Fontana Unified School District

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Offline Distance Learning

Secondary

Grade 6 Science

6th Grade Earth & Space Science

Unit 3: Atmosphere/Hydrosphere: Cycles of Matter History of the Earth

Performance Expectation: MS-ESS2-4

Lesson Outcomes:

- By the end of the lesson, students should be able to:
- Describe the main processes of the water cycle.
- Explain how the force of gravity and energy from the sun drive the water cycle.
- Explain how weather is related to water cycle processes.
- Explain how energy from the sun drives wind and water currents.
- Explain how energy from the sun is distributed around the globe.

Activity 1

A. Quick Write (2-4 Mins)

   What Do You Know about Energy Transfer and the Water Cycle?

B. Reading Ocean Motion PDF
   Air moves as a current, just like water currents flow through the ocean. The global wind patterns are determined by the same principles that cause global ocean currents to flow, and these are also the same principles that cause water to cycle throughout the atmosphere! So what is the principle behind all of this energy transfer? (Hint: It has to do with thermal energy—heat—from the sun.)

   One way to start thinking about this principle is to think about what happens when you heat a pot of water. What happens to the water in the pot when the water begins to boil? If you observe carefully, you can see there is a pattern of movement in the pot. What kind of pattern of movement do you think takes place inside a pot of heated water? How might this be similar to how wind and water systems flow throughout Earth's surface? In this concept, you will learn about how water, wind, and thermal energy from the sun cycle about Earth's surface.

SCRAPBOOK Ocean Motion

Wave Hello

All waves, no matter how large, start as rough spots—cat's paws—on the surface of the water. At winds over six knots, waves start to build. The harder the wind blows, the bigger the waves get. Such waves are called gravity waves. If waves become too steep to support themselves, they start to break. In shallow water, waves break because the bottom slows the waves down. In deep water, the wind builds the waves up so fast they collapse under their own weight. In the case of a boat in a breaking wave, the boat will become part of the curl. It will either be flipped end over end or shoved backward. Pressures of six tons per square inch have been measured in breaking waves.

—From *The Perfect Storm*, by Sebastian Junger

Highest Wave Ever Measured:

112 feet (34 m) by the U.S. Navy Tanker *Ramapo* off the coast of Russia in 1933.

