Norfolk Public Schools
Science Learning in Place Plan: Science 6H Lessons

Week 10: May 18 – 22, 2020 (Conservative Policies)

Monday	Tuesday	Wednesday	Thursday	Friday
Conservation Policies Assignments: • **Read** the following lessons: -Keeping Water Clean and Safe -Protecting the Air -Caring for Land Resources • **Highlight or Underline** sentences that identify main ideas for each section. • **Research and record** any words you do not know, and the definition. (dictionary, online, phone, ask family, etc.)	**Conservation Policies** Assignments: • **Review** the following lessons: -Keeping Water Clean and Safe -Protecting the Air -Caring for Land Resources • **Complete** the lesson questions 1-3.	**Conservation Policies** Assignments: • **Review** the following lessons: -Keeping Water Clean and Safe -Protecting the Air -Caring for Land Resources • **Complete** the lesson questions 4-6.	**Conservation Policies** Assignments: • **Read** the article "Apple Suppliers Commit to Using Green Energy" • **Complete** the Quiz questions 1-4. • **Justify** your answers by highlighting or underlining and numbering sentences in the article with the number of the question it supports.	**Conservation Policies** Assignments: • **Read** the 6.9 Earth Resources • **Complete** the lesson review questions 1-4.

Week 11: May 25 – 29, 2020 (Weather and Earth-Moon-Sun Interactions)

Monday	Tuesday	Wednesday	Thursday	Friday
Weather Assignments: • **Read** the lesson on Weather Maps • **Complete** the lesson review questions 1-4.	**Weather** Assignments: • **Review** the lesson on Weather Maps and analyze the map key on page 284. • **Apply.** Examine the four highlighted cites on the map. Use the space provided to identify current weather conditions in each city. Then forecast the weather conditions for Miami in the near future.	**Earth-Moon-Sun-Interactions** Essential Question: How are Earth's days, years and seasons related to Earth's movements in space? • **Read** the lesson on *Earth's rotation, revolution, tilt and length of year*. • **Complete** the lesson review questions 1-4.	**Earth-Moon-Sun-Interactions** Essential Question: How do the Earth, moon and sun affect each other to cause moon phases and eclipses? • **Read** the lesson on *Moon Phases and Eclipses*. • **Complete** the lesson review questions 1-3.	**Earth-Moon-Sun-Interactions** Essential Question: What causes tides? • **Read** the lesson on *Tides*. • **Complete** the lesson review questions 1-3.

Week 12: June 1 – 5, 2020 (Energy Budget and Watersheds)				
Monday	Tuesday	Wednesday	Thursday	Friday
Energy Budget Assignments: • **Read** the PBS article on the *Earth's Energy Budget* • **Complete** the lesson review questions 1-3.	**Energy Budget** Assignments: • **Review** the PBS article on the *Earth's Energy Budget* • **Complete** the lesson review questions 4-6.	**Energy Budget** Assignments: • **Analyze** the *Energy Budget* diagram. • **Complete** the *Matching Activity* by placing the action of incoming sunlight into the correct box of the diagram.	**Watersheds** Assignments: • **Read** the article on *Sea Rise and Storms on the Chesapeake Bay*. • **Complete** the lesson quiz questions 1-4.	**Watersheds** Assignments: • **Review** the article on *Sea Rise and Storms on the Chesapeake Bay*. • **Complete** the lesson quiz questions 5-8.

Table 3 How You Can Prevent Water Pollution

• Never pour household chemicals (paints, thinners, cleaners, pesticides, waste oil) down the drain or into the toilet.
• Never dump toxic chemicals in the gutter or onto the ground.
• Don't put items that contain hazardous substances, such as batteries or old computer monitors, into the trash.
• Find out about hazardous waste collection sites and times from your local sanitation or public works department.
• Avoid using hazardous substances in the first place.

PLANET DIARY

For links on effects of Oil Spills visit PlanetDiary.com/HSES.

FIGURE 23 Air Sampler Devices such as this monitor air pollutants.

Keeping Water Clean and Safe

Both the public and government officials pressed for action on pollution. **Starting in the 1970s, the federal government passed several laws to prevent or decrease pollution and protect resources.**

America's polluted rivers and lakes got early attention. In 1972, the U.S. Congress passed the Clean Water Act (CWA). Among other provisions, the law requires industries to reduce or eliminate point source pollution of water above ground. The number of sewage treatment plants increased, which eliminated the discharge of raw sewage into many lakes, rivers, and bays. Today, there are still water pollution problems. But because of the CWA, the number of U.S. lakes and streams safe for fishing and swimming has doubled, and the discharge of pollutants by industries has decreased by billions of kilograms a year.

The Safe Drinking Water Act, passed in 1974, helped protect drinking resources. It set maximum contaminant levels for a number of pollutants that could harm the health of people. Public water resources are cleaner today because of this law. See **Table 3** for ways that individuals can help conserve water and keep it clean.

Protecting the Air

As lawmakers were tackling water pollution in the 1970s, air pollution was also on the agenda. **In 1970, Congress passed the Clean Air Act, the nation's most important air pollution law.** It established National Ambient Air Quality Standards (NAAQS) for six pollutants known to cause health problems—carbon monoxide, ozone, lead, sulfur dioxide, nitrogen oxides, and particulates (fine particles). Air monitors, such as the one in **Figure 23,** sample the air. If the maximum permissible level of pollutants in the air is exceeded, local authorities must come up with plans to bring these levels down. Since 1970, the total emissions of the six pollutants regulated under the Clean Air Act has decreased 60 percent. This happened despite the fact that over the same time span, energy consumption increased 42 percent and the U.S. population grew by 39 percent.

Today, power plants and motor vehicles use pollution control devices to reduce or eliminate certain pollutants released during fossil fuel combustion. In motor vehicles, devices called catalytic converters change harmful emissions to substances that are less harmful. For example, a catalytic converter changes carbon monoxide into carbon dioxide and water. Power plants are now more likely to use low-sulfur coal. These controls cut down on emissions of sulfur and nitrogen oxides that often produce acid precipitation.

Increased use of renewable energy sources, such as solar, wind, and hydroelectric power, can also help clear the air. These energy sources cause less air and water pollution than do fossil fuels.

