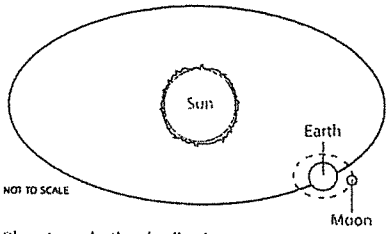
LESSON 45

Our Solar System

What makes up our solar system?



Planets and other bodies in space move in elliptical orbits.

The **sun** is the center and largest body of our **solar system.** Nine planets and their moons **revolve,** or travel around, the sun. Smaller bodies—icy **comets** and chunks of rock called **asteroids**—also revolve around the sun. Everything travels in the same direction and in its own **orbit,** or path. Beyond our solar system are the stars that make up the rest of the universe.

The pull of **gravity** holds the bodies of the solar system together. Gravity between the sun and the planets keeps the planets in their orbits. Gravity between each planet and its moons keeps the moons in orbit around the planet.

The orbit of a planet is a kind of oval path called an **ellipse.** It takes each planet a fixed length of time to complete one revolution around the sun. Because a planet's movements are predictable, space scientists know where it will be at any time. They need this information when planning space flights and doing research.

Show What You Know

1. Name five objects that make up our solar system.

_____

_____

2. What prevents the planets from flying off into space? What prevents a planet's moons from flying off into space?

_____

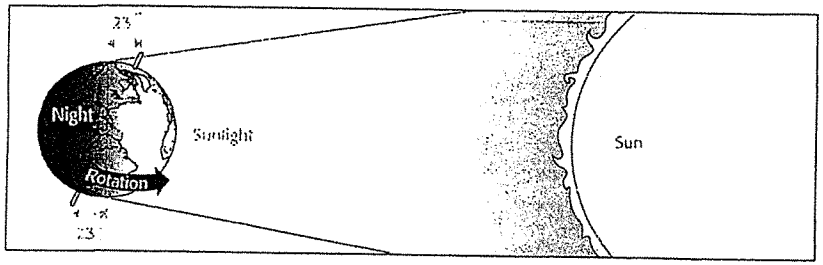
_____

_____

LESSON 46

Rotation

What causes day and night on Earth?



As Earth rotates on its axis, half of the globe experiences daytime.

In addition to orbiting the sun, Earth **rotates** on its axis like a spinning top. Imagine a line drawn between the North and South Poles and through Earth's center. This line is Earth's **axis.** Earth rotates from west to east. Because of this motion, the sun, moon, and stars appear to be moving from east to west. As seen from Earth, these bodies rise in the east and set in the west.

Earth's **rotation** causes daytime and nighttime. When a location on Earth faces the sun, it has daylight. When that location faces away from the sun, it is in darkness and has nighttime. One complete rotation is called a **day** and takes 24 hours. We tell time based on Earth's rotation. Earth is divided into 24 time zones. Each time zone represents one hour in a day. When it is noon at one location, it is noon at all locations within that time zone.

Earth's moon also rotates, but it turns much more slowly than Earth does. It takes the moon the same amount of time to rotate as it takes to revolve around Earth—about 28 days. Because of this, the same side of the moon always faces Earth. Humans had never seen the opposite side of the moon until spacecraft flew around the moon.

Show What You Know

Explain how you know that Earth rotates.

_____

_____

LESSON 47

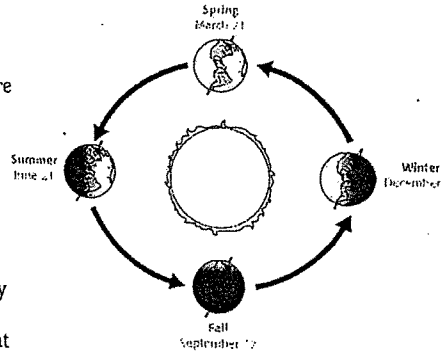
Earth's Revolution

What causes the seasons?

Earth's axis is tilted 23 $\frac{1}{2}$ degrees. This tilt causes the axis to be pointed toward the sun during some parts of its orbit and away from the sun during other parts. The time it takes Earth to orbit once around the sun is a **year**, or 365 $\frac{1}{4}$ days. During a year, the Northern and Southern Hemispheres experience **seasons**—changes in the number of daylight hours and average daily temperatures.

When Earth's axis is pointed away from the sun, the Northern Hemisphere has the fewest hours of daylight. This happens on December 21, the first day of winter on the calendar. From December to June, the number of daylight hours in the Northern Hemisphere increases.The Northern Hemisphere has the most hours of daylight on June 21. This is the first day of summer.

Sunlight strikes the side of Earth that is pointed toward the sun more directly than it strikes the side of Earth that is pointed away from it. More direct sunlight means more energy is received. Thus the Northern Hemisphere receives more solar energy during summer than winter. The Southern Hemisphere experiences seasons opposite those experienced in the Northern Hemisphere.



The Northern Hemisphere is cold in winter because the sun's rays strike it less directly. The opposite is true in the Southern Hemisphere.

Show What You Know

Why does the Southern Hemisphere experience winter in June?

_____

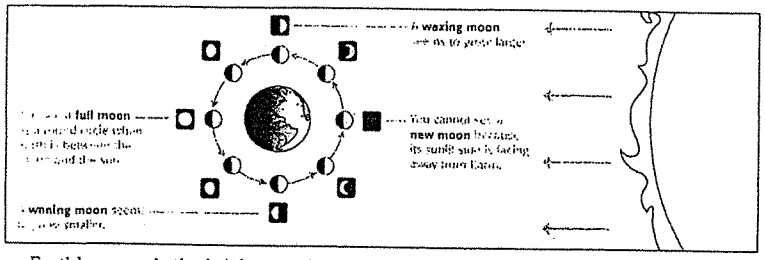
_____

_____

LESSON 48

Moon's Revolution

What causes the phases of the moon?



