Incredible WATER

with the Water Lion

4-H Water Project Unit 2

Note to Educators and 4-H Leaders

This project is most appropriate for youth ages 8–11. It addresses several portions of Pennsylvania's Academic Standards for Environment and Ecology (4.1.4, 4.1.7, and 4.2.4) and Science and Technology (3.4.4, 3.5.4–C, 3.5.4–D, and 3.5.7–D).

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Issued in furtherance of Cooperative Extension Work, Acts of Congress May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture and the Pennsylvania Legislature. T. R. Alter, Director of Cooperative Extension, The Pennsylvania State University.

Produced by Information and Communication Technologies in the College of Agricultural Sciences

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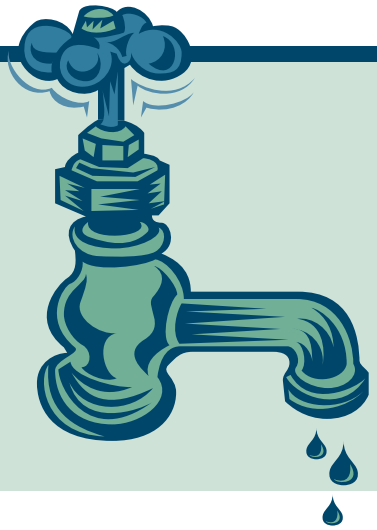
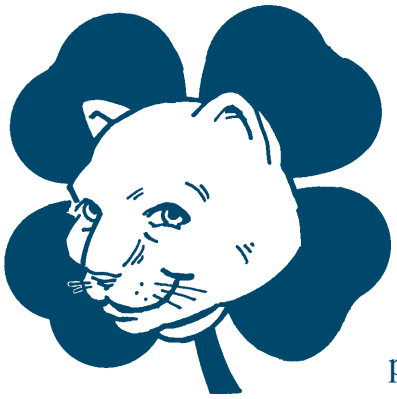


Introduction

The Water Lion welcomes you to Unit 2 of the 4-H water project. You may have already completed Unit 1 of the project about water conservation. However, you can start the 4-H water project with either Unit 2 or Unit 1.

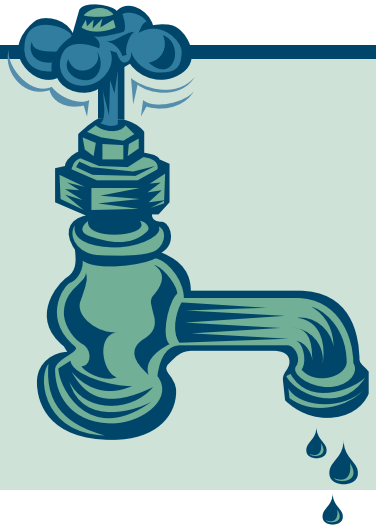
In this unit, the Water Lion will guide you through activities about the properties of water. You'll also learn about the water cycle, which makes all life on Earth possible. Come along as we learn about what makes water special, why we can't live without it, and how it moves around our world!



Rivers, oceans, glaciers, icebergs, ice cubes, snow, rain, fog, steam, and clouds. What do all of these things have in common? They're all forms of water. How can such different things all be made of one basic substance? Because water occurs naturally in three forms: solid (ice), liquid (water), and gas (steam or water vapor).

Water is useful to people because it has three forms and five unique properties. Water is unlike any other substance in the world. You'll learn why in this unit. We're fortunate to live in Pennsylvania, where there's usually a lot of water.

Every day we hear news stories about how water affects our lives. Droughts, floods, and severe storms happen around the world and right here in Pennsylvania. Water and the water cycle affect us in many ways. The water cycle is the constant movement of water between and within the ground, lakes, rivers, ponds, plants, animals, and the atmosphere. This unit will teach you about the parts of the water cycle. You'll also have a chance to teach other people what you learn.



Section 1

Water, Water, Everywhere!

Water Keeps Us Alive

What do a tulip, a hippopotamus, a blue jay, and a person have in common? They all need water to live! Tulips and other plants soak up water from the soil through their roots. Hippos drink water from ponds and rivers, and they also stand in water for hours to stay cool. Blue jays and other birds get most of the water they need from the fruits, seeds, and insects they eat. Birds also use water to clean their feathers. And, of course, people drink and bathe in water.

But did you know that when you drink milk, you're drinking mostly water too? The same goes for fruit juices. Even fruits and vegetables are mostly water, as you can see from the chart on page 4. People use water for bathing and cleaning and making products. Paper, clothing, and even electricity are made using water.

However, the use of water in manufacturing is not as important as our basic need to drink water. Without water, you would not be alive. Neither would anything else. Water makes up about 60 percent of an adult's weight. It makes up about 70 percent of a child's weight. A person can live for only a few days without water. Water helps our joints move, helps us digest our food, helps

Wetlands provide habitat for many birds, plants, and animals.

carry blood through our bodies, and removes wastes. You should drink about 2 quarts of water each day.

Let's begin our activities by finding out how much water is in you!

Activity 1: How Much Water Is In Your Body?

How much water is in your body?