Cars with electric and hybrid (combination of electric and either natural gas, gasoline, or diesel) motors produce fewer or no tailpipe emissions. Several of these lower-emissions vehicles are now available. Some of the hybrid models are also very efficient and get high gas mileage. When a car can go farther on a tank of gas, it uses less fuel and creates less pollution than do cars with low gas mileage.

Energy conservation is an important air pollution control strategy. Fossil-fuel combustion produces most of the electricity in the United States. If we can use less electricity we would have to burn less fossil fuel. Less fossil-fuel combustion means less air pollution. You can see several energy conservation tips in **Table 4.**

Reading Checkpoint *What did the Clean Air Act do?*

Table 4 How You Can Save Energy

• Recycle when possible.
• Let the sun in on bright winter days using solar energy to warm rooms.
• Use energy-saving fluorescent bulbs instead of incandescent bulbs where you can.
• Turn off lights when you leave a room. Turn off the radio, TV, or computer when you're not using them.
• Walk or ride a bike when you can.
• When buying electric products, look for the Energy Star sticker which denotes energy-saving products.

Caring for Land Resources

Protecting land resources involves preventing pollution and managing land resources wisely. Farmers, loggers, manufacturers, and individuals can all take steps to care for land resources.

Farming Farmers now use many soil conservation practices to prevent the loss of soil and preserve soil fertility. In contour plowing, farmers plow across a hillside rather than up and down the hill. This method of farming decreases water runoff that washes away soil. Another conservation method is strip cropping, in which crops with different nutrient requirements are planted in alternating strips. Strip cropping helps preserve the fertility of soil.

To reduce the chemicals added to soil and crops, some farmers and gardeners now use smaller amounts of pesticides and chemical fertilizers. Natural fertilizers such as compost or animal manure have replaced commercial chemical fertilizers on some fields. **Compost** is partly decomposed organic material that is used as fertilizer. Integrated Pest Management (IPM) uses natural predators or mechanical processes (such as vacuuming pests off leaves) to decrease the number of harmful insects and other organisms.

Forests Selective cutting conserves forest resources. In this method of logging, some trees in an area of a forest are cut, while other trees remain. This practice preserves topsoil as well as the forest habitat. Clear-cutting, on the other hand, removes whole areas of forest and destroys habitats and contributes to the erosion of topsoil.

FIGURE 24 A Recycling Facility Recycling saves resources, reduces energy consumption, and prevents pollution.

Disposal of Waste Some laws reduce the possibility of toxic substances getting into the soil. Sanitary landfills have largely replaced open dumps and old-style landfills. Sanitary landfills have plastic or clay liners that prevent wastes from leaking into the surrounding soil or groundwater. The Resource Conservation and Recovery Act (RCRA) passed in 1976 has decreased the illegal and unsafe dumping of hazardous waste. The law requires companies to store, transport, and dispose of hazardous waste according to strict guidelines. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 established the Superfund to clean up abandoned hazardous waste sites that are a danger to the public or the environment.

Reading Checkpoint *What is the RCRA and what does it do?*

Recycling Creating less waste by using fewer products and recycling products also helps preserve land resources. **Recycling** is the collecting and processing of used items so they can be made into new products,. Many communities now have recycling centers to help with this task. Items that can be recycled include newspapers and magazines, other kinds of paper, plastics, glass bottles, and aluminium containers. By conserving resources and producing less waste, everyone can contribute to a cleaner, healthier future.

Lesson Review Questions

1. Describe laws passed in the 1970's to prevent water pollution.

2. Identify the most important air pollution control law.

3. What are National Ambient Air Quality Standards?

4. How does selective cutting of forests conserve topsoil?

5. Explain how recycling conserves resources and energy.

6. What is the relationship between petroleum production, the increased use of hybrid cars, and the level of air pollutants regulated by the Clean Air Act that are in the air?

Apple suppliers commit to using "green energy"

By Washington Post, adapted by Newsela staff on 04.19.19

Workers install panels at a solar station in Hongyuan, China, in June 2015. Photo by: Jie Zhao/Corbis via Getty Images

Apple recently made an announcement. The maker of iPhones, iPads and Mac computers said that 21 of its manufacturers have pledged to get all their electricity from renewable sources. These are energy sources such as wind and solar power that do not emit greenhouse gases such as carbon dioxide.

Apple's manufacturers are the companies that make parts for Apple products. With this change, more than 40 percent of the energy used by Apple and all its manufacturers would come from renewable sources.

The plan continues Apple's commitment to "green energy," the company said. Last year, it purchased enough renewable energy for all of its own operations. It also bought renewable energy for many of its suppliers.

A Wealthy Company Takes On Climate Change

Apple relies on these outside companies to make its products. Their manufacturing produces most of the pollution related to Apple's business. Apple's goal is to reduce its greenhouse gas emissions. These gases include carbon dioxide. Scientists have linked such gases to climate change. They contribute to warmer average temperatures around the world.

A majority of those suppliers were based in China, said Apple's Lisa Jackson. She is a company vice president who works on Apple's environmental plans. She said the company is excited that it is making good progress. One aim is to show other companies they can also do more to protect the environment.

The announcement from Apple comes at a welcome time for environmentalists. Apple is one of the wealthiest companies in the world. More and more customers are asking top companies to take the lead in addressing climate change.

Apple Isn't Alone

The U.S. government is no longer playing a leading role on the issue. President Donald Trump has said reducing greenhouse gases hurts American businesses. In 2017, he withdrew the country from the Paris climate accord. This agreement seeks to reduce greenhouse gas emissions worldwide. Nearly all of the countries in the world joined it.

Jackson joined Apple after working for President Barack Obama. Obama helped craft the Paris climate accord. She mentioned that the U.S. leaving the agreement is part of why Apple wanted to do more.

Apple is not only very wealthy. Its products are very well known. The company can have a big influence on other companies. Apple wanted to set a good example and cuts its own emissions. Other big companies are also taking action. Google, for example, is helping local leaders identify sources of carbon pollution.

Apple also raised money to promote climate-related efforts. The company contributed to 40 environmental projects. They have ranged from solar rooftops in Japan to water conservation in Oregon.

Old Chargers And Cords Become "E-Waste"

For others, it may take more convincing that Apple really wants to protect the environment. Many have pointed out problems with Apple products. They often result in mountains of "e-waste," they say. Critics blame the company's steady stream of new products. People get rid of old devices for new ones. For example, Apple frequently has changed the design of power chargers on its cellphones and laptops. This change leads to many power cords being thrown away.