Earth's **moon** is the brightest object in the sky, but it gives off no light of its own. The light we see is light from the sun that hits the moon's surface and is reflected to Earth. To people on Earth, the moon appears to change its shape during the month. These changes are the moon's **phases.**

As Earth revolves around the sun, its moon revolves around Earth. As the moon moves through its orbit, its position in the sky changes relative to the positions of the sun and Earth.

Although one full side of the moon is always lighted, the portion of the sunlit side that you see changes during the month.

Sometimes, one body in space blocks the view of another body. This is called an **eclipse.** During a solar eclipse, the moon passes between the sun and Earth and blocks your view of the sun. During a lunar eclipse, Earth comes between the moon and the sun and casts a shadow on the moon.

Show What You Know

Use these terms to complete the sentences.

new moon **full moon** **waxing moon** **waning moon**

1. When Earth is between the moon and the sun, you see a _____.
2. You cannot see a _____.
3. A _____ occurs after a new moon and before a full moon.
4. A _____ occurs after a full moon and before a new moon.

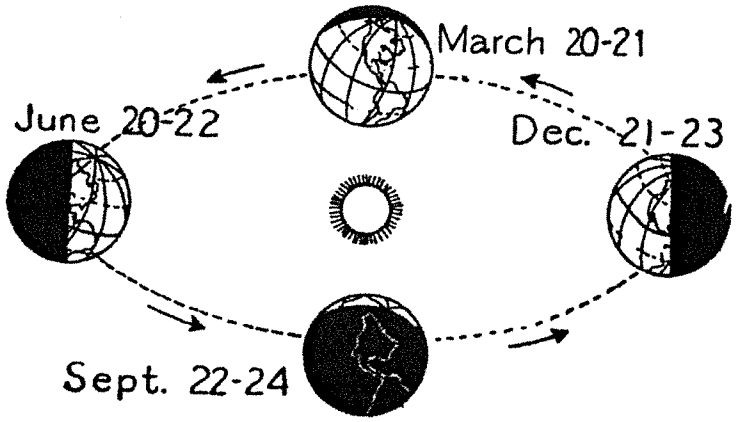
Name _____

Why Do We Have Seasons?

Understand how the tilt of the Earth's axis causes the seasons.

Read the passage and answer the questions below.

The Earth's axis is at a 23.5-degree angle. This means as the Earth orbits the sun, parts of the globe are tilted closer and others are tilted away. This is why we have seasons. The places tilted toward the sun are getting more direct sunlight, which makes it warmer. The places tilted away are getting indirect sunlight, therefore the temperatures are cooler. This is also why when we in the Northern hemisphere are experiencing summer, it is winter in the Southern Hemisphere. The diagram below shows how different parts of the globe angle toward the sun at different times of the year. For example, in the Northern Hemisphere in December, it is winter because it is tilted away from the sun.



1. What season would it be in the Northern Hemisphere in late June? _____
2. Explain how the tilt of Earth's axis effects the seasons. _____
3. What kind of temperatures would you expect if an area is getting indirect sunlight?

   _____
4. When is it winter in the Southern Hemisphere? _____
5. Explain why there are usually mild temperatures during spring and fall.

   _____

   _____

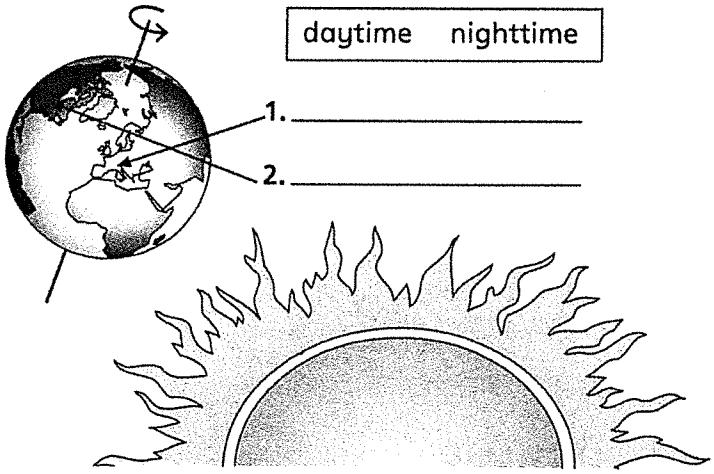
   _____

SCIENCE

The Earth. Rotation and Revolution.

The Earth has two movements: rotation and revolution. **Rotation** is the movement of the Earth on its axis. **Revolution** is the movement of the Earth around the Sun.

1 Label.

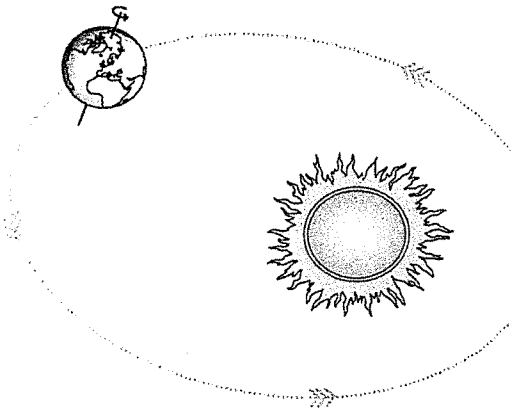


Daytime and nighttime

The Earth rotates on its axis. This movement is called rotation. The Earth takes 24 hours to rotate completely. In the half of the Earth that faces the Sun it is daytime. In the other half it is nighttime.