1. Your weight: _____ (pounds)

2. Multiply your weight by 2:
_____ (pounds)

3. Divide your answer to question 2 by 3. This is the number of pounds of water in you: _____ (pounds of water)

4. Divide your answer to question 3 by 8. This is the number of gallons of water in you: _____ (gallons of water)

Water in Food

What have you eaten today? How much water did it have in it? Almost all foods include some water. Fruits and vegetables have the most water in them. The chart on the next page shows how much water is in different foods.

Activity 2: How Much Water Is in Your Food?

Get an apple and cut a thin slice from it. Use a pencil or pen to trace the shape of the apple slice on a paper towel. Set the towel near (not on) a radiator or sunny windowsill to dry for a few days. Then retrace the apple slice. What happened? How could you get the apple back to its earlier size?

Make a drawing below of your apple slice before drying and after drying.

Before

After

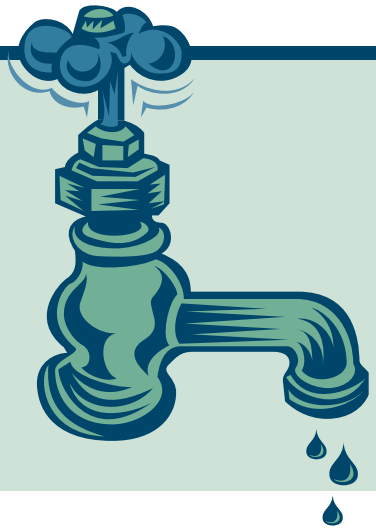
Adapted from "4-H Water Wise Guys," Department of 4-H and Other Youth Programs, Florida Cooperative Extension Service, University of Florida. April, 1992. And from "Critical Issue: Water. You Can Make a Difference." Cornell Cooperative Extension Association of Nassau County. Lesson 7: Water in Food.

What's Next?

Next, you'll learn more about water's three forms and how water changes form.

How much water is in your food?

Food	Percent water (each droplet equals 10%)
CUCUMBER	10
WATERMELON	9.5
BROCCOLI	9
ORANGE	9
CABBAGE	9
MILK	9
APPLE	8
CARROT	8
COOKED PASTA	8
FISH	8
POTATO	8
CORN	7
BANANA	7
EGG	6.5
BEEF	6.5
BREAD	5
BAGEL	4.5
BACON	3
WHEAT GRAIN CEREAL	2
COOKED POPCORN	1



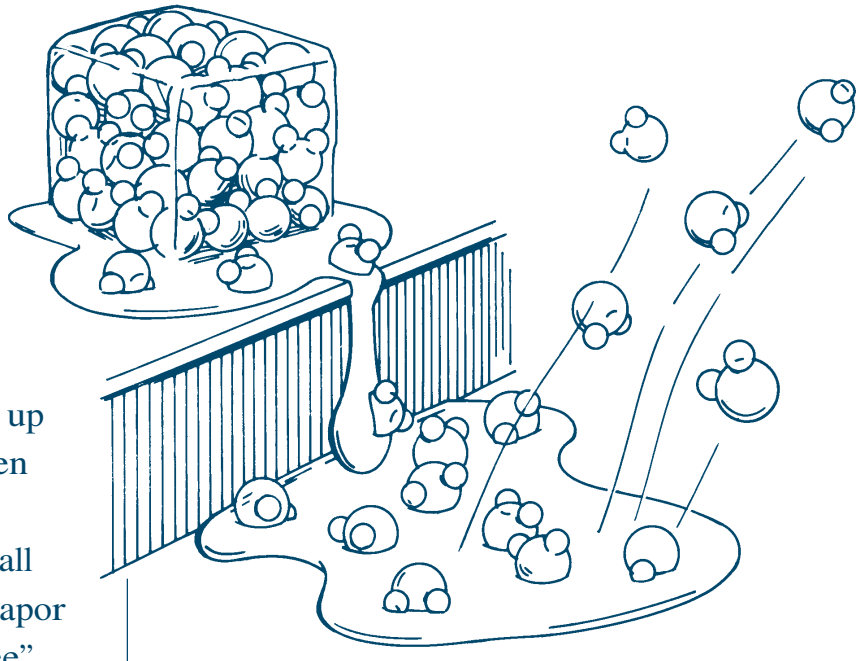
Section 2
Water's Three Forms

Introduction

When two very tiny particles of hydrogen, called **atoms,** and one oxygen atom combine, they produce one **molecule** of water. A molecule is two or more atoms bonded together to make a substance we know. One drop of water contains billions of molecules of water.

Water is the only substance that occurs naturally on Earth as a solid, liquid, and gas. The diagrams here show how water molecules behave in solids, liquids, and gases. The space between water molecules determines whether water occurs as a solid, liquid, or gas. When the molecules are closest together and lined up neatly, water occurs as solid ice. When the molecules are farthest apart and jumbled, water occurs as a gas. We call this gas "water vapor." While water vapor itself is actually invisible, you can "see" water vapor as the steam rising from a pot of boiling water or as your breath on a cold day. When the distance between water molecules is midway between the solid and gas states, and the molecules are slightly jumbled, water occurs as a liquid.