Jackson said Apple is working on the charger question. At the same time, it is taking other actions. The company is committed to using recycled materials in many of its devices. Using recycled materials can reduce the need for mining.

Last October, Apple took a step with how it uses aluminum. The company committed to using recycled aluminum in many of its products. Recycling can reduce the amount of energy needed to make new materials. Jackson noted that smelting aluminum remains a major source of emissions.

Quiz

1 Read the section "Apple Isn't Alone."

Which sentence from the section shows why Apple is reducing the amount of greenhouse gases it produces?

(A) Jackson joined Apple after working for President Barack Obama.

(B) Apple wanted to set a good example and cut its own emissions.

(C) Other big companies are also taking action.

(D) The company contributed to 40 environmental projects.

2 Read the paragraph from the section “A Wealthy Company Takes On Climate Change."

> *Apple relies on these outside companies to make its products. Their manufacturing produces most of the pollution related to Apple's business. Apple's goal is to reduce its greenhouse gas emissions. These gases include carbon dioxide. Scientists have linked such gases to climate change. They contribute to warmer average temperatures around the world.*

Which of the following is an accurate explanation of what this paragraph means?

(A) The companies that make Apple products cause pollution that leads to climate change.

(B) Apple is the company that is most responsible for greenhouse gas emissions in the world.

(C) Scientists are trying to convince companies that greenhouse gases are bad for the environment.

(D) Climate change happens when renewable resources are burned for energy.

3 Based on the article, what is one reason why Apple wanted to do more to reduce greenhouse gases?

(A) Google announced it was only using renewable energy.

(B) President Trump withdrew from the Paris climate accord.

(C) Fossil fuels and carbon dioxide became too expensive to use.

(D) Climate change started hurting Apple's factories worldwide.

4 Based on the article, how might Apple's decision affect other companies?

(A) They might not be able to afford Apple's products.

(B) They might get in trouble for having too much e-waste.

(C) They might take more action to help the environment.

(D) They might decide to join the Paris climate accord.

6.9 EARTH RESOURCES

Conserving Resources

Whether the natural resources you use are renewable or nonrenewable, you should be careful how you use them. To conserve natural resources, try to use them only when necessary. For example, leaving the faucet on while brushing your teeth wastes clean water. Turning the faucet on only to rinse your brush saves water that you may need for other uses.

Conserving resources also means taking care of the resources even when you are not using them. For example, it is important to keep lakes, rivers, and other water resources free of pollution. Polluted lakes and rivers can affect the water you drink and harm the plants and animals, including humans, who depend on them to survive.

Another way to conserve natural resources is to recycle. Recycling is the process of reusing materials from waste or scrap. Recycling reduces the amount of natural resources that must be obtained from Earth. Recycling also conserves energy. Newspaper, aluminum cans, most plastic containers, and cardboard boxes can be recycled. Most plastic containers have a number on them. This number informs you whether the item can be recycled.

Virginia's Conservation Policies

Soil is another natural resource. If we do not take care of our soils, we can ruin them or even lose them. Soil is a resource that must be conserved. Soil conservation is a method to maintain the fertility of the soil by protecting the soil from erosion and nutrient loss. Virginia has made a number of public policy decisions regarding land use as a way of conserving the soil. These include preventive measures that can be taken to reduce soil erosion. Back in the 1930s, Virginia established soil and water conservation districts "to develop comprehensive programs and plans to conserve soil resources, control and prevent soil erosion, prevent floods and conserve, develop, utilize and dispose water." Today, there are 47 such districts throughout the state that serve as local resources for people who want to become involved in soil and water conservation. In 2012, the Virginia Association of Soil and Water Conservation Districts was recognized for developing and implementing a model statewide training program to make its citizens aware of the need to conserve our natural resources. One reason why the association received this award can be seen in a farming practice that has been promoted in northern Virginia.

Lesson Review Questions

1. Identify 3 ways to conserve natural resources.

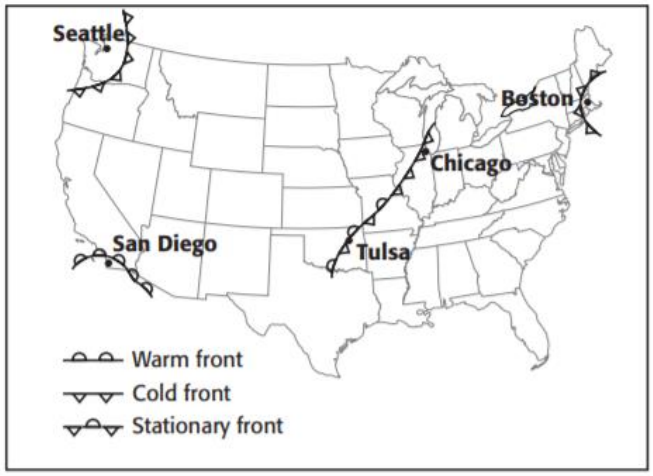
2. What is recycling? Name a minimum of 4 materials in the home that can be recycled.

3. What is soil conservation?

4. Describe public policy developed in Virginia to conserve soil.

Weather Maps

Atmospheric measurements are used to create weather maps. In the United States, the National Weather Service (NWS) collects data from about 1000 weather stations across the country. The NWS then uses these data to construct weather maps, such as the one shown below.



Notice that this weather map includes three types of fronts: warm, cold, and stationary. The area in which two types of air masses meet is called a front.

- A warm front forms where warm air moves over cold, denser air. In a warm front, the warm air gradually replaces the cold air. Warm fronts generally bring drizzly rain and are followed by clear and warm weather.
- A cold front forms where cold air moves under warm air, which is less dense, and pushes the warm air up. Cold fronts can move quickly and bring thunderstorms, heavy rain, or snow. Cooler weather usually follows a cold front because the air mass behind the cold front is cooler and drier than the air mass that it is replacing.
- A stationary front forms when a cold air mass meets a warm air mass. In this case, however, both air masses do not have enough force to lift the warm air mass over the cold air mass. So, the two air masses remain separated. This may happen because there is not enough wind to keep the air masses pushing against each other. A stationary front often brings many days of cloudy, wet weather.