Wave Words

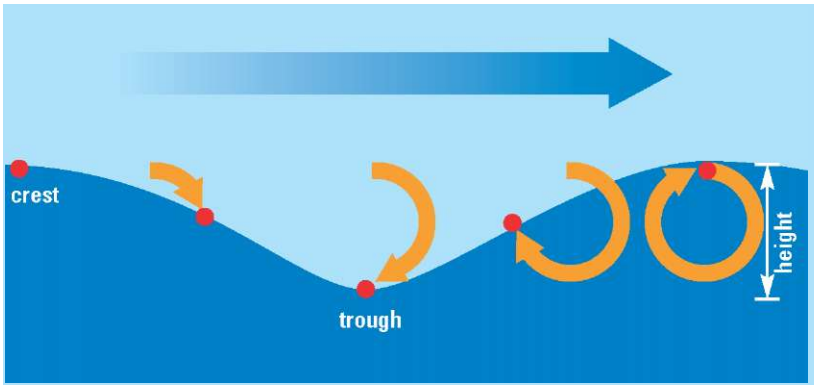
Crest: Highest point of a wave

Trough: Lowest point of a wave

Height: Vertical distance between the trough and the crest

Breaker: Wave that breaks apart as it approaches land, producing surf

Swell: Large, smooth wave



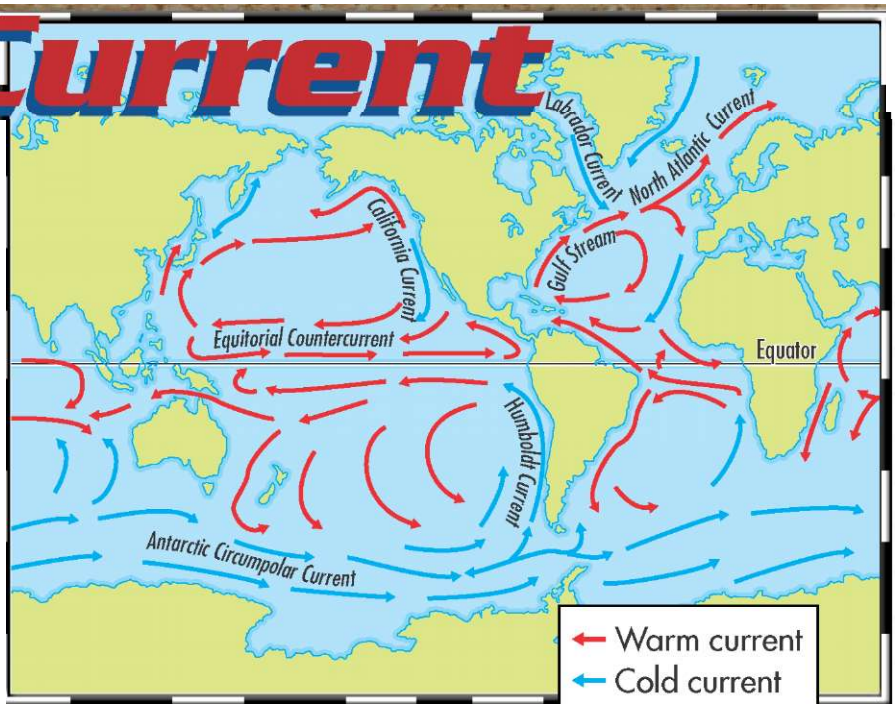
Hey, Dude! The Killer Waves of Maui

Waves and currents are two additional ways that water moves. Of the two, currents are the long-hard movers, although waves are real shakers.

About once a month storms in the North Pacific send swells south toward the Hawaiian Islands at about 50 mph (80 kmph). One island in the chain, Maui, has a huge underwater ridge extending about a half mile (.8 km) from its north shore. When the swells reach the shallow water they begin to break. And do they ever break! The speed of the waves is cut to about 25 mph (40 kmph). But they also begin to rise to more than 50 feet (15 m) as they approach the shore. It's like skiing down a five-story building. "When you fly down one of these waves, it's not a wave anymore," says one surfer. "It's a mountain moving 25 miles an hour."

It's Current

Current: A mass of moving water, called a river of the sea. Comes in two kinds: surface and subsurface. Surface currents extend only a few hundred feet below the surface. These currents occur when winds blow across the ocean causing the waters to move. When the surface water moves, deeper water rises to replace it, forming a subsurface current. These currents run deep beneath the surface and at some point turn and flow toward the surface. This is known as upwelling, the movement of cold water from the deep ocean up to shallower depths. Upwelling brings water that contains nutrients called plankton to the surface where fish and other living creatures can feed on them.



Current Celebrities

Largest Current

Kuroshio Current, off the eastern coast of Japan, is about 3,300 feet (1,000 m) deep. Because of its dark waters it is known as the "black current."

The Gulf Stream

Runs northeast from Florida as far as North Carolina, then flows across the Atlantic as far north as England. Moves 60 miles (100 km) a day and carries 100 times as much water as all of the rivers on Earth. One of the first people to draw a chart of the Gulf Stream was Benjamin Franklin. Warm water from the Gulf Stream reaches the southern coast of Iceland. The water warms Iceland enough so that the average winter temperature of the capital, Reykjavik, is higher than that of New York City.

El Nino

In a year with normal weather patterns, steady winds blow westward and push warm surface water toward the western Pacific Ocean. In some years, around Christmas time, winds weaken and warm water spreads over almost the entire tropical Pacific Ocean. This warm water prevents the upwelling of cool, nutrient-rich deeper water along the east coast of the Pacific. Fish die and severe climate changes take place. Rain follows the warm water eastward, causing drought in southern Asia and Australia and floods in North and South America.

La Nina

The reverse of El Nino. At the end of December, westbound winds grow stronger than usual, pushing warm water farther west than normal. This action allows hurricanes crossing the Atlantic to move farther west and to become more powerful than usual.

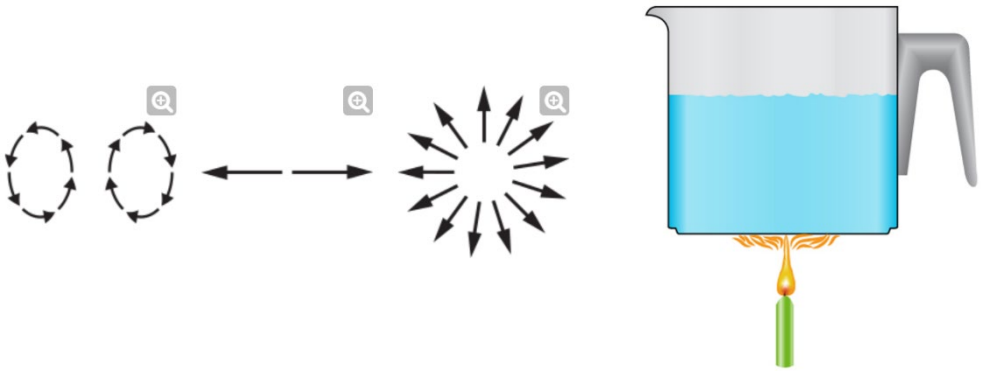
Activity

CATCH A WAVE Start collecting interesting tidbits about waves and currents in your own scrapbook. Look for magazine articles, pictures, and memorabilia.