2 Write.

summer	short	June
365	March	long



The Four Seasons

The Earth orbits the Sun. This movement is called revolution. The Earth takes (1) _____ days and six hours to orbit the Sun. The Earth's axis is at an angle and this gives us the four seasons: spring, (2) _____, autumn and winter. In the northern hemisphere summer starts on 21st (3) _____ and finishes on 22nd September. In summer the days are very (4) _____. When it is summer in the northern hemisphere it is winter in the southern hemisphere.

Winter starts on 21st December and finishes on 20th (5) _____. In winter the days are (6) _____. When it is winter in the northern hemisphere it is summer in the southern hemisphere.

3 True or false?

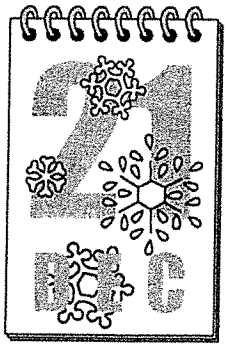
1 The Earth takes 365 days and 6 hours to rotate on its axis. _____

2 When it is daytime in Spain, it is nighttime in some other countries. _____

3 Rotation and revolution are the two movements of the Earth. _____

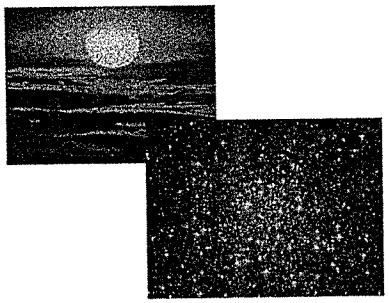
4 Spain is in the northern hemisphere. _____

5 In the northern hemisphere the days are short in summer. _____



K5 Learning

Objective Concepts (gravity, climate, solar system, hydrogen, helium, elements, ultraviolet rays, cluster, galaxy, Milky Way Galaxy); Sight words (surface, core, dangerous, causes, amount, glowing, tiny, twinkling)

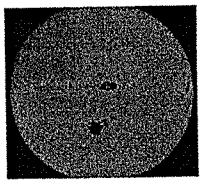


Vocabulary	
surface	amount
core	glowing
dangerous	tiny
causes	twinkling

The Sun and the Stars

By: Sue Peterson

Scientists know many things about the Sun. They know how old it is. The Sun is more than 4½ billion years old. That would be too many candles to put on a birthday cake!

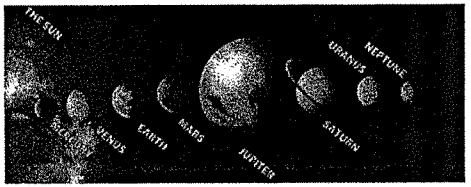


They also know the Sun's size. The Sun may seem small, but that is because it is so far away. It is about 93 million miles (150 million kilometers) away from the Earth. The Sun is so large that the diameter of the Sun is 109 times the Earth's diameter. The Sun also weighs as much as 333,000 Earths.

The Sun is made up of gases: 75% hydrogen and 25% helium. Hydrogen is the simplest and lightest of all of the known elements. When you combine hydrogen with oxygen, you get water. You probably know what helium is. It is the gas that can be put into balloons to make them stay in the air and float.

Scientists also know the temperature of the Sun. The surface of the Sun is about 10,000 degrees Fahrenheit (5,600 degrees Celsius). That might sound hot, but the Sun's core is even hotter. The core is the central region where the temperature reaches about 27 million degrees Fahrenheit (15 million Celsius).

The Sun is the center of our Solar System. Besides the Sun, the Solar System is made up of the planets,



moons, asteroid belt, comets, meteors, and other objects. The Earth and other planets revolve around the Sun.

The Sun is very important. Without it, there would be only darkness and our planet would be very cold and be without liquid water. Our planet would also be without people, animals, and plants because these things need sunlight and water to live.

The Sun also gives out dangerous ultraviolet light which causes sunburn and may cause cancer. That is why you need to be careful of the Sun and wear sunscreen and clothing to protect yourself from its rays.

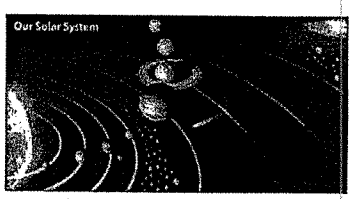
Scientists have learned many things about the Sun. They study the Sun using special tools or instruments such as telescopes. One thing they do is to look at the amount of light from the Sun and the effect of the Sun's light on the Earth's climate.

The Sun is actually a star. It is the closest star to the Earth. Scientists also study other stars, huge balls of glowing gas in the sky. There are over 200 billion stars in

the sky. Some are much larger than the Sun and others are smaller than the Earth. They all look tiny because they are so far away from the Earth. This distance is measured in light-years, not in miles or kilometers. (One light-year is equal to the distance that light travels in one year. This is about six trillion miles or ten trillion kilometers!)

Stars look like they are twinkling because when we see them, we are looking at them through thick layers of turbulent (moving) air in the Earth's atmosphere. That is why the words are written in the song: *Twinkle, Twinkle, Little Star.*

Stars have lifetimes of billions of years. They are held together by their own gravity. Over half of the stars in the sky are in groups of two. They orbit around the same center point and across from each other. There are also larger groups of stars called clusters. These clusters of stars make up galaxies. Our Solar System is located in the Milky Way Galaxy.



