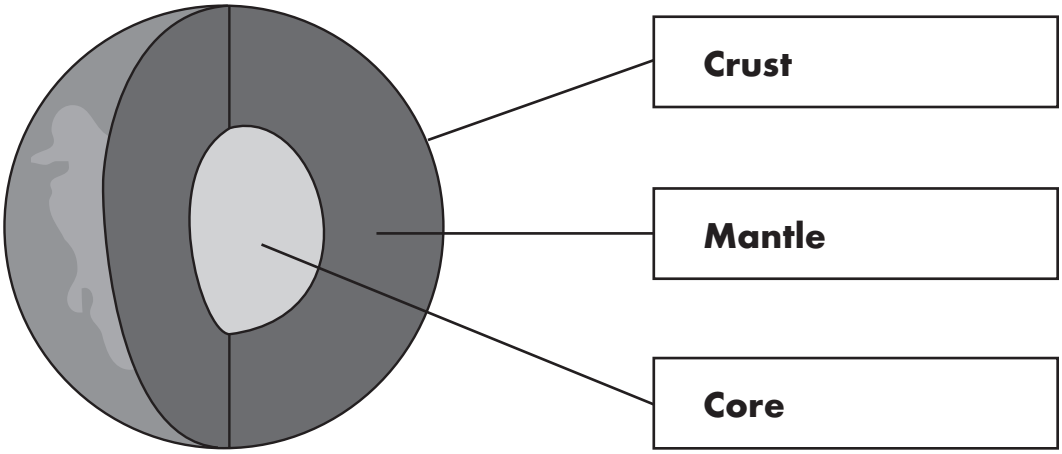
Volcano: A vent in the crust of the earth or another planet from which usually molten rock, ash and steam are ejected. Volcanic terms include the following:

- **Eruption:** When ash, lava flows and gas are ejected from deep within the earth.
- **Igneous rock:** Rock that is formed when magma cools and hardens.
- **Lava:** What magma is called when it reaches the surface of the earth.
- **Magma:** Molten rock when it is underground.
- **Tephra:** Rock fragments of all sizes thrown into the air above a volcano.
- **Vent:** An opening in the earth's surface through which volcanic ash, lava flows and gas are emitted.

Plate Tectonics Resource Page

Basic Structure of the Earth

Understanding plate tectonics requires a little knowledge of the earth's basic structure. If you could slice through the earth, you would find that it is made up of three layers.



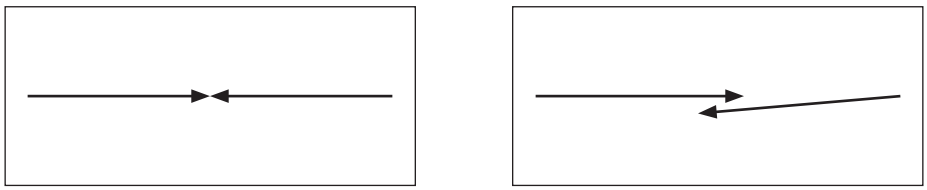
The innermost layer is a very hot **core** of iron and nickel. The inside of the core is solid and the outside is liquid. The middle layer is the **mantle**. It is composed of rock that flows very slowly. The outermost layer is the **crust**. There is oceanic crust and continental crust.

The crust and the upper part of the mantle (which is cooler and more rigid than the lower parts) together make up the **lithosphere**. The lithosphere is broken into huge rocky slabs called **tectonic plates**. These plates ride on top of the **asthenosphere**, a hot, semisolid part of the mantle that lies directly under the lithosphere.

Plate Tectonics

Sometimes when the plates move, they can either collide or bump into each other or one can slide under the other. These are called **convergent boundaries.** Sliding under one another is called **subduction,** and often results in volcanoes. If the crusts collide, mountains can be formed.

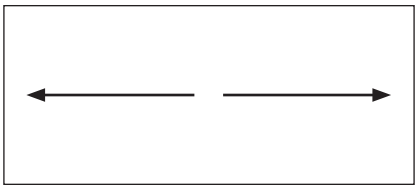
Convergent boundaries



Subduction

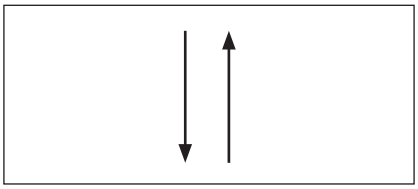
A second type of plate has a **divergent boundary**. This is when the plate move apart. The space that this creates is filled with new crustal material that comes from the molten magma below it.

Divergent boundaries



The third type of movement involves **transform boundaries**. This is when the plates build up as they try to slide against one another. Eventually the pressure becomes too great and the plates break apart. This causes an earthquake. A fault line is made.

Transform boundaries



Scientists still have a lot to learn. The better able they are to understand the movement of the plates, the more readily they will be able to predict earthquakes and volcanoes and ultimately save lives.

Proof of Movement of the Plates

Continental drift is the theory that explains why the landmasses on the surface of the planet have changed over time. There is fossil and plant evidence of the continental drift. Identical fossils and plants are found on different continents and no where else. This leads us to the conclusion that the continents were once joined. These plants and animals could have lived on the continents when the continents when they were connected. Then when the continents divided, animals and plants from one area were stuck in other areas. Scientists believe that the continents had moved and formed through the movement of tectonic plates.

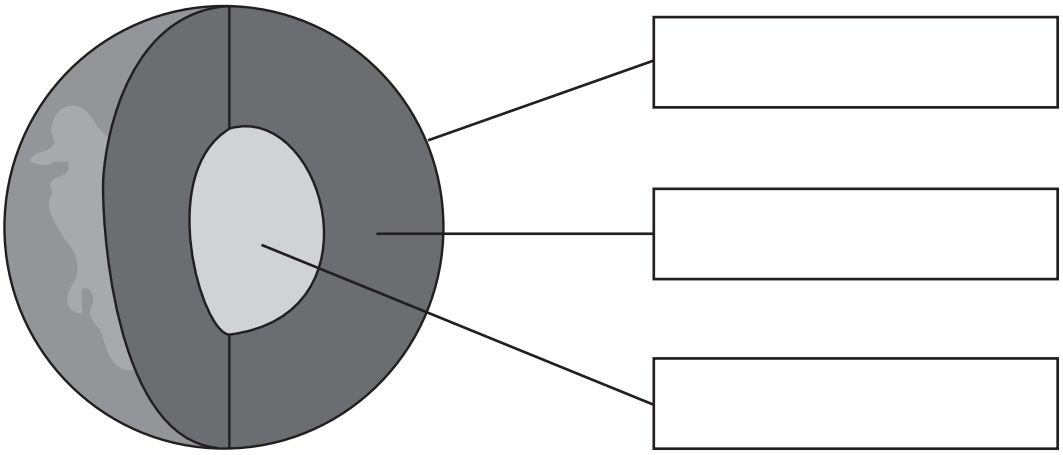
The Changing Earth

The movement of the plates has caused and continues to cause enormous changes in the earth. Mountains have formed, volcanoes have erupted and earthquakes have shaken the land. This is all due to **plate tectonics.**

Name_____

Formative Assessment

1. Label the three main layers of the earth.



2. What are tectonic plates?

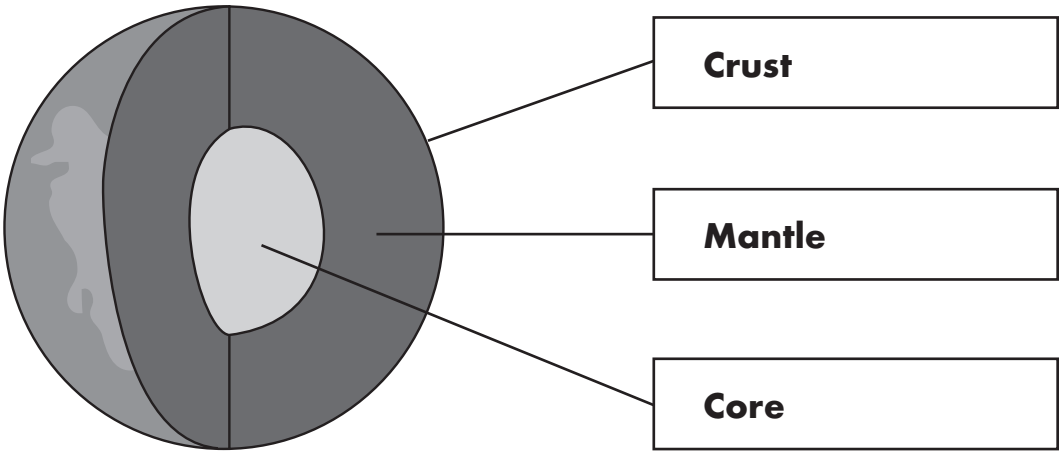
3. What causes earthquakes?

4. What causes volcanoes?

5. What is Pangea?

Formative Assessment Possible Answers

1. Label the three main layers of the earth



2. What are tectonic plates?

   The term for the field of study of large scale motions of the earth's lithosphere.

3. What causes earthquakes?

   a. Tectonic plates move against each other.

   b. Earthquakes cause the shaking, rolling or sudden shock of the earth's surface.

   c. Earthquakes happen along fault lines in the earth's crust. Earthquakes can be felt over large areas although they usually last less than one minute. Earthquakes cannot be predicted – although scientists are working on it!

4. What causes volcanoes?

   a. An eruption occurs when pressure forces the magma up through the conduit and out the vents.

   b. Lava, steam, ash and gas all come out of the volcanic vent.

5. What is Pangea?

   Pangea is the name of the supercontinent that existed millions of years ago which included most of the continental land masses. The continents drifted apart to their present locations.

Our Changing Earth — Expert Groups

Overview

In this lesson, students will do research and become experts on a topic dealing with the changing earth. They will find five facts about their topic. They will make a presentation to the class about their topic. They will also make a study sheet explaining their topic to the class.

Standards Addressed

Grade 8, Science, Earth Science

6-8 Benchmark

E. Describe the processes that contribute to the continuous changing of Earth's surface (e.g., earthquakes, volcanic eruptions, erosion, mountain building and lithospheric plate movements).

Y2003.CSC.S01.G06-08.BE.L08.I09 / Earth Systems

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Y2003.CSC.S01.G06-08.BE.L08.I10 / Earth Systems

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Y2003.CSC.S01.G06-08.BE.L08.I13 / Earth Systems

13. Describe how landforms are created through a combination of destructive (e.g., weathering and erosion) and constructive processes (e.g., crustal deformation, volcanic eruptions and deposition of sediment).

Y2003.CSC.S01.G06-08.BE.L08.I14 / Earth Systems

14. Explain that folding, faulting and uplifting can rearrange the rock layers so the youngest is not always found on top.

Y2003.CSC.S01.G06-08.BE.L08.I15 / Earth Systems

15. Illustrate how the three primary types of plate boundaries (transform, divergent and convergent) cause different landforms (e.g., mountains, volcanoes and ocean trenches).

Materials

- Presentation materials such as poster board, markers, PowerPoint software, video camera

Time Needed

This lesson should take three to four days – one for student research, one to prepare presentations and one or two to give presentations.

Procedure

1. Break the students into groups. Two or three is an ideal group size, if possible.

2. Give a copy of the Topic Research handout to each group.

3. Have the students do research on their topic. They should write five facts about their topic on the group handout and then write a question about each fact. Initial each group's handout to make sure the information is accurate. The resource sheet can be duplicated and given to the class to use as a resource guide.