C. Reflection Questions

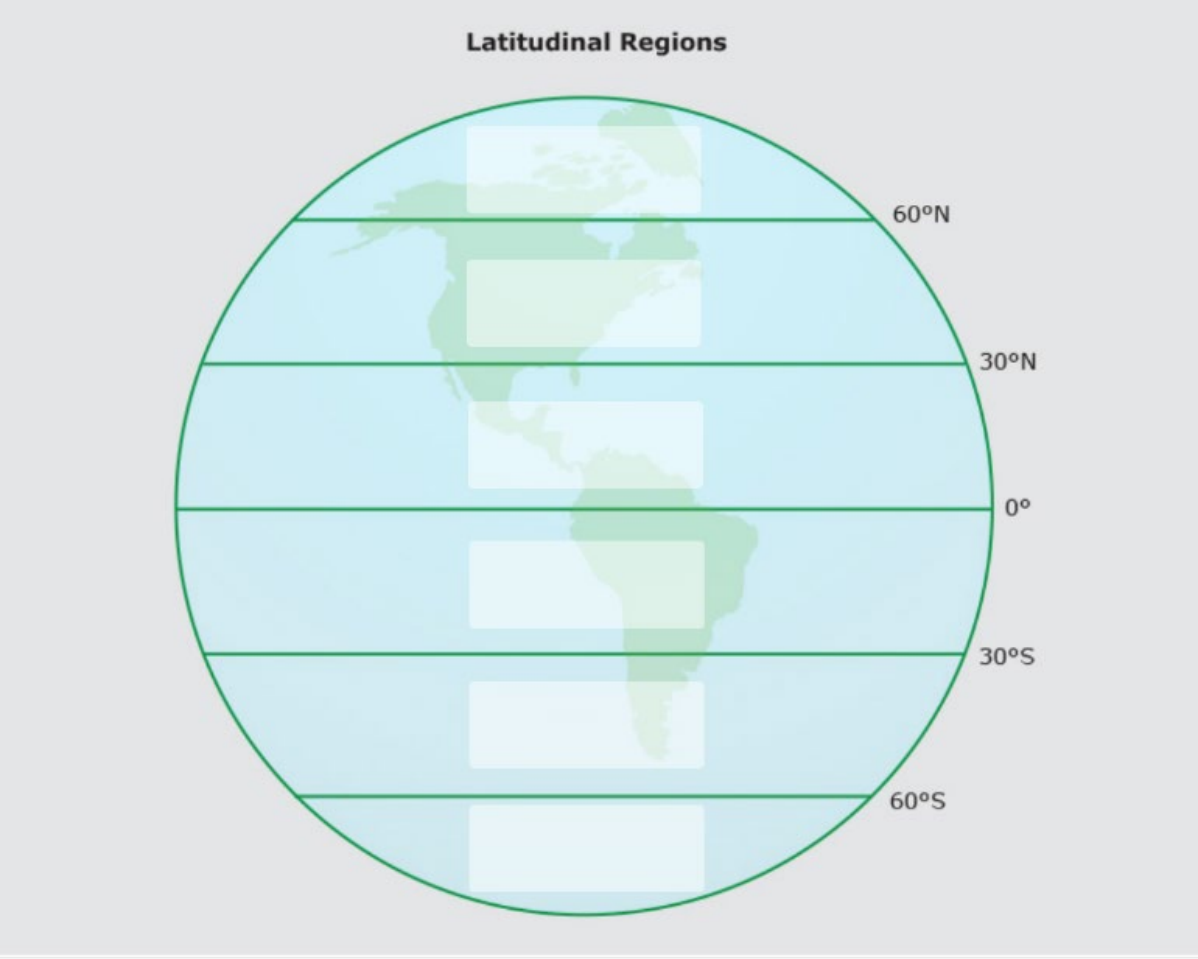
1. Heating Water

In the following image, a pot of water is being heated by a flame. Think about how warmer and cooler regions of water would move around this pot as it is heated. Which sets of arrows show the correct movement of warm and cool water regions?



2. Solar Energy Distribution

Look at the image of Earth below and think about how energy from the sun is distributed around the world. Which regions are hotter, and which are colder? Add labels (**Hottest Regions, Moderate Regions, or Coolest Regions**) to the appropriate temperature bands.