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C. Matching. Draw lines between the words and what they mean.

1. gravity	a. the kind of weather a place has
2. climate	b. the Sun and everything that revolves around it
3. solar system	c. a force which tries to pull two objects toward each other
4. hydrogen	d. the central region
5. helium	e. the simplest and lightest of known elements
6. elements	f. an element in air that can be used to inflate balloons
7. core	g. a number of things together
8. ultraviolet rays	h. simple substances from what things are made
9. cluster	i. light from the Sun that can harm

Multiple-Choice Questions (Put an X in front of the correct answer.)

1. What is **one comparison** the author makes about the size of the Sun?
   - ☐ a. There is darkness without the Sun.
   - ☐ b. The diameter of the Sun is 109 times the Earth's diameter.
   - ☐ c. Scientists study the Sun with special tools.
   - ☐ d. The Sun is 93 millions miles away.

2. What is the **main idea** of this text?
   - ☐ a. The Sun and stars are fun to look at.
   - ☐ b. The Sun and stars are far away.
   - ☐ c. The Sun and stars are larger than you think.
   - ☐ d. The Sun and stars are described so you can learn more about them.

Practice

Language Work

A. Fill in the blank and spell.

surface	s __ __ f a c __	_____
core	c __ __ e	_____
causes	c __ __ s e s	_____
amount	a m __ __ n t	_____
tiny	t __ n __	_____

B. Use each word in a sentence. Underline the word used.

dangerous _____

_____.

glowing _____

_____.

twinkling _____

_____.

2. Why do scientists feel it is important to study the Sun?

3. Why does the Sun look so small, but it is really large?

3. What does the text say about the size of stars?
   - ☐ a. They are all the same size.
   - ☐ b. They are all small and you can see them twinkle.
   - ☐ c. Some stars are larger than the Sun and others are smaller than the Earth.
   - ☐ d. They are all smaller than the Sun.

Definitions (Write the meaning of each word as it is used in the text.)

1. surface

2. glowing

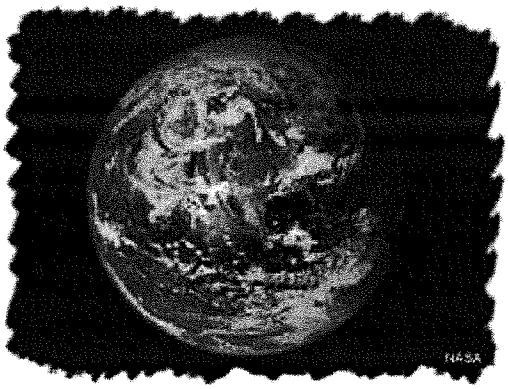
3. twinkling

Extended Response (Answer in complete sentences.)

1. Why do you think the author included a section on the Sun and another section on stars in the same text?

About The Earth

Let's get the basics out of the way. The Earth is the third **planet** from the Sun. We all live on Earth and it is currently the only planet where evidence of life exists. As we discover more planets in other systems, we are finding a variety of worlds that might support life. However, we have no direct evidence for life anywhere else in the Universe.



THE EARTH AS SEEN FROM SPACE.

Of the eight planets in the Solar System, the Earth is one of the inner planets and is made of rock and metal. You may also hear it described as a **terrestrial** planet as opposed to gas giants that include Jupiter and Saturn. Because of our distance from the Sun and our atmosphere, we exist in a very narrow temperature range that allows water to exist in solid, liquid, and gas states across the planet. We live in the "**Goldilock's Zone**" or for those of you who will become scientists... the **circumstellar habitable zone**.

Life has developed over billions of years because liquid water is present across our planet. What else makes the Earth special? We have an **atmosphere** made up of nitrogen (N_2), a relatively inert gas. If we had clouds of sulfuric acid (H_2SO_4) or methane (CH_4), life may never have developed. Venus is a planet with sulfuric acid clouds while Saturn's moon, Titan, has methane in its atmosphere.

The Plates and Mantle

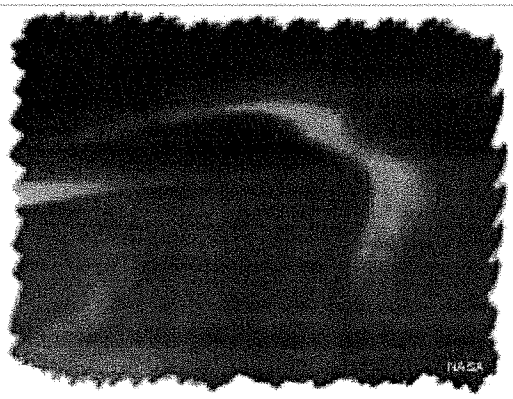
You will learn about the several layers of the planet in class, but you will spend your whole life on the **lithosphere**. The lithosphere is the solid surface layer of the planet. It is a cool crust that surrounds the liquid and solid interior of Earth. You will probably spend your life above water which means you will live on a group of large landmasses or rock plates.

The rock plates that float across the surface of the Earth are called **tectonic plates**. Those plates float on the **mantle**, an area between the core and the crust. While the mantle is able to move in a very slow way, it is basically solid. It is a very special solid that is able to deform and move. It's super-hot, but not hot enough to be liquid rock. There are places where magma

seeps to the surface, but the mantle is basically a plastic-like solid that can slowly swirl and move around the planet.