4. Have the groups make a presentation that presents the five facts about their topic. Presentations can use PowerPoint, posters, skits, models, etc.

5. Sometimes, if the students are doing a complicated project such as a video or a PowerPoint presentation, they might need more preparation time. You can use your judgment as to when you want the presentations made. Perhaps a few days of work at home between research and presentation may be warranted.

6. Students can go to this project's website, **http://westernreservepublicmedia.org/earthmotion3**, for a helpful hotlist of resources.

7. Create a test from the questions created by the students.

Evaluation

Presentation Rubric

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Quality of Information	Information clearly relates to the group's topic. It includes several supporting details and/or examples.	Information clearly relates to the group's topic. It provides one or two supporting details and/or examples.	Information clearly relates to the group's topic. No details and/or examples are given.	Information has little or nothing to do with the group's topic.
Organization	Information is very organized, with well-constructed paragraphs and subheadings.	Information is organized with well-constructed sentences.	Information is organized, but sentences are not well-constructed.	The information appears to be disorganized.
Amount of Information	Five facts are given and five questions are asked about the topic.	Four facts are given and four questions are asked about the topic.	Three facts are given and three questions are asked about the topic.	Two facts are given and two questions are asked about the topic.
Delivery	Student used a clear voice and correct, precise pronunciation of terms.	Student's voice is clear. Student pronounces most words correctly.	Student incorrectly pronounces terms. Audience members have difficulty hearing presentation.	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear.

Evaluation of Test

A percentage correct from the test can be used as an evaluation.

Topic Answers

Group 1 Topic: Earth's Internal Structure

Answers

1. Of what is the earth made?

   The thin oceanic crust is composed of primarily mafic materials (silicate mineral or rock that is rich in magnesium and iron). The thicker continental crust is composed primarily of felsic material (silicate minerals, magma and rocks that are enriched in the lighter elements such as silicon, oxygen, aluminium, sodium and potassium).

   The earth's core is thought to be composed mainly of an iron and nickel alloy.

2. Explain the difference between the oceanic crust and the continental crust.

   There are two different types of crust: thin oceanic crust that underlies the ocean basins and thicker continental crust that underlies the continents.

3. What are the three parts of the earth's interior?

   a. *Crust – very thin (three to 30 miles)*
   b. *Mantle – mobile*
   c. *Core – very hot*

Group 2 Topic: Plate Tectonics — History

Answers

1. Who is Alfred Wegener?

   Wegener came up with the idea of continental drift. In the early 1900s, Wegener proposed the idea of continental drift. His ideas centered around continent moving across the face of the earth. The idea was not quite correct, compared to the plate tectonics theory of today, but his thinking was on the proper track.

2. What is Pangea?

   A supercontinent that existed 250 million years ago that included most of the earth's continental landmasses.

Group 3 Topic: Plate Tectonics — Evidence

Answers

1. What does it mean to have evidence about something?

   Evidence is information that tends to prove or disprove something; grounds for belief or proof.

2. Name at least two things that prove that plate tectonics is real.

   a. *The plant Glossopteris was found throughout India, South America, southern Africa, Australia and Antarctica.*
   b. *Fossils of one of the first marine reptiles were found in both South America and South Africa.*
   c. *Giant frog found in Madagascar, Africa and South America.*
   d. *A single granite rock formation was found running through America, the British Isles and the Caledonian Mountains in northern Europe.*

Group 4 Topic: Plate Tectonics — Convergent Plates

Answers

1. What does the word convergent mean?

   Tending to come together or merge.

2. What happens when an oceanic plate and a continental plate converge?

   When a thin, dense oceanic plate collides with a relatively light, thick continental plate, the oceanic plate is forced under the continental plate. This phenomenon is called subduction.

3. What happens when a continental plate converges with another continental plate?

   When two continental plates collide, mountain ranges are created as the colliding crust is compressed and pushed upward.

4. What happens when two oceanic plates converge?

   When two oceanic plates collide, one may be pushed under the other and magma from the mantle rises, forming volcanoes in the vicinity.

Group 5 Topic: Plate Tectonics — Divergent Plates

Answers

1. What does divergent mean?

   Separating, dividing, moving apart.

2. What happens when continental tectonic plates diverge?

   As the two plates pull apart, normal faults develop on both sides of the rift and the central blocks slide downwards. Earthquakes occur as a result of this fracturing and movement. Early in the rift-forming process, streams and rivers will flow into the sinking rift valley to form a long linear lake. As the rift grows deeper, it might drop below sea level allowing ocean waters to flow in.

3. What happens when two oceanic plates diverge?

   Extensional forces stretch the lithosphere and produce a deep fissure. When the fissure opens, pressure is reduced on the super-heated mantle material below. It responds by melting and the new magma flows into the fissure. The magma then solidifies and the process repeats itself.

   Effects that are found at a divergent boundary between oceanic plates include a submarine mountain range such as the Mid-Atlantic Ridge, volcanic activity in the form of fissure eruptions, shallow earthquake activity, creation of new sea floor and a widening ocean basin.

Group 6 Topic: Plate Tectonics — Lateral or Transform Plates

Answers

1. What does lateral mean?

   To move sideways or against one another.

2. What does transform mean?

   To change.

3. What happens when tectonic plates move laterally?

   When two plates move sideways against each other (at a transform plate boundary), there is a tremendous amount of friction which makes the movement jerky. The plates slip, then stick as the friction and pressure build up to incredible levels. When the pressure is released suddenly, and the plates suddenly jerk apart, this is an earthquake.

Group 7 Topic: Earthquakes

Answer:

1. What is an earthquake?

   An earthquake is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane. The location below the earth's surface where the earthquake starts is called the hypocenter and the location directly above it on the surface of the earth is called the epicenter. Source: ***http://earthquake.usgs.gov/learn/kids/eqscience.php***

   The earth has four major layers: inner core, outer core, mantle and crust. The crust and the top of the mantle make up a thin skin on the surface of our planet. But this skin is not all in one piece; rather, it is made up of many pieces like a puzzle covering the surface of the earth. Not only that, but these puzzle pieces keep slowly moving around, sliding past one another and bumping into each other. We call these puzzle pieces tectonic plates, and the edges of the plates are called the plate boundaries. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. Since the edges of the plates are rough, they get stuck while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick on one of the faults and there is an earthquake. Source: ***http://earthquake.usgs.gov/learn/kids/eqscience.php***

2. What is the hypocenter or the epicenter of an earthquake?

   It is where the earthquake starts.

3. The main part of the earthquake is called the mainshock. What are aftershocks?

   The largest, main earthquake is called the mainshock. Mainshocks generally have aftershocks that follow. These are smaller earthquakes that occur afterwards in the same place as the mainshock. Sometimes there are foreshocks, named as such when the main earthquake is not the first one. Source: ***http://earthquake.usgs.gov/learn/kids/eqscience.php***

4. What are faults and faultlines?

   An earthquake is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane.

Group 8 Topic: Volcanoes

Answers

1. What is a volcano?

   Volcanoes occur along the earth's tectonic plates where molten rock is forced upward from magma reservoirs deep in the earth. The magma may be 50 to 100 miles below the ground. As the magma rises, it gives off gases that cause an explosion in the vents of the volcano. Lava can reach temperatures of over 2000 degrees Fahrenheit. Molten rock, dust and gases push through the opening in the earth's crust and form a mountain. A violent explosion can cause the top of the volcano to blow off, leaving a deep crater. Source: ***http://42explore.com/volcano.htm***

   There are four types of volcanoes: active, intermittent, dormant, and extinct. Volcanoes can occur on land or in the water.

2. What impact do volcanoes have when they erupt?

   These effects of volcanic eruptions are mostly the result of certain hazards. Volcanoes provide different hazards during an eruption. Each hazard poses different risks affecting different areas. The most threatening hazards include: pyroclastic flows, volcanic ash, debris, avalanches, landslides, tsunamis, lava and gas. Source: ***http://library.thinkquest.org/17457/english.html***

3. Where are some active volcanoes today?

   They are all over the world. See some of the Internet sites listed for a list of specific sites.

Group 9 Topic: Ring of Fire

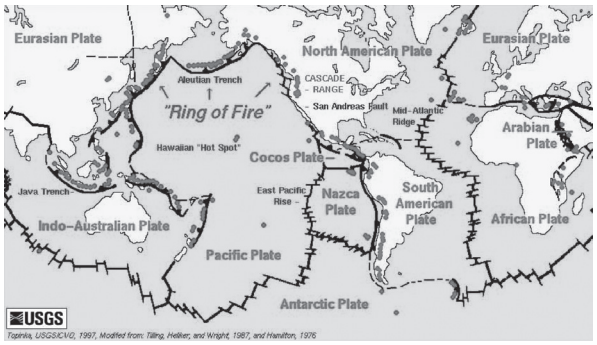
Answers

1. What is the Ring of Fire?

   The Ring of Fire is a zone of frequent earthquakes and volcanic eruptions that encircles the basin of the Pacific Ocean. It is shaped like a horseshoe and it is 40,000 kilometers long. It is associated with a nearly continuous series of oceanic trenches, island arcs and volcanic mountain ranges and/or plate movements. It is sometimes called the circum-Pacific belt or the circum-Pacific seismic belt. Ninety percent of the world's earthquakes and 81 percent of the world's largest earthquakes occur along the Ring of Fire.

2. Where is the Ring of Fire?

   It is on the west coast of the United States and goes across the Pacific Ocean, south around Asia and then back across the Pacific. It encompasses the Pacific Plate and the Nazra Plate.



3. Why is it important to know about the Ring of Fire?

   Many volcanoes and earthquakes occur in these regions. It is important to understand the effect of moving tectonic plates.

Group 10 Topic: Vocabulary

Answers

1. What are tectonic plates?

   The earth's rocky outer crust solidified billions of years ago, soon after the earth formed. This crust is not a solid shell; it is broken up into huge, thick plates that drift atop the soft, underlying mantle. The plates are made of rock and drift all over the globe; they move both horizontally (sideways) and vertically (up and down). Over long periods of time, the plates also change in size as their margins are added to, crushed together or pushed back into the earth's. These plates are from 50 to 250 miles (80 to 400 km) thick. Source: ***http://www.enchantedlearning.com***

   Movement of the plates causes disturbances of the earth like earthquakes and volcanoes.

2. What is the lithosphere?

   The lithosphere is the outer solid part of the earth, including the crust and uppermost mantle. The lithosphere is about 100 kilometers thick, although its thickness is age dependent (older lithosphere is thicker). The lithosphere below the crust is brittle enough at some locations to produce earthquakes by faulting, such as within a subducted (moving under) oceanic plate.

3. What is subduction?

   When continental and oceanic plates collide the thinner and more dense oceanic plate is overridden by the thicker and less dense continental plate. The oceanic plate is forced down into the mantle in a process known as subduction. As the oceanic plate descends it is forced into higher temperature environments. At a depth of about 100 miles (160 km) materials in the subducting plate begin to approach their melting temperatures and a process of partial melting begins.

4. What are ocean trenches?

   A deep-sea trench is a narrow, elongate, V-shaped depression in the ocean floor. Trenches are the deepest parts of the ocean, and the lowest points on earth, reaching depths of nearly 7 miles (10 km) below sea level. These long, narrow, curving depressions can be thousands of miles in length, yet as little as 5 miles (8 km) in width. Source: ***http://www.enotes.com/earth-science/ocean-trenches***

Names _____

Subtopic _____

Our Changing Earth
Topic Research

1. Do research on your subtopic and find the answer to the questions on your group's Topic and Questions handout.

2. Decide what the most important information is and write it below. These are the facts that you will use when making your presentation.