3. The Water Cycle

Some examples of different parts of the water cycle are listed below. Match each example with the correct part

Examples		Parts of the Water Cycle
A shallow river dries up.	○	○ Condensation
Snow falls on a cold afternoon.	○	○ Evaporation
Retreating glacier deposits drift.	○	○ Precipitation
Fog forms over a field in the morning.	○	○ Runoff

Activity 2

A. Quick Write (2 to 4 Mins)

How Do Solar Energy and Gravity Drive the Processes of the Water Cycle?

B. Reading Water Drop Odyssey

Energy and the Water Cycle

The most important source of energy that drives the water cycle is the sun. Solar radiation (sunlight) provides the energy that melts ice to produce liquid water and that causes evaporation of liquid water to form water vapor. The phase changes can also operate in reverse: water vapor releases energy as it condenses, and liquid water releases energy as it freezes to form ice.

Sunlight also provides the energy that causes winds. As Earth's surface absorbs sunlight, it heats up. This thermal energy in the ground and water is then transferred to the atmosphere by conduction and radiation. As air warms up, it becomes less dense than the surrounding air. The cooler air sinks, forcing the warmer air upward. This force, called buoyancy, pushes air up through the atmosphere. This process of transferring energy within matter that is moving is called convection. The low pressure beneath these rising air masses is filled further by cooler air rushing in from nearby areas, which causes wind. Some winds are global winds and blow almost continuously in roughly the same direction, while others happen as a part of local weather. Winds move air masses containing water vapor from place to place. Winds also cause ocean currents, which move liquid water (and thermal energy) to different locations on Earth.

Force and the Water Cycle

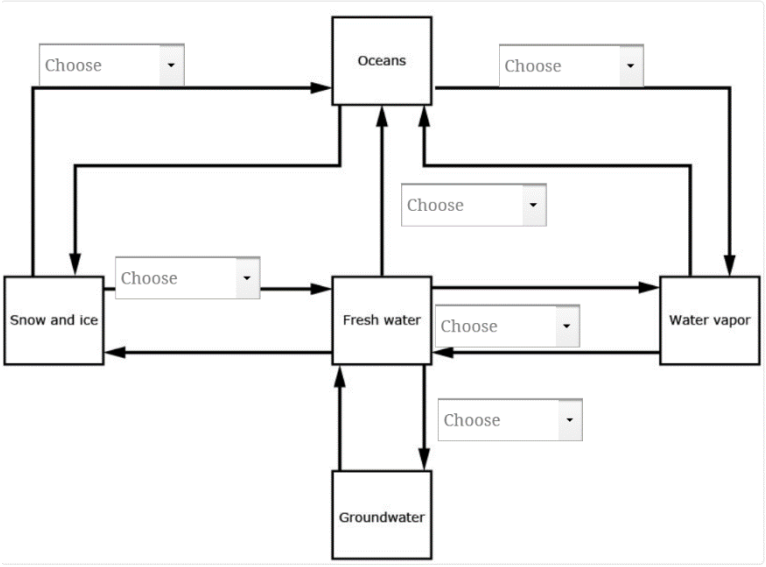
The basic forces that drive the water cycle are gravity and buoyancy. Gravity causes ice crystals and water droplets in clouds to fall to the ground or ocean surface. It causes liquid water to flow downhill in streams and rivers toward lakes and oceans. It causes solid water to flow in glaciers from higher elevations to lower elevations, where the water melts and flows on the land or enters the oceans. Gravity also causes liquid water to percolate down into the ground to the groundwater reservoir. Groundwater itself flows because of gravity from higher elevations to lower elevations, and it will return to the surface in a stream within a valley.

Buoyancy is the force present when a mass has less density than the fluid around it. A warm air mass is buoyant compared to the cooler air around it. As a result, the warmer air will be forced upward by the cooler air below it. Similar processes occur in the oceans with warm masses of water. Humid air is less dense than dry air, thus as water evaporates into the air, the air becomes less dense and rises. In both cases, currents result. In the atmosphere, we call these currents winds.