Liquid and Solid in the Core

The core of the Earth has two distinct regions. There is a liquid outer core and a solid inner core. Both layers of the core are made of iron and nickel. The inner core is a giant furnace at super-high temperatures and pressures. The flowing metal of the outer core helps create a **dynamo effect**. Dynamos can create large magnetic fields. In the case of the Earth, the **magnetic field** protects our planet from space, **solar winds** and solar radiation.



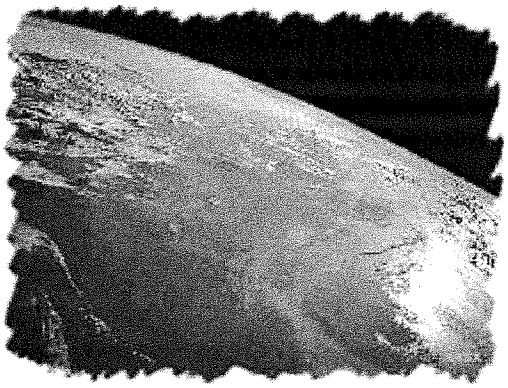
THE AURORA BOREALIS AS SEEN FROM THE ISS ORBITING EARTH.

Scientists have also discovered that the pressure and temperature increase as you move towards the center of the planet. The **outer core** of the Earth has extreme temperatures and pressures that keep iron (Fe) and nickel (Ni) molecules in a liquid state. Current evidence suggests that the inner core is 6,000 degrees Celsius (10,800 degrees Fahrenheit). The mantle has a range of 500 to 4,000 degrees Celsius (900-7200 ^{o}F). Room temperature is about 23 degrees Celsius (74 ^{o}F).

The **Aurora borealis** and **Aurora australis** are locations above the north and south poles where solar winds collide with the **magnetosphere**. The colors of the aurora change when different types of molecules in the atmosphere are hit by the charged particles from the sun.

Up in the Sky

What is the sky? What is air? What is the atmosphere? The **atmosphere** is a thin layer of **gases** that surrounds the Earth. It seals the planet and protects us from the vacuum of space. It protects us from electromagnetic radiation given off by the Sun and small objects flying through space such as meteoroids. Of course, it also holds the **oxygen** (O_2) we all breathe to survive.



THE ATMOSPHERE IS ONLY A THIN LAYER OF GASES SURROUNDING OUR PLANET.

In the same way that there are layers inside of the Earth, there are also layers in the atmosphere. All of the layers **interact** with each other as the gases circulate around the planet. The lowest layers interact with the surface of the Earth while the highest layers interact with space. On your level, you may feel the atmosphere as a cool breeze. Other times you will feel it as a hot or humid day that seems to push on you from all sides.

An Envelope of Gases

When compared to the **diameter** of the Earth, the atmosphere is very thin. The thickness of the atmosphere is a balance between the **gravity** of the Earth and energetic molecules that want to rise and move towards space. The molecules in the upper layers of the atmosphere become excited as energy from the Sun hits the Earth. The molecules in the lower layers are cooler and under greater **pressure**.

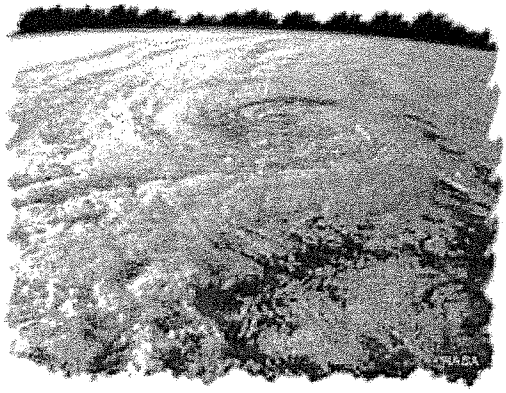
If the Earth were larger, the atmosphere would be **denser**. The increased mass and related gravity of a larger planet would pull those gas molecules closer to the surface and pressure would increase.

The atmosphere is more than just layers of gases surrounding the planet. It is also a moving source of life for every creature of the planet. While the majority of the atmosphere is **composed** of nitrogen (N_2) molecules, there are also oxygen and carbon dioxide (CO_2) which plants and animals need to survive. You will also find ozone (O_3) higher in the atmosphere which helps filter harmful ultraviolet radiation from the Sun. The atmosphere also

protects us from the vacuum and cold of space. Without our atmosphere, the Earth would be as barren and dead as the Moon or Mercury.

Connecting Climates

There is no single **climate** of the planet. Specialized climates are found in areas all over the planet and might include deserts, rainforests, or polar regions. The common trait of all of these climates is the atmosphere. The atmosphere **circulates** gases and particles between all of these regions.



HURRICANES ONLY SHOW UP IN CERTAIN CLIMATE TYPES.

The hot air from the equator eventually moves north or south to other climate regions. That warmer air combines with cooler air, mixing begins, and storms form. The constant mixing of the atmosphere maintains a stable system that helps organisms survive. Oxygen will never run out in one area of the planet and **temperatures** will not skyrocket in another. The atmosphere balances the possible extremes of the Earth and creates an overall stability.

A great example is seen in the way **tropical cyclones** (hurricanes) form over the Atlantic Ocean. Because of global atmospheric circulation, systems start over the Sahara Desert in Africa, move across the west coast of northern Africa, pick up large amounts of water as they pass over the warm Atlantic Ocean and Caribbean Sea, and finally dump all of the rain on the Caribbean or south eastern coast of the United States. In addition to the stormy weather, the atmosphere can also carry dust and particles from the Sahara to North America.