List the five main facts that explain your topic:

1.

2.

3.

4.

5.

_____ Teacher initials indicating that facts are correct.

Now write five test questions that you plan to submit. Create at least two short essay-type questions. The other three can be in the format of true-false, multiple choice, matching or fill-in-the-blank. Write the questions in blue and the answers in red.

1.

2.

3.

4.

5.

Now plan how you will teach the information. Remember that you are being graded on how well the class does in answering your questions. You must plan a strategy to ensure that they will remember what you want them to know. Think about how you learn best! Describe your strategy below. Remember, "cute" may not be the same as "effective."

_____ Teacher initials showing presentation is acceptable.

Names _____

Our Changing Earth

Group 1 Topic: Earth's Internal Structure

Answer these questions:

1. Of what is the earth made?

2. Explain the difference between the oceanic crust and the continental crust.

3. What are the three parts of the earth's interior?

Names _____

Our Changing Earth

Group 2 Topic: Plate Tectonics — History

Answer these questions:

1. Who is Alfred Wegener?

2. What is Pangea?

Names _____

Our Changing Earth

Group 3 Topic: Plate Tectonics — Evidence

Answer these questions:

1. What does it mean to have evidence about something?

2. Name at least two things that prove that plate tectonics is real.

Names _____

Our Changing Earth

Group 4 Topic: Plate Tectonics — Convergent Plates

Answer these questions:

1. What does the word convergent mean?

2. What happens when an oceanic plate and a continental plate converge?

3. What is subduction?

4. What happens when a continental plate converges with another continental plate?

5. What happens when two oceanic plates converge?

Names _____

Our Changing Earth

Group 5 Topic: Plate Tectonics — Divergent Plates

Answer these questions:

1. What does divergent mean?

2. What happens when continental tectonic plates diverge?

3. What happens when two oceanic plates diverge?

Names _____

Our Changing Earth

Group 6 Topic: Plate Tectonics — Lateral or Transform Plates

Answer these questions:

1. What does lateral mean?

2. What does transform mean?

3. What happens when tectonic plates move laterally?

Names _____

Our Changing Earth
Group 7 Topic: Earthquakes

Answer these questions:

1. What is an earthquake?

2. What is the hypocenter or the epicenter of an earthquake?

3. The main part of the earthquake is called the mainshock. What are aftershocks?

4. What are faults and faultlines?

Names _____

Our Changing Earth
Group 8 Topic: Volcanoes

Answer these questions:

1. What is a volcano?

2. What impact do volcanoes have when they erupt?

3. Where are some active volcanoes today?

Names _____

Our Changing Earth
Group 9 Topic: Ring of Fire

Answer these questions:

1. What is the Ring of Fire?

2. Where is the Ring of Fire?

3. Why is it important to know about the Ring of Fire?

Names _____

Our Changing Earth
Group 10 Topic: Vocabulary

Answer these questions:

1. What are tectonic plates?

2. What is the lithosphere?

3. What is subduction?

4. What are ocean trenches?

Hands-On Plate Tectonics

Objective:

In this lesson, students will define plate tectonics and demonstrate knowledge of the concepts of convergent and divergent motions of the earth.

Standards Assessed

Grade 8, Science, Earth and Space Science

6-8 Benchmark *E. Describe the processes that contribute to the continuous changing of Earth's surface (e.g., earthquakes, volcanic eruptions, erosion, mountain building and lithospheric plate movements).*

Y2003.CSC.S01.G06-08.BE.L08.I09 / Earth Systems

09. Describe the interior structure of Earth and Earth's crust as divided into tectonic plates riding on top of the slow moving currents of magma in the mantle.

Y2003.CSC.S01.G06-08.BE.L08.I10 / Earth Systems

10. Explain that most major geological events (e.g., earthquakes, volcanic eruptions, hot spots and mountain building) result from plate motion.

Y2003.CSC.S01.G06-08.BE.L08.I11 / Earth Systems

11. Use models to analyze the size and shape of Earth, its surface and its interior (e.g., globes, topographic maps, satellite images).

Y2003.CSC.S01.G06-08.BE.L08.I13 / Earth Systems

13. Describe how landforms are created through a combination of destructive (e.g., weathering and erosion) and constructive processes (e.g., crustal deformation, volcanic eruptions and deposition of sediment).

Y2003.CSC.S01.G06-08.BE.L08.I14 / Earth Systems /

14. Explain that folding, faulting and uplifting can rearrange the rock layers so the youngest is not always found on top.

Materials

- Box
- Cutting instrument
- Blue paper
- Cardboard strips
- Tape or glue

Procedure

1. Show the class a soft-boiled egg that you have cut in half with the shell still on. Make a comparison between the soft-boiled egg and the layers of the earth. The yolk, which is soft, is the core of the earth. The white of the egg is like the mantle and the shell represents the crust of the earth.

2. Divide the students into groups of two or three.

3. Hand out the Plate Tectonics worksheet and instruct the students to name the layers of the earth.

4. Review the procedure for the simulation exercise.

5. As a class, visit **http://www.ucmp.berkeley.edu/geology/tectonics.html** to see an animation of plate tectonics.

6. Have the students write a paragraph to explain what they have just done. They need to include a diagram showing at least one of the four steps listed.

Vocabulary

Continental crust – The land crust of the earth.

Core of the earth – There are really two cores: an inner core that is solid and is about 4,300 degrees Celsius and a core that is liquid around the inner core. They are composed of mostly iron, with about 10 percent sulfur. (There is some newer information that uranium may be in the core in quantity and may be responsible for much of the earth's inner heat.)

Convergence – The act of moving toward each other and colliding.

Crust – The earth's crust is thin, rocky and brittle.

Divergence – The act of moving away from each other. Where plates diverge, hot, molten rock rises and cools, adding new material to the edges of the mid-oceanic plates. This process is known as sea-floor spreading.

Mantle – The mantle goes around the core and is solid. It comprises most of the earth's mass. The temperature is about 1,000 degrees Celsius.

Oceanic crust – The crust underlying the ocean basin. This layer is much thinner than the earth's continental crust and is young.

Plates – The earth's surface is broken into seven large and many small moving plates, each about 50 miles thick. They move relative to one another an average of a few inches a year or about as fast as fingernails grow.

Plate tectonics – This is a geological theory that says that the surface of the earth is broken into large plates. The size and position of the plates change over time. It was developed by Alfred Wegener. Unfortunately, he died before his theory was accepted as a major paradigm in modern geomorphology.

Transform fault – Plates moving horizontally against each other.

Assessment

Summary of procedure	10 15 25
Clear conclusions are drawn about plate tectonics	10 15 25
Mechanics – spelling and grammar	10 15 25
Diagram of one of the steps listed	10 15 25

Enrichment

Lightweight tissue paper could be attached to a triangular tube and laid over the blue "ocean" paper. If the blue paper is pulled, the tissue paper will wrinkle and ball up at the subduction zone, becoming a "mountain range."

Name(s)_____

Plate Tectonics

Label the layers of the earth below:

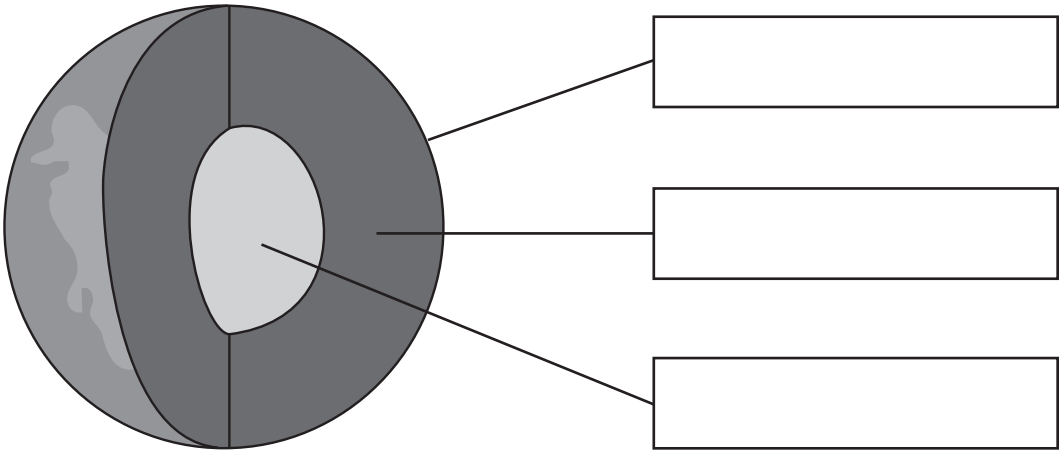


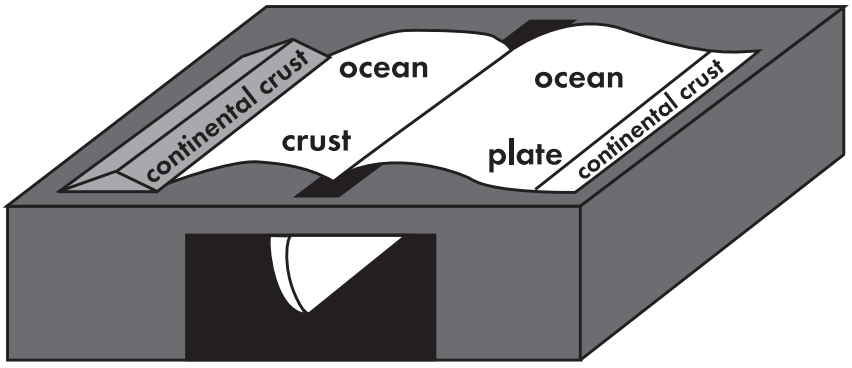
Plate tectonics is a geological theory that says that the surface of the earth is broken into large plates. The size and position of the plates changes over time. The plates move in three ways:

1. Convergence, where the plates move together and collide. This causes mountains to develop.

2. Divergence, where the plates move away from each other. At that time, molten rock rises and cools and adds new material to the edge of the ocean crusts (ocean floor).

3. Transform faults, the horizontal movement of plates against each other. This causes earthquakes.

Now you are to make a simulation of plate tectonics. Follow the directions below to make a box that looks like the following diagram. Cut a long, very thin strip in the top and cut holes in both sides of the box.



Step 1. Take two sheets of blue paper to represent the oceanic plate. On both sheets, place a triangular tube (brown cardboard works well) to represent the plate with an oceanic and continental crust.

Step 2. Put the unattached sides of the papers through the slit so that only about half of the paper is showing. When the paper is pulled down, this represents the convergence of the plates. When the paper is pushed up, this represents the divergence of the plates.

Step 3. Move only the sheet with the cardboard attached so that the cardboard comes to the edge of the slit. This represents the ocean plate disappearing beneath the edge of the continent. This is called **subduction**.

Step 4. On the plain sheet of blue paper, attach another triangle so that this also has a continental and an oceanic crust. Now pull both sheets of blue paper from the bottom. If you do this carefully, one of the triangles will go on top of the other, showing the development of mountains when convergence occurs.

Step 5. If the layers are moved toward the sides of the box, you can see the action of fault lines moving in an earthquake. This is called a **transform fault.**

Go to **http://www.ucmp.berkeley.edu/geology/tectonics.html** and see an animation of the plates moving into the position they currently hold.

Write a paragraph to explain what you discovered when you followed the steps listed above. Be sure to use the correct terminology. Also make a diagram showing one of the steps and what happened when you followed the directions.

_____

_____

_____

_____

_____

_____

Draw diagram below.