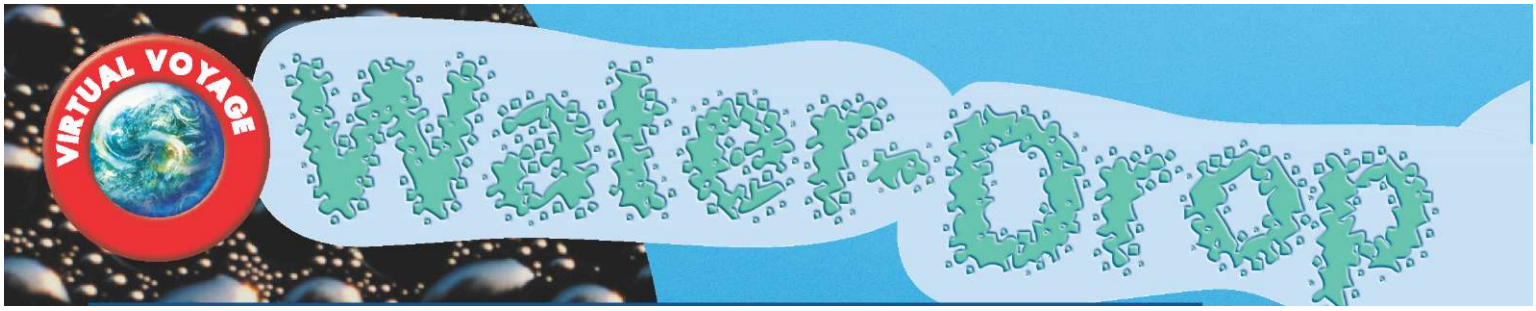
C. Reflection Question

1. Water Cycle Model

This model shows how water moves in its several states between reservoirs on Earth. Which process or force drives the movement that happens at each of the steps in the water cycle? Choices Gravity, Energy Loss, or Energy Gain.



2. Create your own water cycle model with words and pictures.



You are a molecule of water floating along in the Pacific Ocean with a quadrillion or so of your closest water-molecule friends. You've all been on Earth a long, long time—since before the dinosaurs . . . even before the first plants. Today, you and your friends have been bobbing near the ocean's surface. The Sun is beaming down and you're beginning to feel its energy transform you. You feel speeded up. Suddenly, you're no longer part of a liquid. And you're no longer in the ocean. You're a gas!

Life's a Gas

Up, up you go, rising like a balloon ... higher and higher. It's a giddy feeling, but it doesn't last and you're getting cold. You need to reconnect with a few of your old molecule friends and you find just the spot: a nice speck of dust. A bunch of you latch onto the dust and condense into tiny water droplets. You look around. There are billions more like your group, and together you have formed a rather impressive looking cloud. Then a wind comes up and blows you all northeast.

You hope to get back to the ocean before too long. After all, 97 percent of all the water on Earth hangs out there. But no such luck. You drift over land, and much of it is covered with ice. When a million or so of you get together, you're no longer lighter than air. The tug of gravity takes over. You fall, but slowly, as part of a snowflake.

Cold Landing

Wouldn't you know it! You land smack dab in the middle of a snow-covered mountain. More flakes pile on top of you. No choice but to relax and go with the icy flow. Time passes. Lots of it.

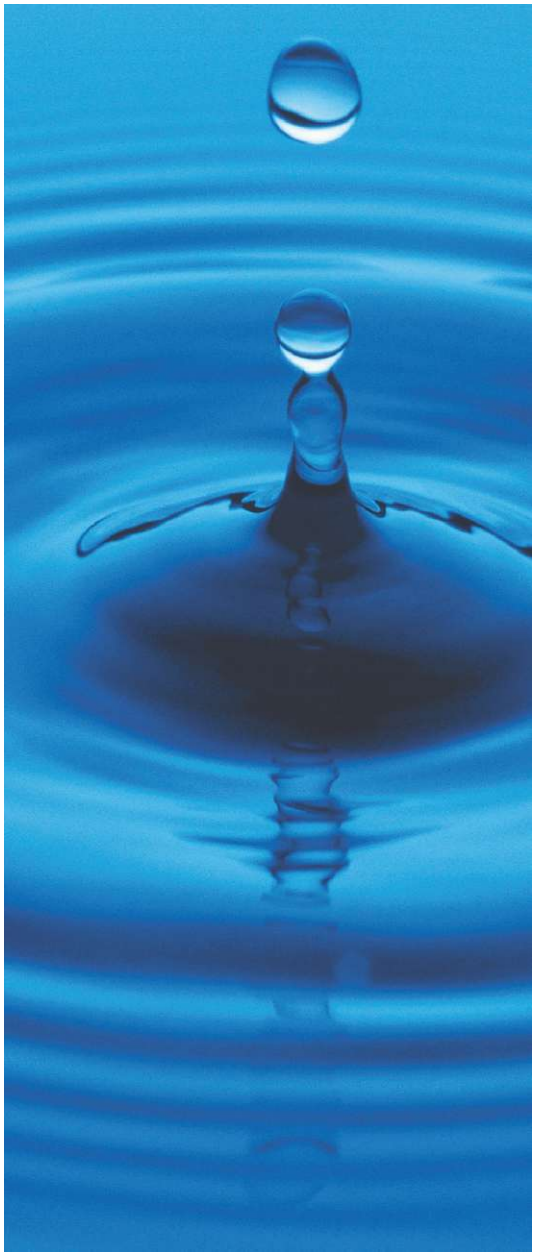
But then you start to feel the Sun again. Suddenly, you realize you've melted into flowing water! You have forgotten how much fun it is to slide down hills. You puddle into a pool and rest awhile until a huge hairy animal with big, curved tusks sucks you up into its snout. Twenty minutes later, you come out another end.