LESSON 35

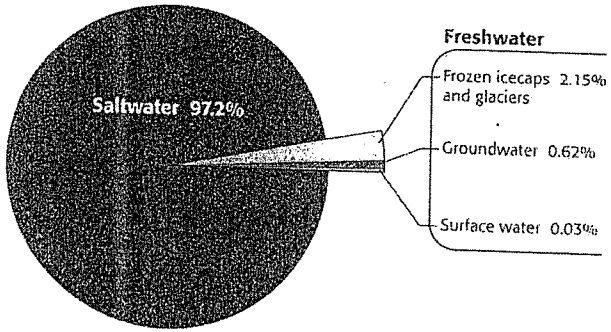
Water

Where is Earth's water located?

Water covers about $\frac{3}{4}$ of Earth's crust. Almost all of Earth's water is saltwater. Most of that saltwater is in the oceans.

Less than 3% of Earth's water is freshwater. Most of that freshwater is frozen in ice caps and glaciers. **Ice caps** are thick sheets of ice that cover areas around the North and South Poles. **Glaciers** are slow-moving rivers of ice.

Less than 1% of Earth's water is liquid freshwater. Liquid freshwater is found in groundwater and surface water. **Groundwater** is water that collects underground. **Surface water** includes lakes, ponds, rivers, and streams. A very tiny percentage of Earth's freshwater is in the form of water vapor in the atmosphere.



Earth's hydrosphere, or all of Earth's water

Show What You Know

Match the terms that describe each other.

1.	_____ Groundwater	a.	lakes and streams
2.	_____ Surface water	b.	oceans
3.	_____ Saltwater	c.	ice caps and glaciers
4.	_____ Frozen water	d.	underground water

Water Source	Percent of fresh water	Percent of total water
Oceans, seas & bays	–	96.6
Ice caps, glaciers & permanent snow	68.7	1.74
Groundwater	–	1.69
fresh	30.1	0.76
saline	–	0.93
Soil moisture	0.05	0.001
Ground ice and permafrost	0.86	0.022
Lakes	–	0.013
fresh	0.26	0.007
saline	–	0.006
Atmosphere	0.04	0.001
Swamp water	0.03	0.0008
Rivers	0.006	0.0002
Biological water	0.003	0.0001

Of all the water on Earth, only a small percentage is drinkable, fresh water.

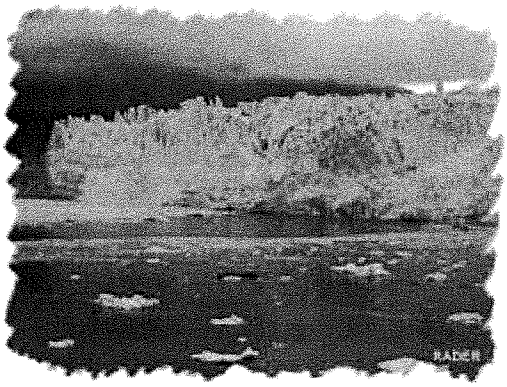
Water, Water, Everywhere

A GOOD PORTION OF THE EARTH'S WATER IS FOUND IN THE OCEANS.

Water is everywhere on Earth. About seventy percent of the surface of the Earth is covered by water. If you were an alien visiting the planet, you would see a giant blue sphere from space (especially on the Pacific Ocean side). Not only is water everywhere, but all life depends on water. The tiniest bacteria and the largest dinosaurs have all needed water. The **hydrosphere** is the world of water that surrounds all of us.

Because water is so important, it makes up an entire section of the earth sciences. You will probably hear the term "**hydro**" many times. The prefix "hydro" has origins in ancient Greek. You will learn about hydrologists that study water and the way it is used and circulated across the planet. Hydrology is the study of water. That water may be at the bottom of the ocean or in clouds found in the **atmosphere**. Anything related to water is a part of the hydrosphere.

Importance of Liquid Water



WATER MOLECULES CAN BE LOCKED IN GLACIERS FOR MILLIONS OF YEARS.

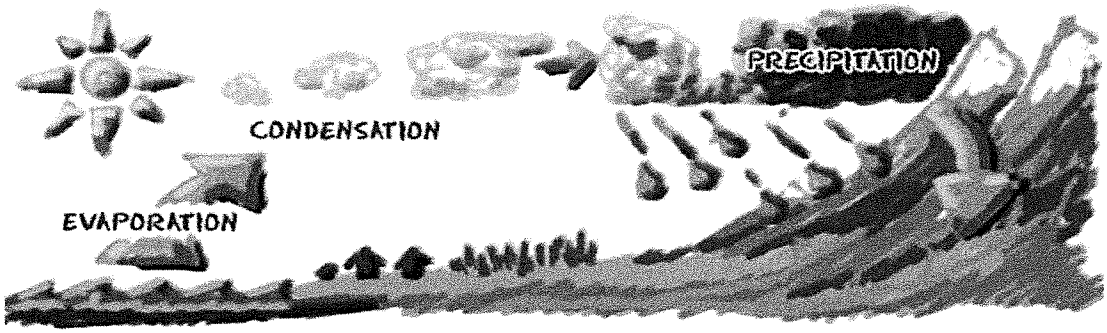
Water is in the air, on the land, between the rocks, and in every living thing. Water, in its purest form, is the compound **H_2O**. There are two **hydrogen** (H) atoms bonded to one **oxygen** (O) atom. Generally, you won't find pure water. There are usually other compounds, ions, or particles **mixed** with water. While water may move and carry other substances with it, you need to remember that the small water molecules are the things that make life on Earth possible.