Show Me: The Moving Earth

Overview

The students will make a model of some aspect of plate tectonics. They will also write a report that explains how their project shows plate tectonics. They will then present their project to the class. This can be used as a summative evaluation in place of the one that follows this lesson.

Standards Addressed

Grade 8, Science, Earth Science, Earth Systems

6-8 Benchmark

E. Describe the processes that contribute to the continuous changing of Earth's surface (e.g., earthquakes, volcanic eruptions, erosion, mountain building and lithospheric plate movements).

Y2003.CSC.S01.G06-08.BE.L08.I09 / Earth Systems

09. Describe the interior structure of Earth and Earth's crust as divided into tectonic plates riding on top of the slow moving currents of magma in the mantle.

Y2003.CSC.S01.G06-08.BE.L08.I10 / Earth Systems

10. Explain that most major geological events (e.g., earthquakes, volcanic eruptions, hot spots and mountain building) result from plate motion.

Y2003.CSC.S01.G06-08.BE.L08.I11 / Earth Systems

11. Use models to analyze the size and shape of Earth, its surface and its interior (e.g., globes, topographic maps, satellite images).

Y2003.CSC.S01.G06-08.BE.L08.I12 / Earth Systems

12. Explain that some processes involved in the rock cycle are directly related to thermal energy and forces in the mantle that drive plate motions.

Y2003.CSC.S01.G06-08.BE.L08.I13 / Earth Systems

13. Describe how landforms are created through a combination of destructive (e.g., weathering and erosion) and constructive processes (e.g., crustal deformation, volcanic eruptions and deposition of sediment).

Y2003.CSC.S01.G06-08.BE.L08.I14 / Earth Systems

14. Explain that folding, faulting and uplifting can rearrange the rock layers so the youngest is not always found on top.

Y2003.CSC.S01.G06-08.BE.L08.I15 / Earth Systems

15. Illustrate how the three primary types of plate boundaries (transform, divergent and convergent) cause different landforms (e.g., mountains, volcanoes and ocean trenches).

Materials

- Paper
- Posterboard
- Scissors
- Tape
- Glue
- Internet resources or other reference material

Procedure

1. Students can work in groups of two or three for this project.
2. Distribute handout Show Me: The Moving Earth and review the directions.
3. Discuss the process of making a model to show a concept.
4. Instruct the groups that once they have created their model plans, they should review them with you before proceeding. At this point, you can either approve the plan by initialling their worksheets or offer suggestions for improvement. The groups will have the most difficulty in developing their model idea.
5. A suggested time frame for this project is to allow one day for groups to decide and develop their plans, a second day for report writing and a third and possibly fourth day for making presentations.

Evaluation for Model Presentation

CATEGORY	4	3	2	1
Model	Shows a full understanding of the topic. Shows plate tectonics at work.	Shows a good understanding of the topic. Some aspect of plate tectonic model needs work.	It is a stretch to see that the model shows plate tectonics.	Model does not show or weakly shows a concept of plate tectonics.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not show an understanding of the topic.
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes one or two words that audience might not understand, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (five or more) words or phrases that are not understood by the audience.
Verbal	Speaks clearly and distinctly all (100-95 percent) the time, and pronounces words correctly.	Speaks clearly and distinctly all (100-95 percent) the time, but mispronounces one word.	Speaks clearly and distinctly most (94-85 percent) of the time. Mispronounces no more than one word.	Often mumbles or cannot be understood or mispronounces more than one word.
Collaboration With Peers	Almost always listens to, shares with and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with and supports the efforts of others in the group. Does not cause conflict in the group.	Often listens to, shares with and supports the efforts of others in the group, but sometimes is not a good team member.	Rarely listens to, shares with or supports the efforts of others in the group. Often is not a good team member.

Name(s)_____

Show Me: The Moving Earth

Your Job:

1. Create a **physical model** that shows plate tectonics in action.
2. Write a **report** on what aspects of plate tectonics your model shows.
3. Make a 2-3 minute **presentation** of your project to the class.

Procedures:

1. Meet with your group and brainstorm ideas of what kind of model you will make.
2. Make a decision about what your model will be.
3. Bring this sheet, explain the project and have the teacher initial this sheet.

   _____ Teacher Initial Here!

4. Gather the materials you need to make your model. Paper, scissors, glue, tape, protractors, rulers and school supplies will be available in class. Anything else you need (clay, sand, etc.) should be brought from home.
5. You will have one class period to make your model, one class period to write your report and a third class period to make your presentation. (The teacher will determine if more time is necessary.)

Checklist for Your Presentation:

Content

- ❑ My model showed tectonic plates.
- ❑ I used facts and logical appeals where appropriate.
- ❑ The information I gave was valuable.
- ❑ I was well-informed about my topic.

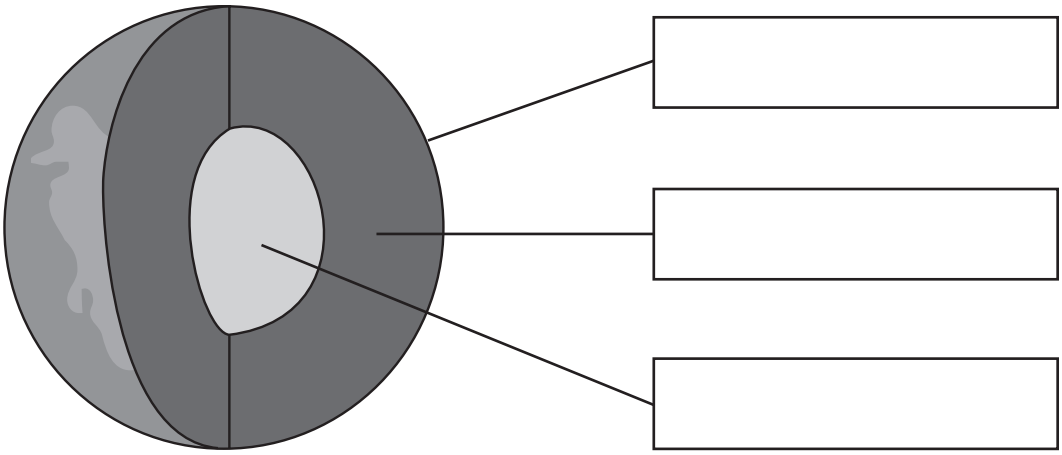
Delivery Organization

- ❑ I used standard grammar.
- ❑ I maintained eye contact most of the time.
- ❑ My pronunciation was clear and easy to understand.
- ❑ I organized ideas in a meaningful way.
- ❑ My topic was stated clearly in the introduction.
- ❑ My introduction was clear and easy to understand.
- ❑ I included necessary background information.

Name_____

Summative Assessment

1. Label the three main layers of the earth.



2. What are tectonic plates?

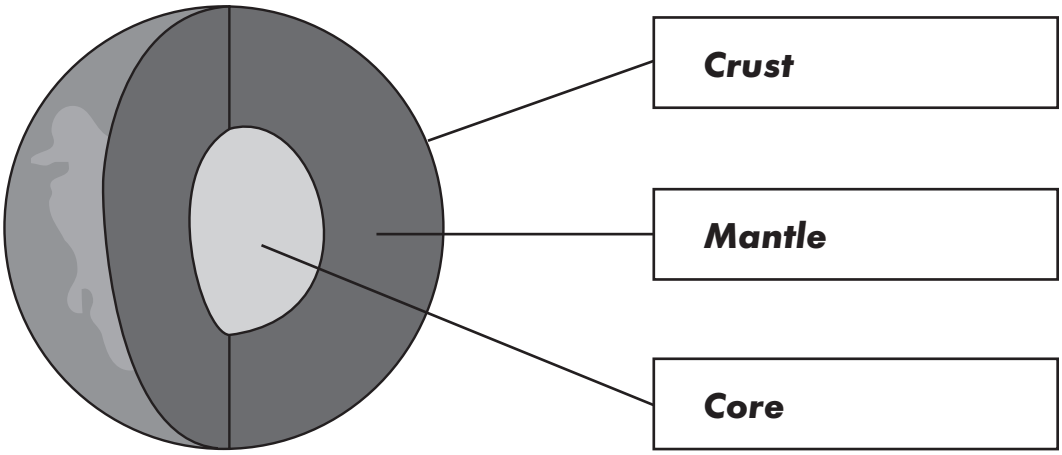
3. What causes earthquakes?

4. What causes volcanoes?

5. What is Pangea?

Summative Assessment Possible Answers

1. Label the three main layers of the earth



2. What are tectonic plates?

   The term for the field of study of large scale motions of the earth's lithosphere.

3. What causes earthquakes?

   a. *Tectonic plates move against each other.*
   b. *Earthquakes cause the shaking, rolling or sudden shock of the earth's surface.*
   c. *Earthquakes happen along fault lines in the earth's crust. Earthquakes can be felt over large areas although they usually last less than one minute. Earthquakes cannot be predicted – although scientists are working on it!*

4. What causes volcanoes?

   a. *An eruption occurs when pressure forces the magma up through the conduit and out the vents.*
   b. *Lava, steam, ash and gas all come out of the volcanic vent.*

5. What is Pangea?

   Pangea is the name of the supercontinent that existed millions of years ago which included most of the continental land masses. The continents drifted apart to their present locations.

EARTH MOTION^3

Our Changing Earth

Module 3: Transfer of Energy

http://www.WesternReservePublicMedia.org/EarthMotion3

Transfer of Energy Overview

The Transfer of Energy module begins with a formative assessment. The main goal of the lessons is to help students understand that energy is transferred through conduction, convection and radiation.

The introductory lesson is a basic review of the transfer of energy. The students visit stations, do experiments and track the results.

In the second lesson, students research earthquakes online to find out where they have occurred. They plot the locations on a world map using longitude and latitude. They then connect the dots on the map, which will show the location of tectonic plates. The goal is for students to understand that the movement of these plates has caused the earthquakes at the boundaries of the plates.

Students then make a presentation about a topic related to plate tectonics. The project must include something about energy (heat) transfer. The medium of presentation is up to the student.

A summative evaluation completes the module.

The module also includes a resource page on the transfer of energy and a vocabulary list.

Standards Addressed

Grade 9, Science, Earth Science

9-10 Benchmark *E. Explain the processes that move and shape Earth's surface.*

Y2003.CSC.S01.G09-10.BE.L09.I05 / Processes That Shape Earth

05. Explain how the slow movement of material within Earth results from:
    - thermal energy transfer (conduction and convection) from the deep interior;
    - the action of gravitational forces on regions of different density.

Y2003.CSC.S01.G09-10.BE.L09.I06 / Processes That Shape Earth

06. Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding).

Y2003.CSC.S01.G09-10.BE.L09.I07 / Processes That Shape Earth

07. Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating).

Transfer of Energy

Energy is everywhere. It makes things move and takes many forms. When anything moves, energy makes it happen.

Light energy travels in **waves**, as do other forms of energy such as radio waves, microwaves, etc. These waves are called **electromagnetic waves** because they combine electrical and magnetic energy. The main difference in different types of waves is their wavelength on the electromagnetic spectrum. The longest waves on the spectrum are good for broadcasts that include radio and television. The shorter waves include X-ray waves and radioactive waves.

Everything has heat energy, whether you think of it as hot or cold. The difference is that a cup of hot water contains more energy than the same amount of cold water. Heat is not the same as temperature. A spoonful of boiling water could be the same temperature as a pan of boiling water, but the water in the pan contains more heat energy than the water in the spoon.