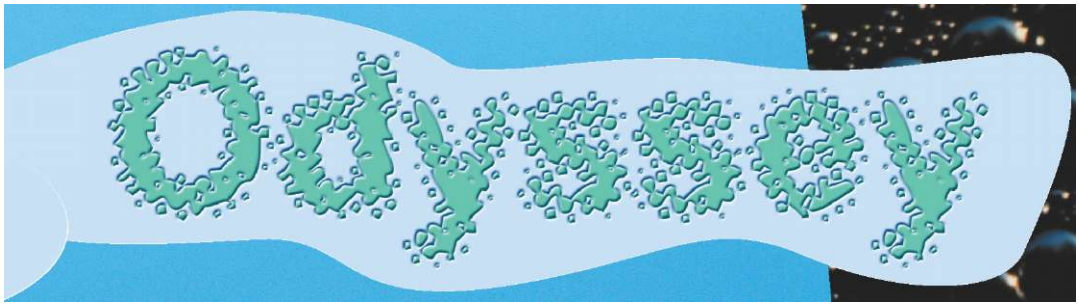
Goin' Down

This time you sink deep into the ground and nestle between chunks of soil and rock. You're in a huge underground reservoir called an aquifer. You know you're in for a long wait, but water molecules are patient, after all. Maybe a plant will absorb you into its roots, and you'll pass into the air again.

Ten thousand or so years pass.

One day, a big tube made of something you've never seen before drops into your quiet reservoir. You're sucked up into it and carried a long distance. Eventually, you leave the darkness and pour forth into a clear container of some kind. A strange, nearly hairless animal raises the container to its mouth, sloshes you around a bit, and spits you into a basin. Gravity pulls you down into another dark tube. What next?





Riding the Rapids

After a long dark ride, you follow gravity into a major river. You are homesick for that great big ocean. "What's the name of this river?" you ask your water-molecule mates. "The Rio Grande," one of them says. You shake your hydrogen bond, wondering what language that poor molecule was speaking.

You go with the flow for days and days. As you pick up more water mates, you also collect an assortment of weird chemicals. Not just salts and minerals and a bit of animal waste like before, but unfamiliar molecules that you can't break apart very easily. You detour through a few fish innards, but the fish become few and far between when the strange chemicals are strongest. Eventually, though, you begin to bump into old sea salts and you know your journey is nearly complete.

Full Circle

When you swoop into a shark's mouth as it clamps down on a fish, you realize you're really home. Those sharks have been around a long time. Gravity has led you back to Mother Ocean—this time, the Gulf of Mexico. You love being a part of this wonderful water world. And you take pride in knowing that without you—without water in all phases—the planet just wouldn't be the same. Life simply couldn't thrive in all its strange and wonderful forms.

But enough philosophy. You're free to splash around again as you please. It's time to just hang out for a few millennia and *flow* with the currents. One day you'll hop on the water cycle again, but for now, the Sun's out of sight and you just don't have the energy.

Activity

CYCLE IN A BOWL **To see up close how the water cycle works, add enough water to cover the bottom of a glass bowl. Cover the top of the bowl with plastic wrap. On top of the wrap, place an ice cube that has been wrapped in plastic or put in a sealable plastic bag. Set the bowl in a sunny window. Write a note about what you think will happen inside the bowl. Check your experiment after half an hour. Where did the water that collects on the underside of the plastic wrap covering the bowl come from? Write an explanation of what happened.**