Weather maps that you see on TV also include lines called isobars. Isobars are lines that connect points of equal air pressure. Isobars that form closed circles represent areas of high or low pressure. These areas are usually marked on a map with a capital *H* or *L*. An *H* represents a high-pressure system. An *L* represents a low-pressure system.

Lesson Review Questions

1. Describe the atmospheric conditions and the type of front that produces thunderstorms.

2. What does isobars connect on a weather map?

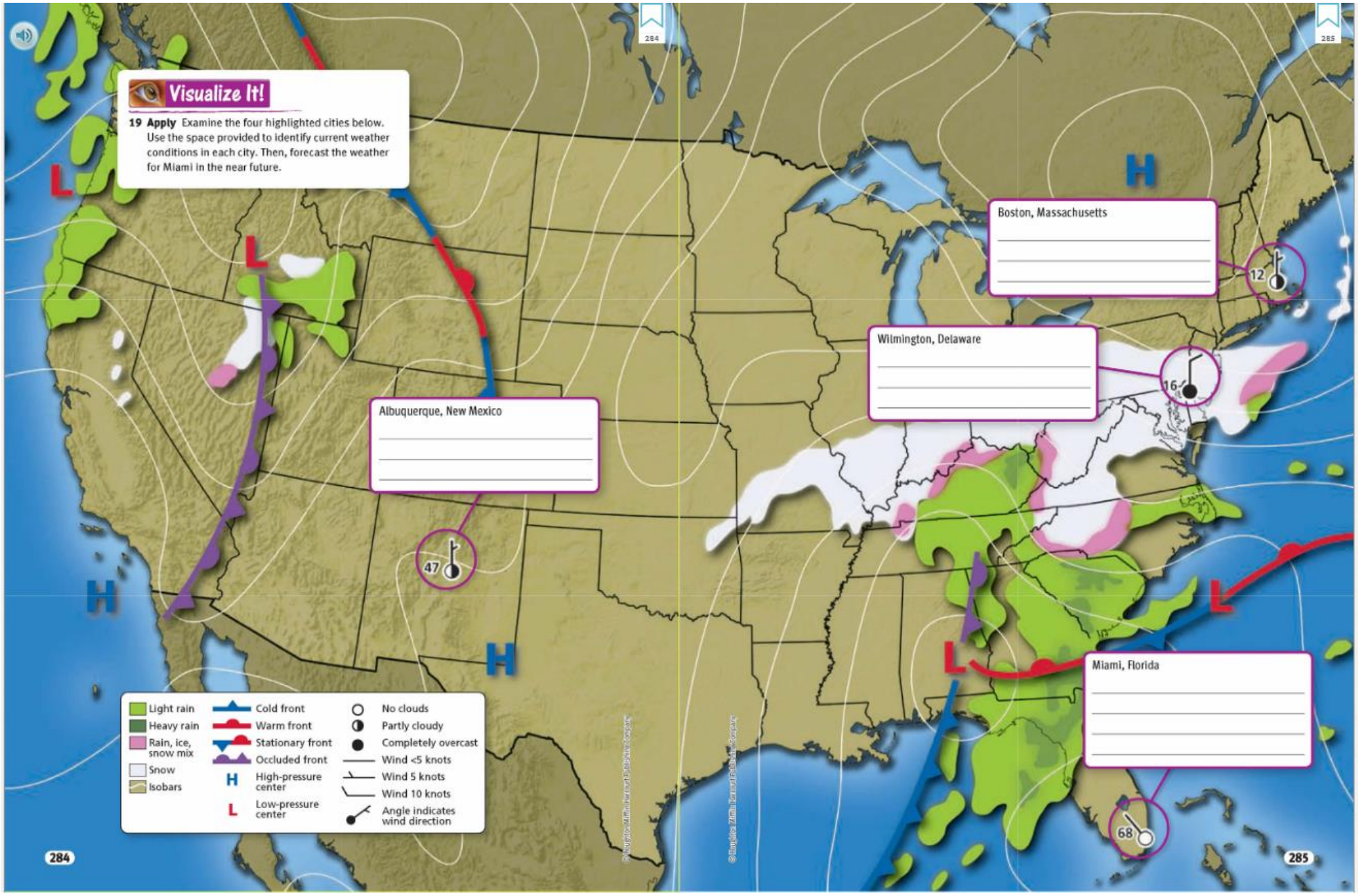
3. What does a *capital H* and a *capital L* represent on a weather map?

4. For each of the three types of fronts provide the following: name of the front, draw the weather map symbol, and describe the type of weather associated with each.

a.

b.

c.


Visualize It!
19 Apply Examine the four highlighted cities below. Use the space provided to identify current weather conditions in each city. Then, forecast the weather for Miami in the near future.
Boston, Massachusetts
Wilmington, Delaware
Albuquerque, New Mexico
Miami, Florida
12
16
47
68
L
H
Light rain
Heavy rain
Rain, ice, snow mix
Snow
Isobars
Cold front
Warm front
Stationary front
Occluded front
High-pressure center
Low-pressure center
No clouds
Partly cloudy
Completely overcast
Wind <5 knots
Wind 5 knots
Wind 10 knots
Angle indicates wind direction
284
285

Earth's Rotation

Earth's rotation explains the mechanics of day and night. As Earth rotates, part of it is in sunlight. It is day in this part of the world. As Earth continues to rotate, that part that was in sunlight begins to face away from the sun. Night is beginning.

Earth's Revolution and Tilt

Earth's revolution is partly responsible for the seasons. In most places in the United States, the year consists of four seasons, but some places in the world that do not have such seasonal changes. For example, areas near the equator have approximately the same temperatures and same amount of daylight year-round. Seasons happen because the Earth not only revolves around the sun but also rotates on its axis at a 23.5° angle. This tilt affects how much solar energy an area receives as Earth moves around the sun.

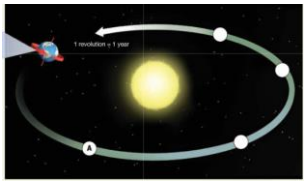
During summer in the Northern Hemisphere, locations there experience warmer temperatures and a greater number of daylight hours because the Northern Hemisphere is tilted toward the sun and receives more-direct solar energy. At the same time, the Southern Hemisphere has colder temperatures and fewer daylight hours because it is tilted away from the sun and receives much less concentrated solar energy. It is important to note that the Earth maintains the 23.5° tilt as it orbits the sun, therefore its axis is pointing toward the North Star at all times during its yearly revolution around the sun.