Heat energy naturally flows from an object of high temperature to an area of low temperature. It can be transferred in three different ways: conduction, convection and radiation.

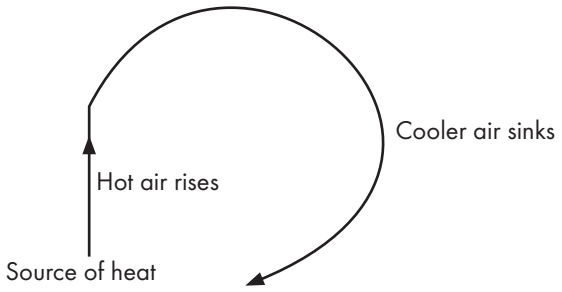
Conduction

Heat deals with the rate of motion of particles. Faster-moving particles are warmer than slower-moving particles. Electrons aren't transferred during conduction; rather, their rate of motion is transferred. The faster particles that touch another object collide with the slower particles, speeding up their rate of motion.

Some materials are better at conduction than others. If you stir a pot on the stove with a metal spoon, the spoon becomes hot. If, however, you use a wooden spoon, it does not become hot. This is because of the way the atoms and molecules are arranged. If items are not conductors, there are no freely moving particles to transfer energy.

Convection

Convection is the way heat is transferred through a liquid or a gas. As a liquid or a gas is heated, it expands and becomes less dense. The less dense part rises. It is replaced by the cooler air. This sets up a convection current by which the liquid or gas rises from the source of heat, cools and sinks and is heated again.



Causes convection currents

Radiation

Infrared radiation is sometimes called heat rays because the rays are invisible and make you feel warm as soon as they hit you. The rays are not heat; rather, the rate of motion of particles makes them feel like heat. The rays are an electromagnetic wave.

Radiation is a form of energy that can travel through the vacuum of outer space as an electromagnetic wave. Objects that are hotter than their surroundings give off energy in the form of **electromagnetic radiation.** As the temperature of an object increases, so does the range of wavelengths. Electromagnetic radiation has the properties of both a wave and a particle.

Some of the wavelengths are visible and we see them as light. The color of the light depends on the wavelength, which in turn depends on the temperature. A hot object giving off light is called **incandescence.**

Energy Changers

Energy can change from one form to another. When you turn a light on, electrical energy is changed into light and heat energy. It is usually possible to follow the trail that energy takes as it changes from one form to another – this is called an energy chain. Scientists have discovered that whenever energy moves from one point to another in one of these chains, the energy may take several forms. Even with all of these changes, the total amount of energy that scientists measure is always the same and cannot be created or destroyed as it changes forms. This is called the **law of conservation of energy.**

Forms of Energy

Energy comes in many different forms, but each is either **kinetic energy** (moving) or **potential energy** (stored). The faster something moves, the more kinetic energy it has. However, even if the object appears not to be moving, all of its particles are moving. Potential energy is stored energy of a particle or system of particles derived from position or condition, rather than motion.

One way or another, all forms of energy involve motion. Types of energy include mechanical, thermal, chemical, electrical, light, sound and nuclear.

Transfer of Energy Vocabulary

Atom: The smallest possible part of a pure chemical element that has the chemical properties of the element.

Conductors and insulators:

- **Conductors:** Materials that allow heat to quickly pass throughout the material – such as metals. Metals have a "sea of electrons" that allows for quick heat transfer.
- **Insulators:** Materials that do not allow heat to quickly pass throughout a material (such as wood or plastic).

Convection: The circulatory motion that occurs in a fluid at a nonuniform temperature owing to the variation of its density and the action of gravity.

Electromagnetic radiation: Energy leaving in the form of an electromagnetic wave.

Electromagnetic spectrum: The complete range of electromagnetic radiation arranged in order from the longest to the shortest.

Electron: A particle with a negative electric charge that moves in an orbital around nucleus of an atom.

Energy: The capacity of a body or system to do work.

Forms of Energy

- **Chemical energy:** Energy released or absorbed by the rearrangement of bonds between atoms.
    - **Exothermic reaction:** Releases energy and makes the surrounding area hotter (fire)
    - **Endothermic reaction:** Absorbs energy making it colder (instant ice pack)
- **Electrical energy:** Energy resulting from a movement of electrons across a circuit (TV, radio, computer or anything you plug in or put batteries in).
- **Heat energy**: Energy created by moving atoms and molecules.
- **Light energy (also electromagnetic energy):** Movement of packets of energy called photons, causing a vibration in charged particles (includes anything you can see and X-rays, microwaves, ultraviolet rays and infrared waves).
- **Mechanical energy:** The energy of things actually moving–like a car moving, a ball that has been thrown or a person falling.
- **Nuclear energy:** Movement of particles of a nucleus of an atom either by one of these metions:
    - **Fission:** Splitting a large atom (uranium or plutonium)
    - **Fusion:** Joining smaller atoms (hydrogen to make helium)
- **Sound energy:** A vibration moving through the medium of the sound; requires a medium.
- **Thermal energy:** The sum of the kinetic energy of all the particles in an object. All particles are moving. Hotter objects and larger objects have more thermal energy.

Law of Conservation of Energy: A principle stating that energy can't be created or destroyed, but it can change from one form to another.

Magnitude: How powerful an earthquake is as measured on the Richter Scale.

Molecule: Two or more atoms joined by chemical bonds. If the atoms are the same, it is an element; if they are different, it is a compound.

Neutron: Particle with no electric charge found in the nucleus of the atom.

Radiation: Heat and light energy given out from a source such as the sun.

Richter Magnitude Scale: Developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes.

Temperature: A property of matter that measures how much movement energy its particles have. There are several scales used to measure temperature, including Kelvin, Celsius and Fahrenheit.

Transmission: When light waves or other energy waves hit a material and continue through it.

Wavelength: Distance from one point on a wave to the same point on the next wave.

Name_____

Formative Assessment

1. What is plate tectonics theory?

2. What are the layers of the earth?

3. Which of the following is convection?
    a. A transfer of heat by two objects touching
    b. A transfer of heat by electromagnetic wave
    c. A transfer of heat by a circulation of a fluid
    d. A transfer of heat by ions

4. Which of the following are radiant energy?
    a. Ultraviolet light
    b. Visible light
    c. Infrared light
    d. X-rays
    e. All of the above

Formative Assessment Answer Sheet

1. What is Plate Tectonics Theory?

   The term for the field of study of large scale motions of the earth's lithosphere.

2. What are the layers of the earth?

   The innermost layer is a very hot core of iron and nickel. The inside of the core is solid and the outside is liquid. The middle layer is the mantle. It is composed of rock that flows very slowly. The outermost layer is the crust. There is oceanic crust and continental crust.

   The crust and the upper part of the mantle (which is cooler and more rigid than the lower part) together make up the lithosphere. The lithosphere is broken into huge rocky slabs called tectonic plates. These plates ride on top of the asthenosphere, a hot, semisolid part of the mantle that lies directly under the lithosphere.

3. Which of the following is convection?

   c. *A transfer of heat by a circulation of a fluid.*

4. Which of the following are radiant energy?

   e. *All of the above.*

Introduction to Transfer of Energy

Overview

Through a teacher demonstration and then hands-on experiments at stations, students will learn about heat transfer through convection, conduction and radiation.

Standards Addressed

Grade 9, Science, Earth Science

9-10 Benchmark *E. Explain the processes that move and shape Earth's surface.*

Y2003.CSC.S01.G09-10.BE.L09.I05 / Processes That Shape Earth

05. Explain how the slow movement of material within Earth results from thermal energy transfer (conduction and convection) from the deep interior and the action of gravitational forces on regions of different density.

Materials

Teacher Demonstration

- Three glass tumblers
- Food coloring
- Heat source (to make hot water)
- Water

Stations

- Beans in a container
- BBs in a container
- Candle in a candle holder
- Spinners
- String
- Black and white paper
- Thermometers

Procedure

Part 1: Introduction — Teacher Demo

1. Ask the students to describe the difference between heat and temperature. Record the answers in some manner so that they can see them. (***Heat*** *is the total thermal energy of an object. It is the transfer of energy between two objects of different temperatures. Heat will always transfer from the higher temperature to a lower temperature, which is one of the laws of thermodynamics.)* ***Temperature*** *is a measure of heat intensity. It is the average kinetic energy of the particles.*
2. Discuss the concept of absolute zero, which is the temperature at which all heat energy is removed from an object so all particles stop moving. Absolute zero is -273 degrees C or -459 degrees F. Scientists have gotten to within a few thousandths of a degree of absolute zero.

3. Heat is noticed by a person when there is a transfer of heat from that person to another object. Adding heat energy makes you hot or causes burns, while losing heat energy makes you cold. There is no coldness or cold energy that you can add to something. Cold is removing energy, which is why cooling is more difficult that heating. In fact, air conditioning and refrigeration came about in the late 1800s and heating came about with homo erectus using fire in the Stone Age. It is difficult to capture energy and put it somewhere else.

4. Temperature is a measure of heat intensity. It is the average kinetic energy of the particles. Heat will always transfer from the higher temperature to a lower temperature. For example, a cup full of cold water still has a lot of heat since it is the sum off the kinetic energy of all the particles. A cup 1/10 full of hot water has a higher temperature, meaning the individual particles are moving faster than the cold water, but since there are so many more particles in the full cup, it would have more total heat.

5. Explain that everything is made up of atoms, which have energy and are constantly in motion. Have three students come to the front and give each an eye dropper and a glass tumbler.

6. Fill each glass with a different temperature of water: cold, room temperature and hot.

7. Have the class make predictions as to what will happen when the food coloring is added.

8. Instruct the students to each put one drop of food coloring into their glass at the same time. Have the rest of the class record what they see at 30 seconds and 60 seconds. *(Water and food coloring are both made up of molecules. Since hotter molecules move faster, the food coloring spreads more quickly in the hottest water. The coloring will spread equally in all the glasses if given enough time.)*

9. Use the Introduction: Transfer of Heat and the Heat Transfers PowerPoint presentations to continue the discussion on how heat can be transferred.

Part 2: Class Experiment

1. Create four stations in the classroom for convection, conduction, radiation and compound.

2. Have the students work with a partner, but each should have his or her own record sheet.

3. Station 1: This station has two cups, one filled with beans and one with BBs. Have the students place a hand in each container and then write which feels colder on the student sheet. They should then measure the temperature of each and record the information. They should explain why the BBs feel colder. *(The BBs feel colder because the heat from a warmer object such as a hand is transferred to the cooler object. Metal is a good conductor of heat and is good at conducting heat away from your hand. Beans are an insulator, or not good at conducting heat. Therefore they will not feel as cold. You perceive the heat that is leaving your hand as cold. This is transfer by conduction. This is a difficult concept. Students will need quite a bit of prompting.)*

4. Station 2: Make copies of the spinner for each student. Have them cut the spinner out and attach a piece of string to it by poking a hole in center. Light the candle. Warn the students about the danger of getting the paper too close to the flame. The candle is hot enough to make it spin from a distance. You may want to have a monitor at this station to assure safety. They should hold their spinner over the candle and record what they observe and why they think it happened. *(As hot air rises, the convection produced causes the spinner to turn.)*

5. Station 3: Prior to class, place outside in the sun one piece each of black and white paper (or place them on a window sill that has sunlight). Ask the students to measure the temperature of each paper and record what they observe and why they think it happened. (*Both papers got heat from the sun. The black paper is warmer because it absorbs light and heat. The white paper reflects them. The warming of the papers is radiant heating or radiation, which occurs through empty space, as in the sun heating.You can also use water, clear and with different colors of food coloring, making it black or brown.)*

6. Station 4: Show each of the three provided pictures and have the students tell what type of energy transfers they are seeing – conduction, convection or radiation.