Liquid water makes the Earth a special place. Our planet has a very nice temperature range that allows water to remain in a liquid state. If we were a colder place like Pluto, all of the water would be permanently frozen and

solid. On the other hand, if we were on a very hot planet, all of the water would be in a gas state. **Water vapor** and solid water are relatively useless to the organisms of Earth.

Things get interesting when you start to have a system with solid, liquid, and gas states of water. Because all of the states exist on Earth, they are all important to scientists. There are solids in the deep **glaciers**, liquids of the **oceans**, and the vapor state of **clouds**. While there might not be a lot of life in or on those glaciers, they will eventually melt. Once they melt, they start to affect all of the life on Earth. All of the physical states are equally important because they are all connected.

The Life of a Water Molecule



THE WATER CYCLE RELIES ON PHASE CHANGES TO MAKE RAIN.

Let's say you're a water molecule. For this example we'll assume you are staying a water molecule and not combining with other compounds. We're going to have you move through the **hydrologic cycle**. You'll start by sitting on the surface of the Pacific Ocean. All of a sudden you are filled with energy, **evaporate**, and move up into the atmosphere.

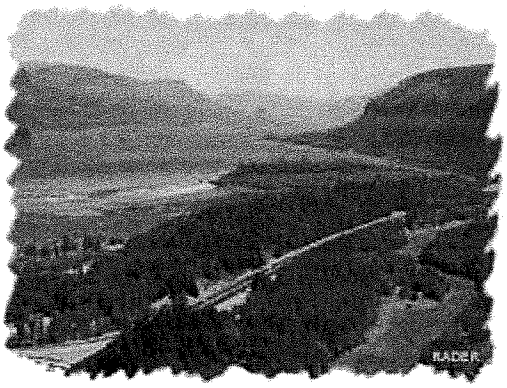
Winds are moving and you see yourself flying over the ocean towards land. Things start to get cold and all water vapor around you begins to **condense**. You all clump together and now you're too heavy to stay in the clouds. You fall to the surface in a raindrop. If you are one of the first drops to fall, you might be **absorbed** into the soil. If you are at the end of a storm, you might wind up in **runoff** and drain into a **river**. From that river you could flow all the way back to the ocean and start your journey over again.

How much time does your journey take? Scientists think that if you are lucky enough to evaporate into a cloud, you spend about ten days floating around the atmosphere. If you're unlucky enough to be at the bottom of the ocean, **percolate** into an **aquifer**, or get stuck in a glacier, you might spend tens of thousands of years without returning to the hydrologic cycle. As of 2013, the oldest ice ever found was about 800,000 years old. That's a long time to stay out of the water cycle.

NEXT STOP ON SITE TOUR

A Big Ball of Life

The **biosphere** is all about life. Physical geographers use the term biosphere to describe our living world. All of the microbes, plants, and animals can be found somewhere in the biosphere. The biosphere extends to the upper areas of the **atmosphere** where birds and insects can be found. It also reaches to dark caves deep in the ground or to the bottom of the **ocean** at **hydrothermal vents**. The biosphere extends to any place that life of any kind might exist.



ATMOSPHERE (SKY)
HYDROSPHERE (RIVER)
BIOSPHERE (TREES AND LIFE)

The biosphere is the crossroads of all the other earth science spheres you will study in class. Think about the possible interactions for a second.

- The land of the **lithosphere** interacts with the oceans of the **hydrosphere** at the coastlines. The coasts are teeming with life such as fish, birds, invertebrates, and mammals.

- The land also interacts with the air of the atmosphere and different **climates**. Rising mountains cool the air and force clouds to drop their water, leading to rain for forests of trees and rivers filled with fish.

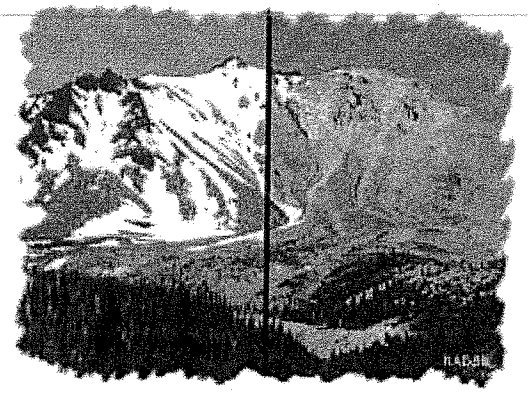
- There is even interaction between the forces deep in the Earth and **energy** coming to the Earth from space. Volcanic vents under the seas are surrounded by life.

All of these interactions create the variety in our living world.

Big, Small, and the Smallest Factors

Many factors affect the biosphere and our life here on Earth. There are large factors such as the distance between the Earth and the Sun. If our planet were closer to the Sun, it might be too hot to support life. If we were further away, it might be too cold. The **tilt** of the Earth is just as important. **Seasons** and seasonal climate changes are direct results of the tilt of the Earth towards or away from the Sun. Summer months allow half of the planet to warm while the other half cools. Six months later, the

temperatures shift in the opposite direction.



SEASONAL CHANGES ARE APPARENT IN THIS SPRING AND SUMMER COMPARISON.

Smaller factors also act on the biosphere. If you were to watch a piece of land that was only one square mile (or kilometer), you would see the influence of climate, daily weather, and **erosion**. These smaller factors change the living space and organisms must react accordingly. For example, how would a family of gophers react if their burrow gets washed away in a mudslide? Even though humans are able to control much of their immediate environment, they are still vulnerable to weather and **earthquakes**.

The smallest of factors in the biosphere work on a molecular level. **Chemical erosion** is a great example of a landscape changing one molecule at a time. **Oxidation** and **reduction** reactions change the composition of rocks and organic materials. There is also **biological erosion**. Tiny organisms, such as bacteria and fungi, are constantly working to break down organic and inorganic materials.