C. Reflection Question

1. Water Cycle Model

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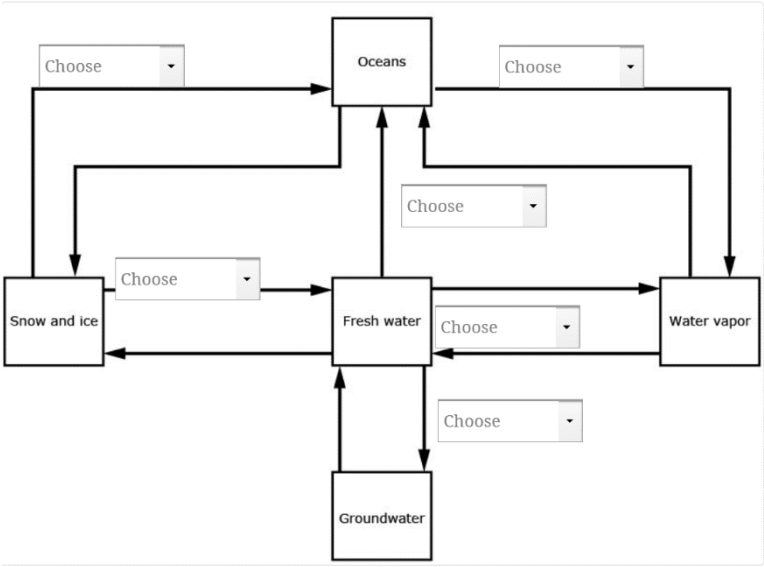


2. Create your own water cycle model with words and pictures.

Activity 3

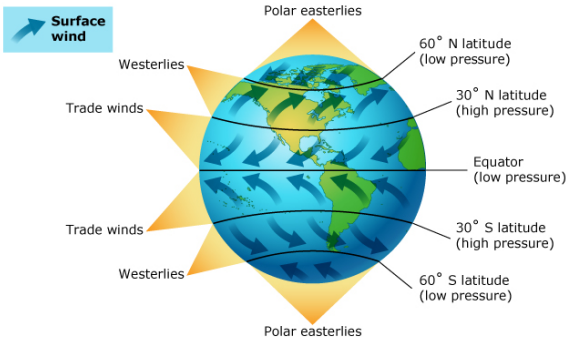
A. Quick Write (2 to 4 Mins)

What Drives Global Wind and Ocean Currents?

B. Reading

What Drives Global Wind and Ocean Currents?

Earth has a global wind system that consists of winds that blow in a constant direction over long periods of time. The planet is circled by six wind belts, three on either side of the equator. Their direction is determined by the amount of solar radiation received at different latitudes and the rotation of Earth.



As air warmed by the sun's radiation rises, it is replaced by cooler air flowing from nearby. This process causes wind. Solar radiation is most direct at the equator; the energy causes air to rise around the globe at this latitude. If the warm air contains enough water vapor, as the air rises it loses this water in the form of rain. Meanwhile, cooler air masses from north and south of the equator flow in to take the place of the rising warm air. As the warm air flows away from the equator, it cools and descends; by the time it reaches Earth's surface again, the air is dry. This dry air forms a band of deserts around the planet along 30° north and south latitude. The air then flows back toward the equator.

These processes produce a worldwide wind pattern in which surface winds move from about 30° latitude toward the equator. However, these global winds are also affected by the rotation of Earth on its axis. This is called the Coriolis effect. As surface air travels over Earth toward the equator, Earth's rotation causes the air to veer to the west. These surface winds are known as the trade winds. A similar circulation occurs between the poles and 60° latitude. Another circulation, which causes surface winds to come from the west in the northern hemisphere, occurs between 60° and 30° latitude. Each of these wind currents also drives water currents in the oceans beneath them.

The global wind system—and the resulting surface currents in Earth's oceans—move thermal energy and moisture around the planet. The wind system has a significant effect on the water cycle, and therefore on weather and climate. For example, in the United States, the prevailing winds are from the west because the latitude is between 30° and 60°. These winds travel over the Pacific Ocean, gathering moisture until they reach coastal mountain ranges. Here the air must rise to get over the mountains. As it rises, it cools and the water vapor it contains condenses and falls as rain or snow. In another example, the westerly winds over the Atlantic Ocean drive warm water in ocean currents across the Atlantic. These movements produce the moderate temperatures and abundant rainfall in Great Britain.

C. Reflection Questions

1. The Trade Winds

The diagram shows the trade winds, which are the predominant winds at the equator. Examine the diagram closely, then select the correct word from the menu to explain how uneven heating of Earth creates these winds.

- The equator receives more solar radiation than higher latitudes.
- This causes air at the equator to become [cooler and rise / cooler and fall / warmer and rise / warmer and fall].
- This movement of air creates an area of [Low, High] pressure at the equator.
- To keep the system in balance, air at mid-latitudes [falls, increasing pressure / falls, decreasing pressure / rises, increasing pressure / rises, decreasing pressure].
- Wind is created when air flows from areas of [Low to High, High to Low] pressure.

2. Energy and Water

As air moves from place to place in the atmosphere, it can gain or lose energy. Gains and losses in energy affect what happens to the water molecules in the air. The motion of air from one place to another can result in condensation of water vapor in the air, or evaporation of water vapor into the air.