   Picture 1
   In this picture, the sun is heating the sand. The sand becomes hot due to radiation.

   Picture 2
   In this picture, the girl is walking on the sand. She is warmed by radiation from the sun, but she also receives heat on her feet by conduction from the sand beneath her. She is also warmed by convection as the heat from the sand warms the air above the sand, which rises and starts a convection cell.

   Picture 3
   The girl gets too warm so she goes into the water. She instantly cools off in the deep water. She cools off because of both convection and conduction. The heat from the girl transfers to the cool water by conduction and the water at the bottom of the pool is cooler because of convection. She also still feels heat from radiation from the sun.

7. After students have completed the stations, go over the correct answers with the class. Students should self-check their work.

Assessment

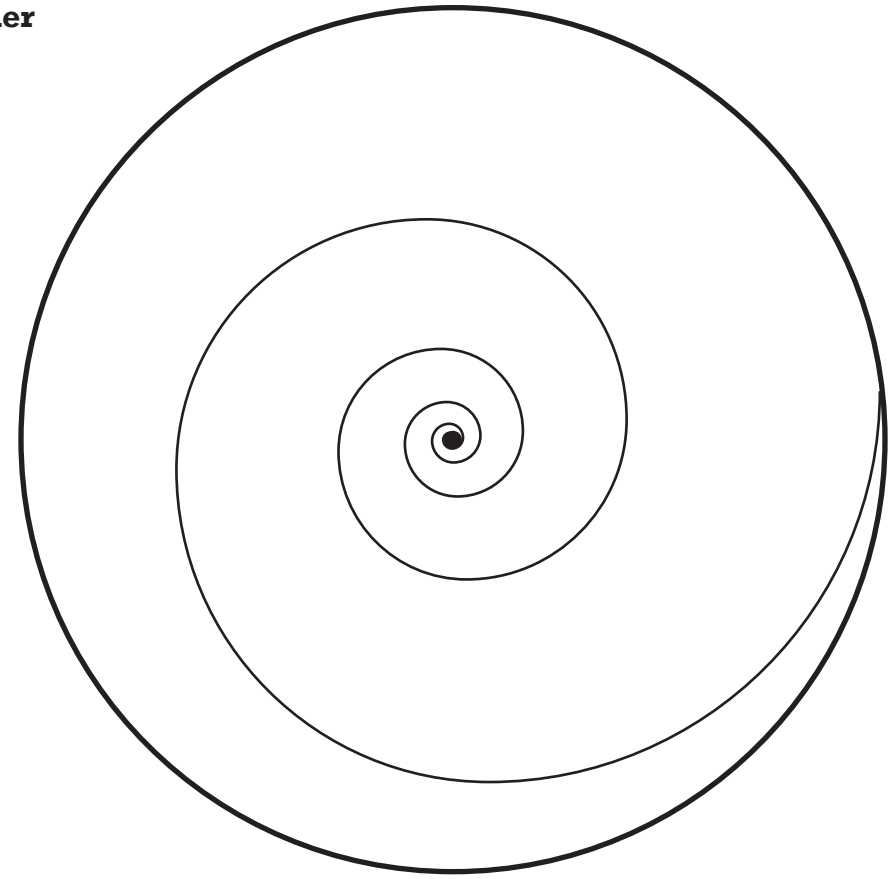
Have the students write the answers to the following questions for a grade.

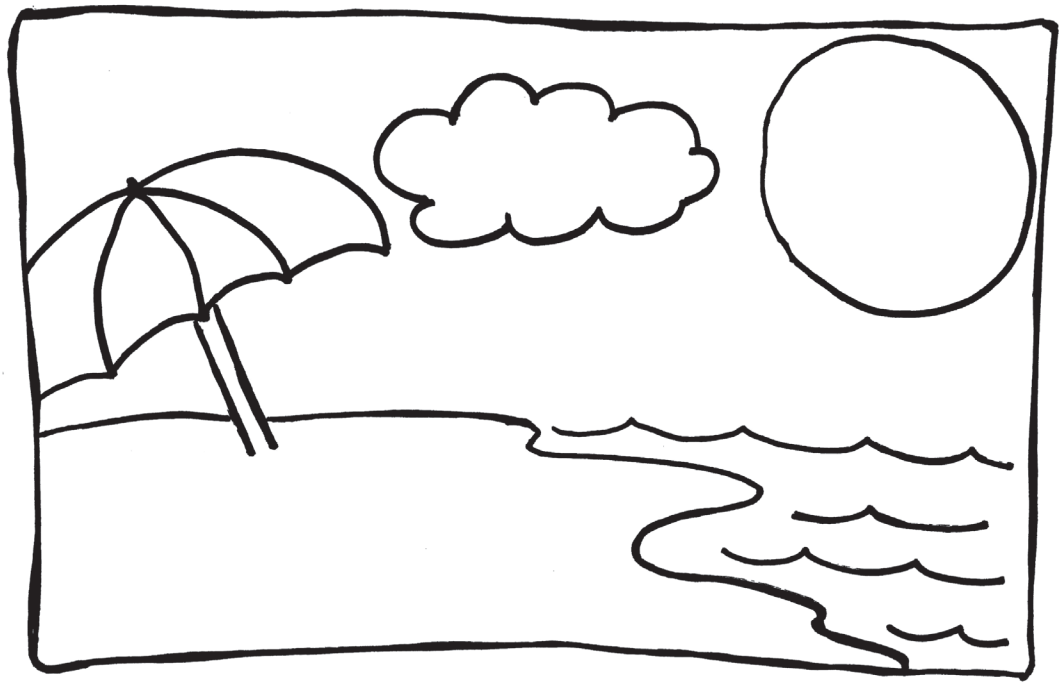
1. You are with your friends at a bonfire. Your chest feels warm but your back still feels cold. What type of heat transfer are you feeling and why? *(The fire radiates heat on your chest. It doesn't go through your body, so your back stays cold. You also see quite a bit of convection from radiation as the ashes rise and fly away. The hot air moves to the side and falls back down. You front is closer so more hot air hits it than your back.)*

2. It is really hot out. Should you close the blinds to keep the room cool? Why or why not? *(Yes, you should close the blinds because heat is radiated through glass. If you leave the blinds open, heat will radiate into the room. If the blinds are on the inside of the house, they will absorb the heat, especially if they are darker colors and transfer the heat to the house. If they are white, they will reflect more heat. If they are shutters on the outside of the windows, they will definitely prevent the heat from entering.)*

3. It is a really hot day. You go to the ice cream store and get a three-dip cone of your favorite flavors. Once outside, you trip over a bike and the ice cream flies out of your cone and melts on the sidewalk. Explain why it melts. *(Radiation from the sun heats the sidewalk, which causes the conduction that is melting the ice cream. Conduction from the ice cream touching the ground will cause it to melt. Remember, conduction is the fastest method of heat transfer; convection is a distance second and radiation is third.)*

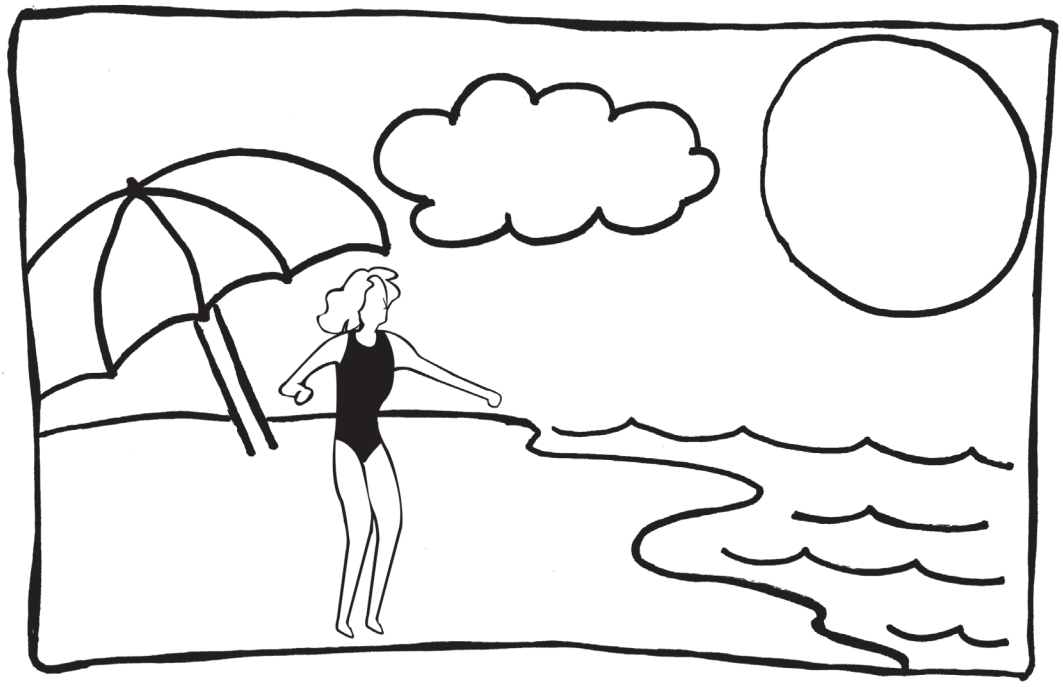
Station 2 — Spinner





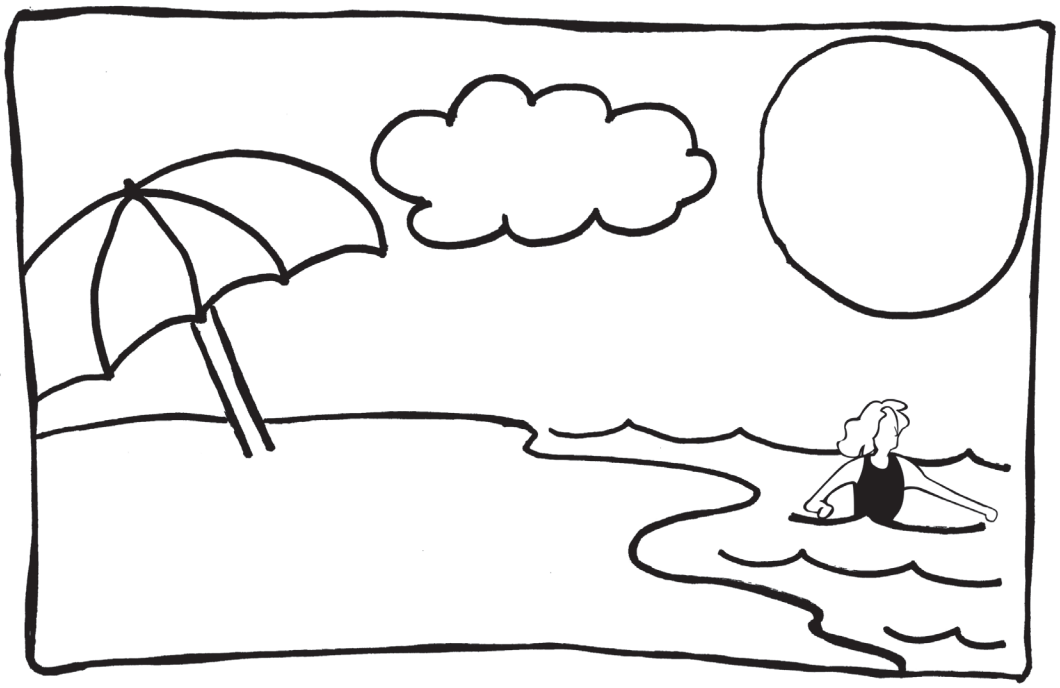
Station 4 — Picture 1

In this picture, the sun is heating the sand. The sand becomes hot due to **radiation**.