Climate Basics

What is a **climate**? Is it weather? Is it the rain? Is it a hot day in August? Yes, yes and yes, but only in one place at a time. Climate is a general **atmospheric** condition in a certain location near the surface of the Earth.

MARINE WEST COAST CLIMATE FROM WASHINGTON STATE.

Is the **Aurora Borealis** (Northern lights) a climate? No. It may be in the sky, but it's not related to climate or weather.

Is climate the same as weather? No. Climate is a **long-term** concept. Climatologists study the weather patterns over decades and even centuries to understand the way a climate is supposed to behave. **Weather** is happening today or this week. If you live on the California coast, you live in a **Mediterranean** climate region. Climate will tell you to expect warm and dry summers, but it cannot tell you the years you will definitely have a drought.

Is there such a thing as a global climate? Yes... Kind of. The global climate is all of the climates of the planet added up. If the entire Earth was getting warmer you would have to say, "All of the global climates are increasing in temperature." You will probably hear a lot about **global climate change**. However, that global change will affect each climate type differently. There might be more or less rain, stronger or weaker storms, or other possible changes with an increase in temperature.

Climate Variety

There are many types of climates across the Earth. You live in one of them or on the border between two. Every year as the **seasons** change, your climate changes a bit. It might get warmer or colder. You might have more or less rain. You might have more or less sunlight that changes all of that other stuff.

Moving and Flowing

As you have learned about the biosphere, **biomes**, and specific **ecosystems**, we have been mentioning the cycles all around you. Whether you look at the food chain or the growth and reduction of populations, ecosystems are always shifting and changing. Forests have spring when plants bloom, autumn when they lose leaves, and winters in the snow. The cycle begins again the next spring.

IT MAY LOOK LIKE A LAKE. BUT IT'S DEATH VALLEY AFTER A BIG THUNDERSTORM.

There are also cycles for the components and the pieces that keep everything alive. There are cycling and flowing **nutrients**, molecules, and **energy**. For example, we have mentioned the water cycle several times. Water evaporates, condenses in clouds, falls as rain, and often returns to the oceans. Biogeochemical cycles cover all of the cycles on Earth that relate to biological, geological, and chemical factors.

Bio-Geo-Chemical

Wow. Talk about a word that describes everything on Earth. The world's cycles all fall under the big grouping of biogeochemical cycles. Let's break it down.

BIO: Biology. Life. Living things. The biological elements of these cycles play a role in the lives of organisms. The cycles might limit the organisms of Earth or they might happen alongside, changing the environment. For example, when **oxygen** (O) is found in you or in a plant, it is in the biological phase of its cycle. When a substance is in this portion of a cycle, it is in a **biotic phase**.

GEO: Earth. **Rocks**. Land. Air. The 'geo' portions of the cycles refer to the non-living or abiotic phases. For example, oxygen cycles through many systems. When oxygen winds up in rocks as iron oxide (FeO) or a crystal, it is in the 'geo' part of its cycle.

CHEMICAL: Molecules. Reactions. Atoms. These are the chemical factors involved in the cycles. Complete molecules are not always passed from one

point to the next. **Chemical reactions** change the molecules by building and breaking chemical bonds. These chemical interactions may be small, but they are very important.

THIS FOREST FIRE RELEASES CARBON FROM THE TREES AND SPREADS IT FOR MILES.

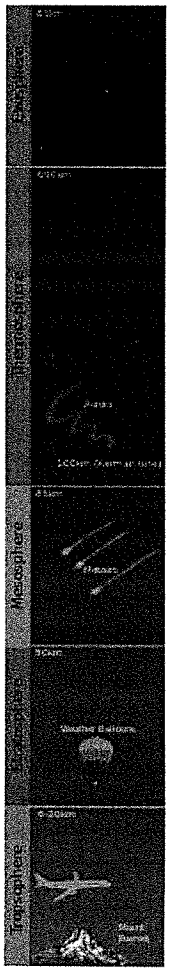
Oxygen, for example, is included in all **oxidation** reactions. One minute oxygen might be in the air and then it is involved in rusting an iron pipe. **Carbon** (C) offers another important example of chemical factors involved in a cycle. Carbon dioxide (CO_2) is found in the atmosphere. It is 'fixed' into sugar molecules when plants go through photosynthesis. It moves from an inorganic form to an organic and biologically useful form.

Most of the cycles we discuss will involve the **recycling** of molecules and nutrients that can be used in systems over and over again. You need to remember that all cycles involve biological, geological, and chemical elements.

Earth Systems

The Earth system is quite complex. Scientists have divided it into four major geological subsystems that make up the natural environment of Earth. These subsystems are sometimes referred to as ecospheres.

The four main ecospheres are the atmosphere, the biosphere, the hydrosphere and the geosphere.



Atmosphere -- the mixture of gases that surround the planet The atmosphere is divided by altitude into different layers. You can see the layers of the atmosphere to the right.

Geosphere -- the solid portions of Earth and the layers within the Earth. See the illustration below.

Biosphere -- all life on Earth. in other words all living organisms on Earth, including those on the land, in the water, and in the air. Within the biosphere, living things form ecological communities based on the physical surroundings of an area. These communities are referred to as **biomes**.

Hydrosphere – all water found on, under, and over the surface of Earth

> **Cryosphere** – those portions of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground

All four major geological subsystems of Earth can function independently from each other, but there is often interaction between them.