Match each description of air motion to whether it is more likely to result in condensation or in evaporation.

warm air rising at the equator :::	air rising to move over a mountain range :::
cool dry air flowing along the surface at 30°S :::	warm air rising at 60° N :::
winds passing over warm ocean water :::	air descending after passing over a mountain range :::

Activity 4

A. Quick Write (2 to 4 Mins)

In What Ways Does the Water Cycle Influence Local Weather?

B. Reading

In What Ways Does the Water Cycle Influence Local Weather?

The water cycle also affects local weather as well as large-scale climate patterns on Earth. Local weather includes the daily changes to cloud cover, precipitation, winds, and temperature that we experience in a place.

Precipitation

Rainfall in a region can be affected by local heating of the air by the sun and by nearby bodies of water. Local heating causes evaporation and warms up air, causing it to rise. As the air rises it cools, and the water vapor condenses to form droplets of liquid water that make up clouds. When the water droplets get big enough, they fall from the clouds back to Earth as precipitation. The presence of a large body of water such as the ocean or a large lake is a source of water vapor that tends to increase local rainfall. Local rainfall is also caused by the movement of large masses of cold air, called fronts, that cause warm air in an area to rise. As the warm air rises it cools, causing condensation that produces rain or snow.

Temperature

Temperatures are affected by season, but the water cycle also has an influence. Water has one of the highest heat capacities of all substances. This results in water losing or gaining heat slowly. Large bodies of water, such as a large lake or an ocean, will moderate the temperature of nearby land. These water bodies can also affect the amount of cloud cover in an area, which also moderates temperatures. Clouds reduce solar radiation and heating, but they also reduce radiative cooling from the land or water. Finally, air with a high water vapor content takes more time to heat up or cool down.

Severe Weather

Most weather is not dangerous, but severe weather can cause serious damage. Severe weather can also affect and be affected by the water cycle. For example, the high heat capacity of water combined with the energy absorbed by the vast oceans can lead to hurricanes and typhoons. The high winds and storm surge caused by a hurricane are one source of damage. Hurricanes also produce large quantities of rainfall that can cause flooding. This type of flooding results when rain is too intense for the ground to absorb the water that falls. This water then runs over the surface of the ground and into streams and rivers; eventually the rivers exceed their banks. Flooding is a change in the balance of overland flow and percolation of water during the water cycle. Flooding is not caused only by hurricanes—many storms are severe enough to cause flooding in an area. A season of excessive rainfall or snowfall over a large area can also lead to flooding.

C. Reflection Questions

Weather Patterns and the Water Cycle

The following passage explains how the water cycle affects weather. Which sentences state incorrect information? Highlight them and write an explanation for why they are incorrect.

The water cycle affects local weather in many ways. Precipitation is a big part of weather, and this is one step in the water cycle. The energy of the sun determines the amount of water vapor in the air that is available for precipitation. That energy also causes the local heating of air masses, decreasing their buoyancy so that they rise and cool. This leads to local storms. When precipitation is intense or occurs over a long period of time, flooding can occur. Flooding is a natural part of the water cycle that results when water flows over the land in large volumes outside of

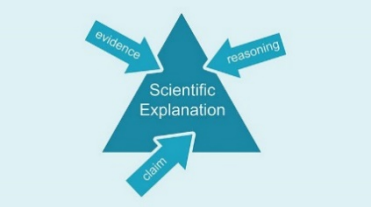
streams and rivers. A flood occurs when the rate of precipitation is less than the rate of percolation into groundwater. Flooding can also occur when the local groundwater reservoir is full. The presence of local bodies of water can affect local temperatures by making them more extreme. Local bodies of water can also increase water vapor in the air and cloud cover. This can reduce changes in temperature between day and night.

Assessment Energy Transfer and the Water Cycle

CAN YOU EXPLAIN?

How do water, wind, and thermal energy from the sun move about Earth's surface?

You should use a scientific explanation to answer this question. Recall that a scientific explanation contains three elements: a scientific claim, evidence to support the claim, and reasoning that connects the evidence to the claim.



As a scientist, select the best way to communicate your explanation. **You may also use a combination of these methods.** Be sure to include your claim, evidence, and reason for connecting the evidence to the claim. Remember, no matter which communication format you choose, it is important to use the proper scientific language to describe your evidence.

-Represent your scientific explanation using a model (physical or diagram). Create an image demonstrating your model.

-Explain your scientific explanation using an oral communication method, such as a video of yourself, a skit, or an audio file. Save your video or audio file to share later with your teacher.

-Present your scientific explanation in a creative written form.

-Write your scientific explanation in the space below.

-Once you have completed your scientific explanation, share it with your family and submit it to your teacher.