Station 4 — Picture 2

In this picture, the girl is walking on the sand. She is warmed by **radiation** from the sun, but she also receives heat on her feet by **conduction** from the sand beneath her. She is also warmed by **convection** as the heat from the sand warms the air above the sand, which rises and starts a convection cell.



Station 4 — Picture 3

The girl gets too warm so she goes into the water. She instantly cools off in the deep water. She cools off because of both **convection** and **conduction**. The heat from the girl transfers to the cool water by **conduction** and the water at the bottom of the pool is cooler because of **convection**. She also still feels heat from **radiation** from the sun.

Station 1

1. On the table are two containers – one with beans and one with BBs. On your student sheet, select the one that you think will be colder.

2. Put your hand in each container. Which one feels colder? Record your answer.

3. Measure the temperature of each container and record it .

4. Write what you discovered. Why did this happen? What kind of heat transfer caused this?

Station 2

1. Take a handout and cut out a spinner. Poke a hole in the top and add a string to it.

2. Hold the spinner over the hotplate.

3. Please do not get too close to the hotplate. It is hot!

4. Record what you see and why you think it happened. What kind of energy transfer do you think caused this to occur?

Station 3

1. You see a black paper and a white paper. On the handout, record which one that you believe will be hotter.

2. Use the thermometer to find the temperature of each and record it on your handout.

3. Explain why you think this happened and what type of heat transfer was at work here.

Station 4

1. You see three pictures. Explain the heat transfer for each picture on your handout.

Name_____

Introduction to the Transfer of Energy

Teacher Demonstration

1. What do you think will happen when the drops of food coloring are added to the water of different temperatures?

2. Were you right? Why did this happen?

Station 1

3. Which do you think will be colder – the beans or the BBs? (circle one)

4. Which actually felt colder – the beans or the BBs? (circle one)

5. What was the temperature of the beans?

6. What was the temperature of the BBs?

7. What actually happened in this experiment and why? What property of transfer of heat actually caused this?

Station 2

8. What do you think will happen to the spinner when you put it over the heat?

9. What actually happened and why did it happen? Name the type of transfer of heat that affected the spinner.

Station 3

10. Which paper do you think will be hotter – white or the black? (circle one)

11. What is the temperature of the white paper?

12. What is the temperature of the black paper?

13. Why is this true and what type of heat transfer is working here?

Station 4

14. Explain the types of transfer of heat that are happening in picture 1.

15. Explain the types of transfer of heat that are happening in picture 2.

16. Explain the types of transfer of heat that are happening in picture 3.

Name_____

What Did You Learn?

Answer these questions. Tell whether convection, conduction or radiation is causing the heat transfer and why.

1. You are with your friends at a bonfire. Your chest feels warm but your back still feels cold. What type of heat transfer are you feeling and why?

2. It is really hot out. Should you close the blinds to keep the room cool? Why or why not?

3. It is a really hot day. You go to the ice cream store and get a three-dip cone of your favorite flavors. You go outside and trip over the bike that was left by the door and the ice cream flies out of your cone and melts on the sidewalk. Does the ice cream melt because of convection, conduction or radiation?

Introduction: Transfer of Heat PowerPoint Presentation

Introduction: Transfer of Heat

Slide 1

Heat

- A form of energy associated with the motion of atoms or molecules.
- Transferred from higher temperature objects to objects at a lower temperature.

Slide 2

How Heat Can Be Transferred

- Conduction
- Convection
- Radiation

Slide 3

Conduction

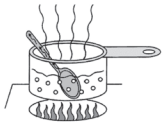
- Transfer of heat through direct contact.
- Occurs anytime objects at different temperatures are touching each other.

- As long as the objects are in contact, transfer of heat will continue until the temperature of the objects is the same.

Slide 4

Conduction (continued)

- Example: If you leave a metal spoon in a pan of soup that you are heating on the stove, it may burn your fingers. The spoon is in direct contact with the hot soup and heat is transferred to the spoon.



Slide 5

Conductors and Insulators

- Some materials conduct heat better than others.
- Materials that transfer heat well are called **conductors**.
- Metals are usually good conductors.
- Wood, paper and plastic are not.
- Materials that stop the transfer of heat are called **insulators** (styrofoam, wool, fiberglass).

Slide 6

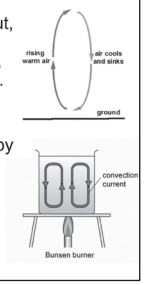
Convection

- The transfer of energy in a liquid or gas.
- When part of a gas or liquid is heated, the particles it is made up of move faster and spread out more.
- The moving particles bump into other particles, causing them to move faster and spread out more.

Slide 7

Convection Currents

- When particles in the air spread out, they become less dense and generally rise above the unheated, more dense particles around them.
- The denser masses of the gas or liquid move in to fill the space left by the heated particles.
- The particles that move away from the source of heat become cooler and more dense.



Slide 8

Radiation

- Energy transferred in the form of rays or waves or particles.
- We will concentrate on the type of radiation that travels as electromagnetic waves.

Slide 9

Heat From the Sun

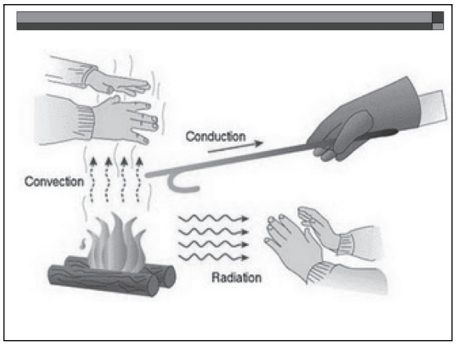
- You can feel the sun warm your skin on a sunny day.
- This is because the energy causes the particles in your skin to move faster = more heat energ

Slide 10

Electromagnetic Waves

- Include visible light, microwaves and infrared light
- Can travel through space.
- The sun is our major sourc

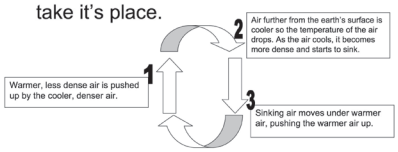
Slide 11



Slide 12

Convection = Basis of Most Winds

- Air is heated by the surface of our planet.
- Warm air rises and cooler air comes in to take it's place.



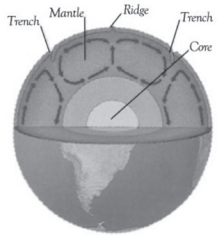
Slide 13

More About This Concept

- Convection is warmer at the earth's surface so air near the earth's surface is heated by the earth.
- Warmer, less dense air rises.
- It is cooler higher up in the atmosphere, so the air becomes more dense again and begins to fall.
- Sinking air moves under warmer air and it all starts over again.

Slide 14

Also Happens Under Earth's Crust

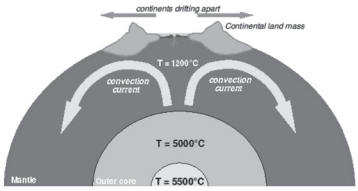


Slide 15

Convection Currents in the Mantle

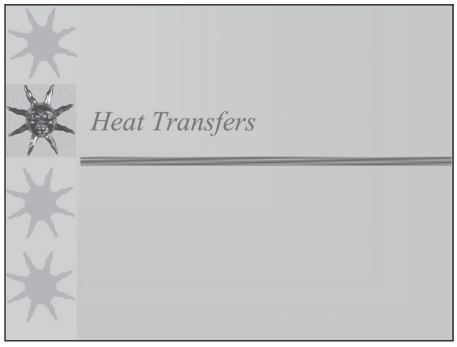
- There is a lot of heat within the earth.
- The surface of the earth is cooler than the lower mantle.
- Heat is transferred to the upper layers.
- Spots where the material conducts more heat become hotter and less dense, so they rise towards the surface.
- Denser material falls.

Slide 16

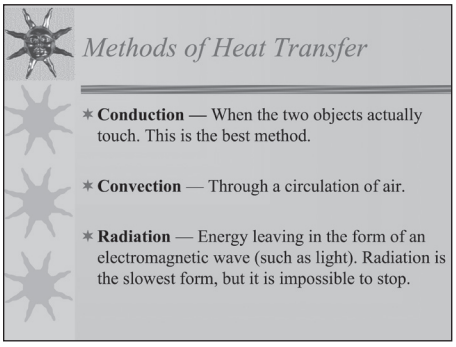


Slide 17

Heat Transfers PowerPoint Presentation



Slide 1



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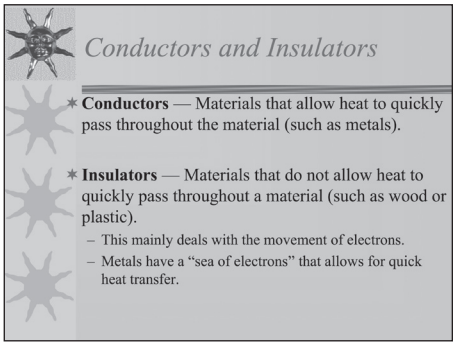

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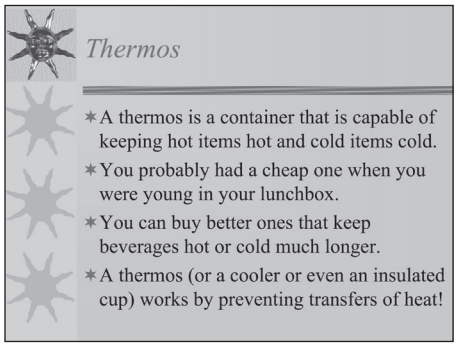

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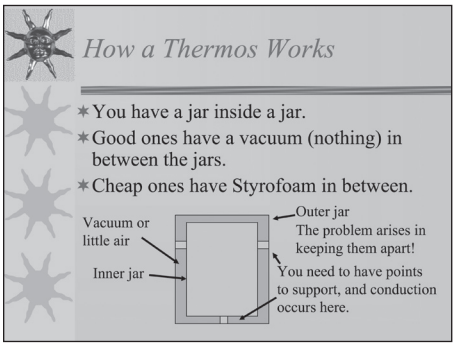

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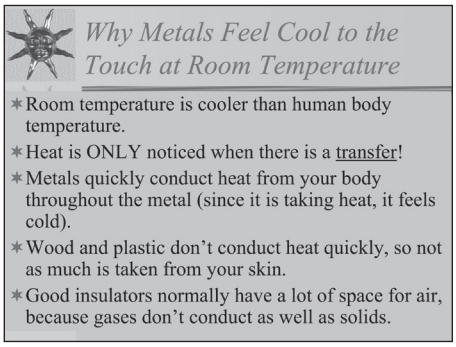

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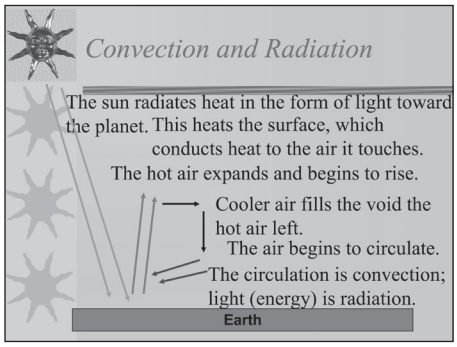

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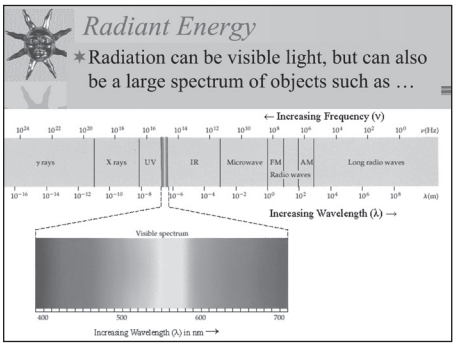


Slide 8

Plate Tectonics and Convection of Heat

Overview

Students will plot the sites of earthquakes on a world map using longitude and latitude. This shows that the processes of plate tectonics are driven by a transfer of energy through convection of heat that happens at the plate boundaries.