During winter in the Northern Hemisphere, the Southern Hemisphere has higher temperatures and a greater number of daylight hours because it is tilted toward the sun and receives more-direct solar energy. At that time, the Northern Hemisphere has lower temperatures and fewer daylight hours because it is tilted away from the sun and receives much less concentrated solar energy. The illustration shows Earth in a Northern Hemisphere winter.

What determines the length of a year?

As Earth rotates on its axis, Earth also revolves around the sun. Although you cannot feel Earth moving, it is traveling around the sun at an average speed of nearly 30 km/s. The motion of a body that travels around another body in space is called **revolution** (reh•vuh•LOO•shun). Earth completes a full revolution around the sun in 365 ¼ days, or about one **year**. We have divided the year into 12 months, each month lasting from 28 to 31 days.

Earth's orbit is not quite a perfect circle. In January, Earth is about 2.5 million kilometers closer to the sun than it is in July. You may be surprised that this distance makes only a tiny difference in temperatures on Earth.



Lesson Review Questions

1. What movement of the Earth explains the why we experience day and night? Describe the position of earth and sunlight during daytime and nighttime.

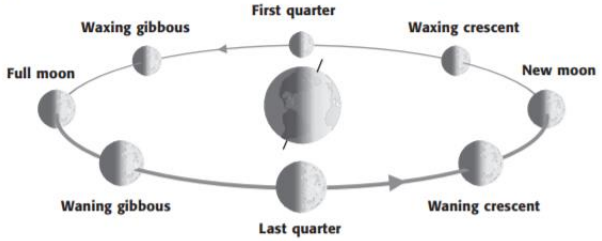
2. Why do we have seasons on Earth?

3. Describe the tilt of the axis, amount of daylight hours and temperatures when the northern hemisphere experience winter.

4. Describe the length of time and the movement Earth makes during rotation and revolution.

Moon Phases and Eclipses

Earth's rotation also accounts for the phases of the moon. The different appearances of the moon due to its changing position are called phases. Within a month, the moon's Earthward face changes from a fully lit circle to a thin crescent and then back to a circle. These different appearances of the moon result from its changing position relative to Earth and the sun. As the moon revolves around Earth, the amount of sunlight on the side of the moon that faces Earth changes. The phases of the moon are shown in this illustration where the sun is shining from the right.



How do lunar eclipses occur?

An **eclipse** (ih•KLIPS) is an event during which one object in space casts a shadow onto another. On Earth, a lunar eclipse occurs when the moon moves through Earth's shadow. There are two parts of Earth's shadow, as you can see in the diagram below. The **umbra** (UHM•bruh) is the darkest part of a shadow. Around it is a spreading cone of lighter shadow called the **penumbra** (pih•NUHM•bruh). Just before a lunar eclipse, sunlight streaming past Earth produces a full moon. Then the moon moves into Earth's penumbra and becomes slightly less bright. As the moon moves into the umbra, Earth's dark shadow seems to creep across and cover the moon. The entire moon can be in darkness because the moon is small enough to fit entirely within Earth's umbra. After an hour or more, the moon moves slowly back into the sunlight that is streaming past Earth. A total lunar eclipse occurs when the moon passes completely into Earth's umbra. If the moon misses part or all of the umbra, part of the moon stays light and the eclipse is called a partial lunar eclipse.

You may be wondering why you don't see solar and lunar eclipses every month. The reason is that the moon's orbit around Earth is tilted—by about 5°—relative to the orbit of Earth around the sun. This tilt is enough to place the moon out of Earth's shadow for most full moons and Earth out of the moon's shadow for most new moons.

This composite photo shows the partial and total phases of a lunar eclipse over several hours.

How do solar eclipses occur?

When the moon is directly between the sun and Earth, the shadow of the moon falls on a part of Earth and causes a solar eclipse. During a total solar eclipse, the sun's light is completely blocked by the moon, as seen in this photo. The umbra falls on the area of Earth that lies directly in line with the moon and the sun. Outside the umbra, but within the penumbra, people see a partial solar eclipse. The penumbra falls on the area that immediately surrounds the umbra.

The umbra of the moon is too small to make a large shadow on Earth's surface. The part of the umbra that hits Earth during an eclipse, is never more than a few hundred kilometers across, as shown below. So, a total eclipse of the sun covers only a small part of Earth and is seen only by people in particular parts of Earth along a narrow path. A total solar eclipse usually lasts between one to two minutes at any one location. A total eclipse will not be visible in the United States until 2017, even though there is a total eclipse somewhere on Earth about every one to two years.

Lesson Review Questions

1. What cause the Earth to observe different phases of the moon?

2. **Describe.** What are two phases of a waxing moon, and how do they appear?

3. **Describe.** Where is the moon in its orbit at the time of a solar eclipse?

Tides

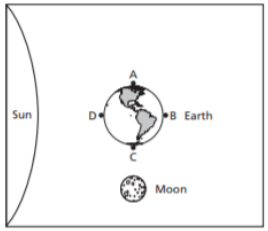
Tides are daily changes in the level of ocean water. They are influenced by the pull of gravity from the sun and the moon. Although these gravitational forces continuously pull on Earth, the moon's gravity is the dominant force on Earth's tides. It pulls on every particle of Earth, but the pull on liquids is much more noticeable than on solids because liquids move more easily.

How often tides occur and the difference in tidal levels depend on the moon's position. The moon's pull is strongest on the part of Earth directly facing the moon. High tide occurs on the part of Earth that is closest to the moon. There, the moon's gravitational pull causes a bulge in the ocean water. At the same time, high tide also occurs on the opposite side of Earth due to inertia of the ocean water. When a high tide occurs, water is drawn away from the area between the high tides, and this area experiences a low tide.

Tides alternate between high tide and low tide because of Earth's rotation and the moon's revolution around Earth. Rotation is the spin of a body on its axis. Revolution is the motion of one body traveling around another body. Earth rotates on its axis while it revolves around the sun. Earth rotates faster than the moon revolves around the Earth. If Earth rotated at the same speed that the moon revolves around Earth, high tide would always occur at the same spot on Earth.