Standards Addressed

Grade 9, Science, Earth Science

9-10 Benchmark *E. Explain the processes that move and shape Earth's surface.*

Y2003.CSC.S01.G09-10.BE.L09.I05 / Processes That Shape Earth

05. Explain how the slow movement of material within Earth results from:
    - thermal energy transfer (conduction and convection) from the deep interior;
    - the action of gravitational forces on regions of different density.

Y2003.CSC.S01.G09-10.BE.L09.I06 / Processes That Shape Earth

06. Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding).

Y2003.CSC.S01.G09-10.BE.L09.I07 / Processes That Shape Earth

07. Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating).

Materials

- Computer with Internet access

Procedure

1. Have the students complete the formative assessment.

2. This lesson can be completed in 30 minutes if you don't want to have that many data points, or over several class periods if you want to have more data points. More points will better show that the daily quakes are at the plate boundaries.

3. Download a world map that gives latitudinal and longitudinal coordinates, such as the one found at **http://www.worldatlas.com/aatlas//printpage/imageg.htm**. Make copies of this map for the students.

4. Have the students visit the website **http://www.earthquake.gov/earthquakes/recenteqsww/Quakes/quakes_all.php**, or you can go to the website on one computer and use a projector so that all can see the data and record it.

5. Find the earthquakes with the greatest magnitudes and have the students record them on their maps.

6. Find each earthquake's location on the map based on the latitudinal and longitudinal coordinates. Positive latitude means north; negative means south. Positive longitude means east; negative means west.

7. Ignore decimals unless you have a very accurate map and want to spend extra time finding each point.

8. The more earthquakes that the students document, the better their final diagram of the tectonic plates will be.

9. Connect the dots on the map, which should outline the plates, provided that you have enough points.

10. Show the students the tectonics plates map at **http://www.worldatlas.com/aatlas/infopage/printpage/tectonic.htm** so they can compare.

11. Review the Heat and Plate Tectonics PowerPoint presentation. Have the students take notes.

12. Have students write a short paragraph that explains why earthquakes tend to occur at the plotted points.

Evaluation

_____ Correctness of the Earthquake Recording Sheet (10)

_____ Correctness of the map placement points (10)

_____ Conclusion paragraph content (20)

_____ Conclusion grammar, spelling, punctuation, etc. (5)

Name(s)_____

Earthquake Record Sheet

Date	Location	Magnitude	Latitude	Longitude

Heat and Plate Tectonics PowerPoint Presentation

Heat and Plate Tectonics

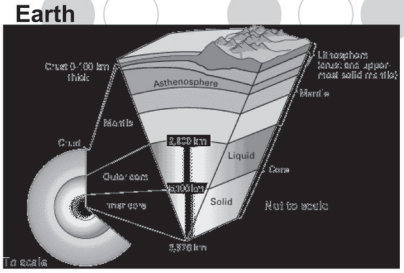
Slide 1

Inside the Earth

- The part of Earth we live on is called the ***crust***. This is a very tiny layer on the planet.
- Beneath that is the ***mantle***. This is a semi-liquid layer that is very hot.
  - Temperature range from 500^0 F to $7,000^0$ F, depending how deep you are.
- At the center is the ***core***. This is even hotter, but is a solid due to the immense pressure on it.

Slide 2

Earth



Slide 3

Where Did All the Heat Come From?

- Most of it came from the formation of the planet. When Earth formed, it was a molten ball of rock.
- It cooled from the outside in.
- Think of a recently hard -boiled egg. The outside gets cool relatively quickly, but the inside stays warm for a long time because it is harder to transfer the heat out.

Slide 4

Earth

- The earth is a big rock: 5,973,600,000,000,000,000,000,000 kg
- How long does it take the center of something that big to cool down?
- It has been cooling for 4.7 billion years and is not cool yet!

Slide 5

Radiation

- There is also another factor heating the interior of the crust.
- Radioactive elements, like uranium, are in the Earth.
- These elements are releasing radiation which is warming the interior of the Earth.

Slide 6

Heat in the Mantle

- What does this heat do?
  - It causes objects to expand, changing their density, causing them to rise.
  - Other objects fill in the spaces they just left.
  - This is a convection current.

Slide 7

Convection and Radiation

A quick look at convection on the surface

The sun radiates heat in the form of light toward the planet. This heats the surface, which conducts heat to the air touching it.

The hot air expands, and begins to rise

Cooler air fills the void the hot air left.

The air begins to circulate.

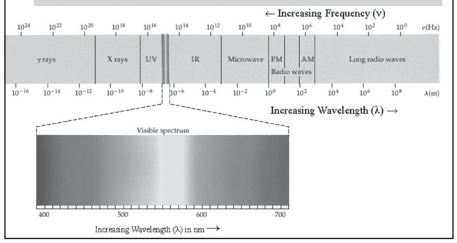
The circulation is convection, light (energy) is radiation.

Earth

Slide 8

Radiant Energy

- Radiation can be visible light, but can also be a large spectrum of things such as …



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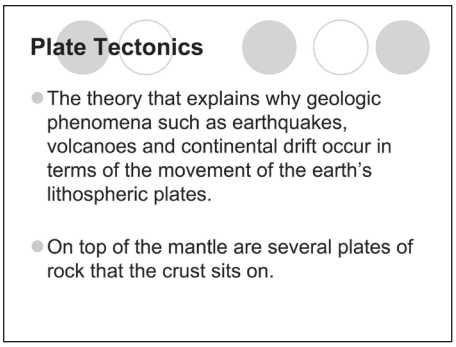

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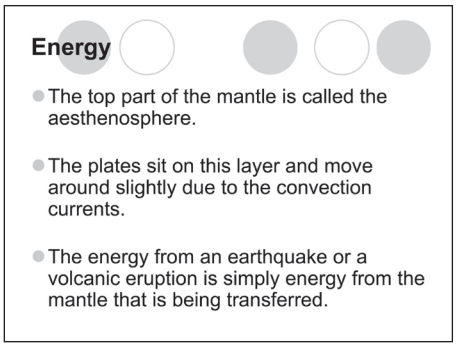


Slide 11

Energy Project

Overview

Students will work in groups to create a project about a topic relating to plate tectonics. The project must include information about heat transfer. It can be a song, skit, speech, video, short story or any other approved method.

Standards Addressed

Grade 9, Science, Earth Science

9-10 Benchmark *E. Explain the processes that move and shape Earth's surface.*

Y2003.CSC.S01.G09-10.BE.L09.I05 / Processes That Shape Earth

05. Explain how the slow movement of material within Earth results from:
    - thermal energy transfer (conduction and convection) from the deep interior;
    - the action of gravitational forces on regions of different density.

Y2003.CSC.S01.G09-10.BE.L09.I06 / Processes That Shape Earth

06. Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding).

Y2003.CSC.S01.G09-10.BE.L09.I07 / Processes That Shape Earth

07. Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating).

Materials

Material will vary depending on what the group is doing. Some possible items needed include the following:

- Poster board
- Computer with PowerPoint, Internet access
- Markers or colored pencils
- Video camera

Procedure

1. Divide students into groups of two or three.
2. Explain that their task is to create a project about plate tectonics that must include something about heat transfer.
3. Distribute the Energy Project student handout.
4. Go over the directions and the method of evaluation.
5. How you allot time to complete this project is up to you. It is important, however, to make sure that students have written down the deadline dates on the handout. It is also important to post the dates somewhere where they are visible to the students.
6. This project can be used as a summative evaluation for students' understanding of the concept of plate tectonics and heat transfer.

Evaluation

Points Received	What Is Due	Points Possible
	Turn in group names, topic and what type of presentation.	10 points
	Rough/draft outline of what you are doing. You will not get this back, so don't give me your only copy!	10 points
	Presentation	40 points
	Visual aids	15 points
	Hard copy of presentation	15 points
	Accountability	10 points

Energy Project

Your Task: Your group will be creating a presentation about a topic related to plate tectonics and heat transfer. The presentation should be approximately five minutes in length and is worth 100 points. You will work in groups of two or three people. Groups will begin making presentations on _____.

Your presentation can be one of the following:

- Speech
- Song
- Skit
- Video
- Short story
- Anything else approved by me

Class game shows are not acceptable. (A skit of a game show is fine, but a quiz show for the class is not.) You will need some type of visual aid (poster, PowerPoint, demonstration, transparency, etc.) that you will explain. You will also need to turn in a hard copy of your presentation.

Your grade will be based on the following:

- Factual content in presentation.
- How smoothly the presentation goes.
- Succesful completion of the project by the deadline.
- An accountability grade given to you by your group members. If you do your share of the work, you should receive full credit.

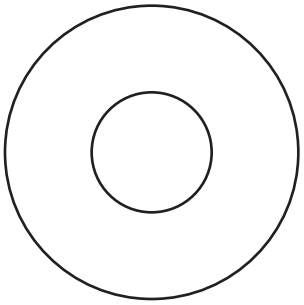
Due Dates

Date	What Is Due	Points Possible
	Turn in group names, topic and what type of presentation.	10 points
	Rough/draft outline of what you are doing. You will not get this back, so don't give me your only copy!	10 points
	Presentation	40 points
	Visual aids	15 points
	Hard copy of presentation	15 points
	Accountability	10 points

Name

Summative Assessment

1. What are the layers of the earth? Label where they would be in a cross section of the earth below.



2. Fully explain why there is movement underneath the earth's crust.

3. What does the plate tectonics theory describe?

4. What are plates, as discussed in the plate tectonics theory?

5. Which of the following is convection?
    a. A transfer of heat by two objects touching
    b. A transfer of heat by electromagnetic waves
    c. A transfer of heat by a circulation of a fluid
    d. A transfer of heat by ions

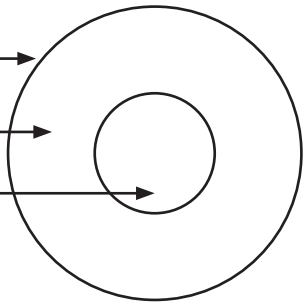
6. Which of the following are radiant energy?
    a. Ultraviolet light
    b. Visible light
    c. Infrared light
    d. X-rays
    e. All of the above

Summative Assessment Answer Sheet

1. *Crust outer most layer where we live very thin*

   Mantle Middle Semi liquid layer

   Core Solid central region



2. *The mantle is hotter as you go deeper in the Earth. This heat causes some materials to expand. This decreases their density and causes them to rise. Cooler materials sink. This is called convection. It causes a mixing of material underneath the crust that moves the crust.*

3. *Why we see changes in the Earth crusts such as volcanism Earthquakes.*

4. *Solid rock layers at the bottom of the crust.*

5. *c. A transfer of heat by a circulation of a fluid*

6. *e. All of the above*

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