Lesson Review Questions

1. What causes tides?



2. Which areas (A, B, C, or D) experience high tides when Earth, moon, and sun are aligned?

3. Look at the table of tide information.

Date	High tide time	High tide height (m)	Low tide time	Low tide height (m)
June 3	6:04 a.m.	6.11	12:01 a.m.	1.76
June 4	6:58 a.m.	5.92	12:54 a.m.	1.87
June 5	7:51 a.m.	5.80	1:47 a.m.	1.90
June 6	8:42 a.m.	5.75	2:38 a.m.	1.87
June 7	9:30 a.m.	5.79	3:27 a.m.	1.75
June 8	10:16 a.m.	5.90	4:13 a.m.	1.56
June 9	11:01 a.m.	6.08	4:59 a.m.	1.32
June 10	11:46 a.m.	6.28	5:44 a.m.	1.05
June 11	12:32 p.m.	6.47	6:30 a.m.	0.78

What was the tidal range on June 9?

PBS LearningMedia

Earth's Energy Budget
Background Reading

Energy is constantly flowing into, through, and out of the Earth system. Earth's primary source of incoming energy is the Sun. Incoming solar radiation enters the Earth system, where it interacts with the air, land, and water in different ways. Some energy is reflected back to space, some is absorbed, and some is emitted as thermal infrared radiation. The various flows of incoming and outgoing energy are the components of Earth's energy budget. When the amount of incoming and outgoing energy is balanced, Earth's global temperature will not change over time. However, If something changes the amount of energy entering or leaving the Earth system, equilibrium is disturbed and the global temperature will increase or decrease.

The rate of energy flow per unit area is known as flux, which is measured in units of watts per square meter. The amount of sunlight that arrives at the top of Earth's atmosphere—averaged over the whole surface area of the Earth, including the day and night hemispheres—is about 340 W/m^2. About 29 percent of incoming sunlight is reflected back to space by materials such as snow and ice on Earth's surface or by clouds, gas molecules, and other particles in the atmosphere. About 23 percent of incoming energy is absorbed by the atmosphere and about 48 percent is absorbed by Earth's surface.

However, when a substance is warmed by absorbing energy, it also radiates heat as thermal infrared energy. Some of the energy that is absorbed by the atmosphere causes the atmosphere to warm up and emit energy as infrared radiation. Greenhouse gases in the atmosphere (such as water vapor, carbon dioxide, and methane) absorb energy radiated by the surface and emit it in all directions. High in the atmosphere, the energy can radiate out to space and is lost from the Earth system. Earth's surface receives energy emitted from the atmosphere, causing it to warm. In fact, Earth's surface receives more than twice the energy from the atmosphere (in the form of infrared radiation) as it receives from the Sun (mostly in the form of visible light)!

The energy absorbed by Earth's surface is balanced by energy leaving the surface through emission of infrared radiation, evaporation, transpiration, and conduction and convection. A small amount of energy radiates directly to space. The rest of the energy heats the atmosphere and is balanced by the atmosphere emitting infrared radiation in all directions, some of which escapes to space at high altitudes. The total outgoing energy at the top of the atmosphere is nearly equal to the total incoming radiation. In recent years, Earth's energy budget has been slightly unbalanced. More energy has been coming in than going out, which has lead to a rise in global temperature.

There are many different factors that can affect the balance of the energy budget. For example, changes in the Sun's output, variations in the shape of Earth's orbit, or the tilt of Earth's axis affect the amount of incoming sunlight (as well as its spatial and temporal distribution). In addition, particles in the atmosphere—such as from volcanic eruptions or human-made air pollution—can affect the amount of energy that is reflected. Greenhouse gases in the atmosphere, which have increased due to human activities such as burning fossil fuels, decrease the amount of heat that can be radiated to space. Other human-produced changes, such as deforestation, also affect how Earth reflects and absorbs energy and can affect the balance between evaporative and conductive cooling at Earth's surface.

Lesson Review Questions

1. What is the primary source of energy for Earth's system?

2. Explain the different ways that energy interacts with Earth's air, land, and water.

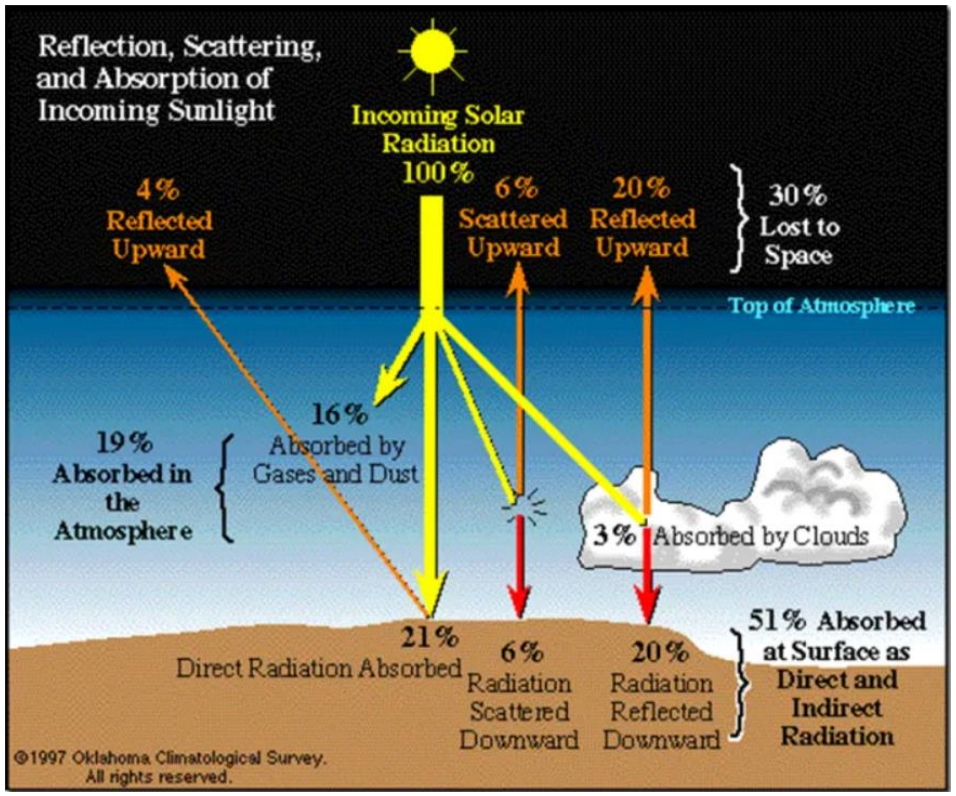
3. Describe the amount (%) of incoming sunlight and how it is distributed between space, atmosphere and Earth's surface.

4. Identify 3 greenhouse gases. What is the role of greenhouse gases in the atmosphere?

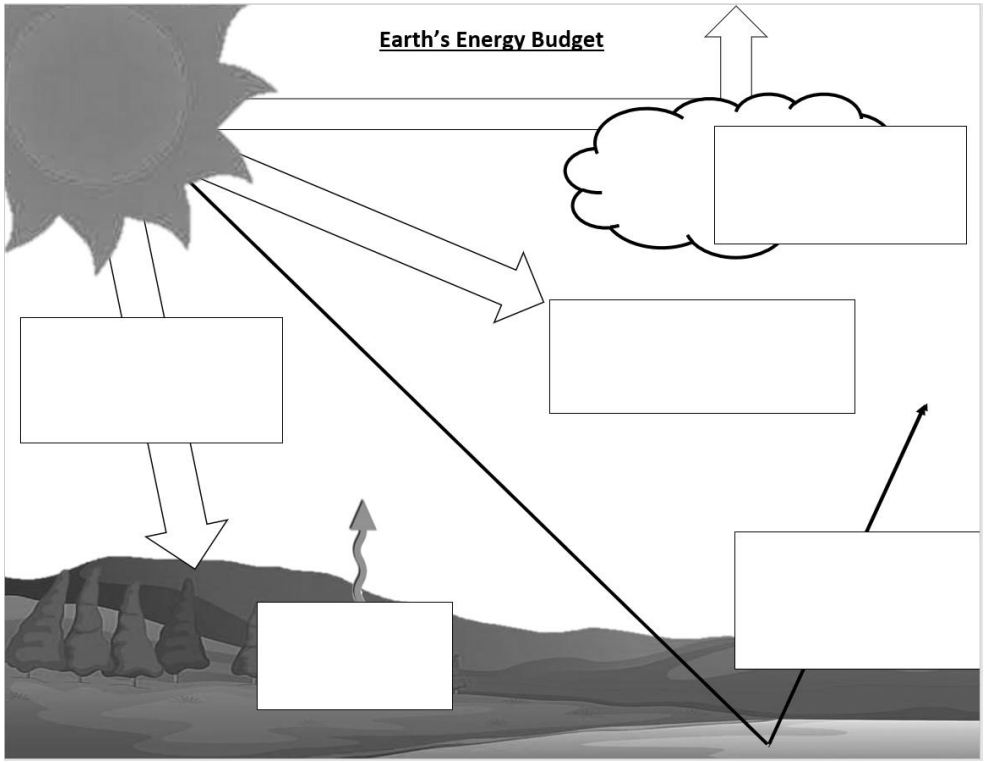
5. How does energy absorbed by Earth's surface leave the system?

6. What factors can affect the balance of the energy budget?

Analyze the Energy Budget Diagram to summarize the actions of incoming solar radiation.



Matching.



Directions: Appropriately match the actions below with each box in the above diagram to summarize the energy budget.

- 4% Reflected upward
- 51% Absorbed at the surface
- 20% reflected to space
- 19% Absorbed in the atmosphere
- 6% Scattered upward

Sea rise and storms on the Chesapeake Bay

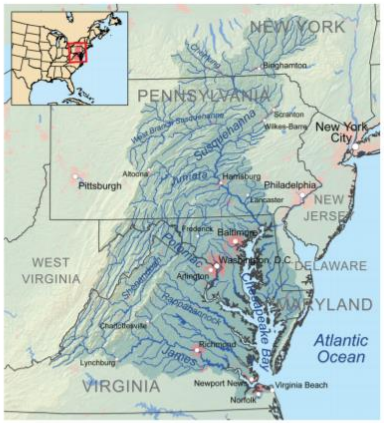
The Chesapeake Bay is a beautiful and vitally important body of water located in both Maryland and Virginia. According to an organization called CSSPAR, the Chesapeake Bay could rise an additional 2 to 4 feet by the end of this century. The name CSSPAR (pronounced "see-spar") stands for Chesapeake Sea Level Rise and Storm Surge: Public Awareness and Response.

Sea levels around the world are rising due to a steady increase in average temperatures. This rise in temperatures is known as global warming. It is primarily caused by the burning of fossil fuels like coal and gasoline. As average temperatures rise, polar ice from both Greenland and Antarctica is melting into the world's oceans. Historically, oceans have risen at an average rate of 5 to 8 inches every 100 years. They are now rising far more quickly.

The Chesapeake Bay's water level is rising at an even faster rate than average, however, because the land underneath the bay is sinking. During the last ice age, glaciers pushed the land surrounding the Chesapeake Bay upward. After the glaciers melted, the land slowly retreated to its original position. As the land sinks, the water in the Chesapeake Bay rises. This process is responsible for about half of the Chesapeake region's sea-level rise.

Already Near Sea Level

Much of the land in the Chesapeake region already lies very near sea level. For that reason, even a small rise would have a major effect.



Researcher Sean O'Connor created maps for CSSPAR that illustrate the predicted effects of sea-level rise on the Chesapeake Bay. If sea-level rise continues at its current rate, the bay would invade the land for miles in some places. It would destroy around 167,000 acres of marshland by the year 2100. Around 1.9 million homes would be destroyed.

The Chesapeake Bay is a precious American resource. It is "the nation's estuary," O'Connor said. An estuary is an area in which freshwater rivers meet the ocean. The mix of fresh and salty ocean water creates a delicate, marshy habitat called wetlands.

Hundreds of rivers empty into the Chesapeake estuary along the shorelines of six states. Around 18 million people live in the Chesapeake region. The U.S. capital, Washington, D.C., is located near the Chesapeake.

Sea-level rise in the Chesapeake Bay will destroy the wetland habitats of many birds, fish, shellfish and plants. Human populations and structures are also at risk. In many low-lying areas, farms and homes will have to be relocated as the bay floods the land. Major cities like Baltimore will be at risk.

Acute Effects Of Storms On The Region

A higher water level in the bay means stronger storm surges and higher floodwaters. A storm surge is a sudden rise in sea level caused by a major storm.

Powerful tropical storms and hurricanes formed in the Atlantic Ocean can smash into the U.S. East Coast. The low-lying Chesapeake region is at risk when one of these storms hits. Cities, towns and highways are all in danger of being flooded if the ocean surges inland.

Global warming is not just causing a rise in sea levels. It is also creating more extreme weather conditions. As global warming intensifies, storms will become more powerful and more frequent.

More intense storm surges are already hitting the Chesapeake. Scientists from CSSPAR compared a 1933 storm to a 2003 storm, Hurricane Isabel. The storms hit the same coastal area with roughly equal force. However, the storm surge from Isabel was higher than the one in 1933.

Hurricane Isabel's surge was measured at 6 to 8 feet above the normal water levels of the Chesapeake Bay. The deadly storm ripped apart buildings and wetlands. It caused millions of dollars in damage, downed thousands of trees and cut off electricity to 2 million people.

What would happen if a storm like Hurricane Isabel hit the Chesapeake 70 years from now? By that point, the sea will be about 2 feet higher than it is now.

Flooding would be worse than anything ever seen before, CSSPAR scientists say. For instance, Isabel caused an 8-foot-high flood in Old Town Alexandria, Virginia. Add another 2 feet to the bay, and the flood would be 10 feet high. Homes, hotels, roads and islands would be flooded and muddy. Much of the nation's capital would be covered in deep, muddy water.

Technology Will Help Spread Information

In the future, storms will likely be much more powerful. However, O'Connor says, improved technology may reduce human deaths when such storms hit. For example, weather satellites and GPS will help people understand how strong a surge will be and how long it will last. Such technology will allow people to get out of a storm's path in time, O'Connor believes.

Fast Facts

The Chesapeake's Living Shorelines

O'Connor does not believe building retaining walls is the best response to the flooding threat. He recommends creating so-called living shorelines along the coast. The first step is to place rows of stone just off the shoreline. Seagrasses are then planted along these rows of stone. Over time, sand and mud are trapped behind these "walls" of stone and grass. As a result, the shoreline grows stronger and even expands.

Quiz

1 According to CCSPAR, water levels in the the Chesapeake Bay could rise an additional 2 to 4 feet by the end of this century. What is causing this?

(A) the burning of fossil fuels

(B) the tides in the ocean are changing

(C) the temperatures on Earth are lowering

(D) the rate of rainfall is increasing

2 Which selection from the article BEST supports the idea that those who live near the Chesapeake Bay are particularly at risk when ocean levels increase?

(A) During the last ice age, glaciers pushed the land surrounding the Chesapeake Bay upward. After the glaciers melted, the land slowly retreated to its original position.

(B) Much of the land in the Chesapeake region already lies very near sea level. For that reason, even a small rise would have a major effect.

(C) Hundreds of rivers empty into the Chesapeake estuary along the shorelines of six states. Around 18 million people live in the Chesapeake region.

(D) Global warming is not just causing a rise in sea levels. It is also creating more extreme weather conditions. As global warming intensifies, storms will become more powerful and more frequent.

3 Why are water levels in the Chesapeake Bay increasing at a faster rate than water levels around the world?

(A) Temperatures around the Chesapeake Bay are increasing causing rainfall to increase in the area.

(B) Global warming is more intense in the Chesapeake Bay causing water levels to rise at a quicker rate.

(C) Glaciers around the bay have melted causing the land underneath the bay to sink.

(D) Changes in the tides have caused water levels to increase in the Chesapeake Bay.

4 Read the conclusion below.

Rising water levels have already led to stronger storm surges in the Chesapeake Bay.

Which detail from the article provides the BEST support to the statement above?

(A) Powerful tropical storms and hurricanes formed in the Atlantic Ocean can smash into the U.S. East Coast.

(B) The low-lying Chesapeake region is at risk when one of these storms hits. Cities, towns and highways are all in danger of being flooded if the ocean surges inland.

(C) Scientists from CSSPAR compared a 1933 storm to a 2003 storm, Hurricane Isabel.

(D) The storms hit the same coastal area with roughly equal force. However, the storm surge from Isabel was higher than the one in 1933.

5 Global warming has caused sea levels to increase all over the world. Why are rising sea levels in the Chesapeake Bay of special interest?

(A) The waters in the Chesapeake Bay contain large amounts of pollution that will spill over harming people and animals in the area.

(B) The Chesapeake Bay contains a large amount of items from historical times. As the lands flood, these items will be lost.

(C) Even though the Chesapeake Bay is not heavily populated, it is home to mainly farmland. Farmlands continue to be in increased danger as water levels increase.

(D) Many people, as well as a large diversity of plants and animals, surround the Chesapeake Bay. Increased water levels will put these in danger.

6 Which selection from the article is BEST illustrated by Image 1?

(A) If sea-level rise continues at its current rate, the bay would invade the land for miles in some places. It would destroy around 167,000 acres of marshland by the year 2100. Around 1.9 million homes would be destroyed.

(B) The Chesapeake Bay is a precious American resource. It is "the nation's estuary," O'Connor said. An estuary is an area in which freshwater rivers meet the ocean. The mix of fresh and salty ocean water creates a delicate, marshy habitat called wetlands.

(C) Human populations and structures are also at risk. In many low-lying areas, farms and homes will have to be relocated as the bay floods the land. Major cities like Baltimore will be at risk.

(D) The first step is to place rows of stone just off the shoreline. Seagrasses are then planted along these rows of stone. Over time, sand and mud are trapped behind these "walls" of stone and grass.

7 In 2003, a storm called Isabel hit the coastal area. The force was the same as a storm that hit in 1993. Isabel was 8 feet above the normal water level for that area, From this information, what would you expect storms in this area to be be like 20 years from now?

(A) Storms will probably affect less land in the area.

(B) Storms will probably become less dangerous than they are now.

(C) Storms will probably remain the same as they are currently.

(D) Storms will probably be even more dangerous in this area.

8 How do the map and the text in the introduction [paragraphs 1-3] develop an understanding of the Chesapeake?

(A) They both show how glaciers changed the Chesapeake.

(B) They both show that the Chesapeake's sea level is rising.

(C) They both show that the land is sinking in the Chesapeake.

(D) They both show where the Chesapeake can be found.