Heat causes water molecules to change form from solid to liquid to gas. For ex-



Water occurs naturally in three states: solid (ice), liquid, and gas (water vapor or steam).

ample, water exists as ice on a pond in winter when there is little heat from the sun. Then spring arrives and the air becomes warmer. The sun's heat melts the ice and loosens the attachments, or bonds, between the water molecules. This changes the ice into water. In summer, increasing heat from the sun causes some water molecules to **evaporate** from the pond. Evaporation occurs when water changes from liquid to gas.

You've already seen solid water (ice) melt into liquid. Complete Activity 3 to see how evaporation and condensation occur.

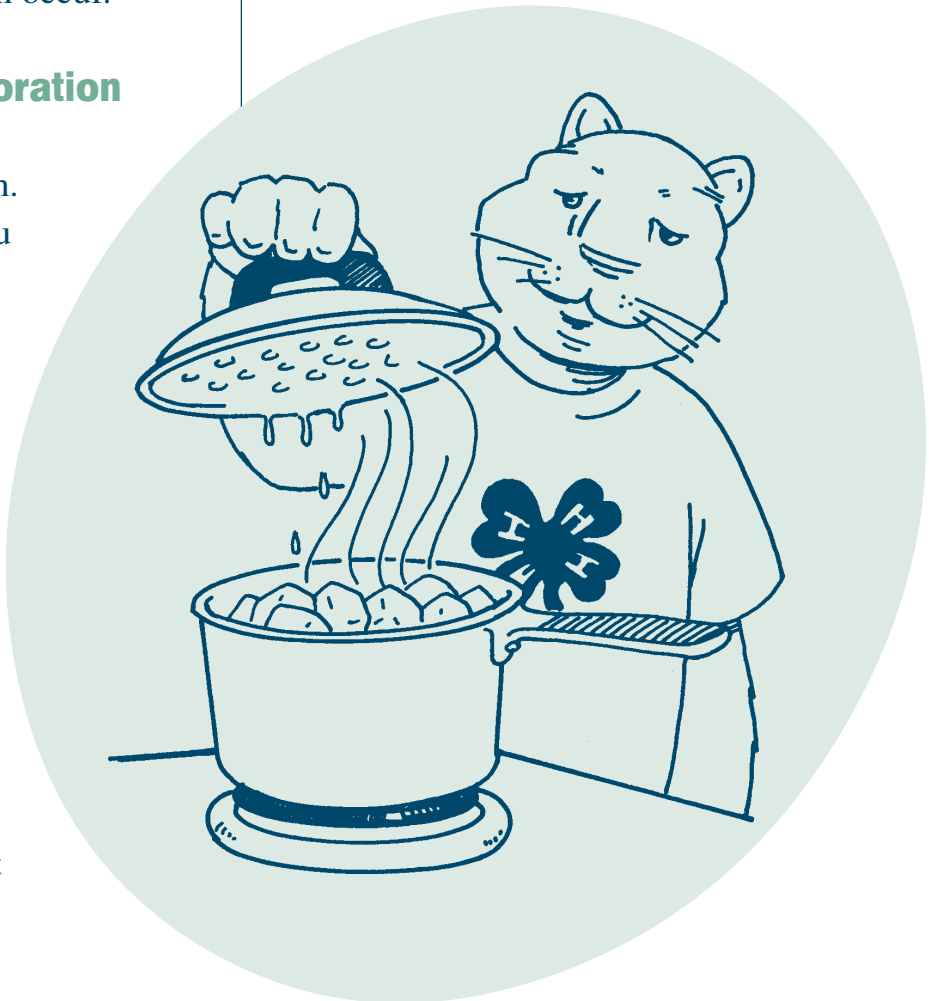
Activity 3: Witness Evaporation and Condensation

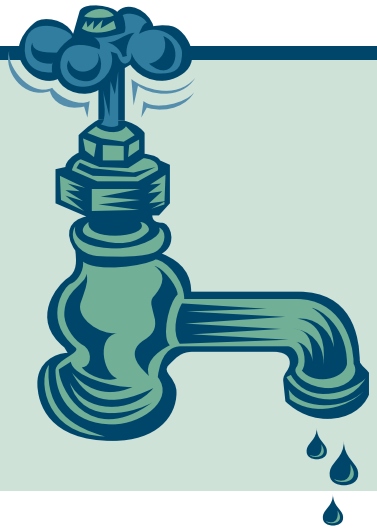
Place some ice cubes in a pan. Ask an adult to work with you while you heat the water in the pan to boiling. Watch the ice melt into water. Water boils at about 212 degrees Fahrenheit (°F). This temperature is the same as 100 degrees Celsius (°C). You can see water evaporating as steam (or water vapor) while the water boils. Hold the pan's cover over the pan. As water vapor comes in contact with the cover, which is cooler than the pan, water drops form. This is **condensation.** You have now seen water change from a solid to a liquid to a gas and back to a liquid.

Adapted from "Splash2O: A Science-based Program for Learning about Society and Water," The Ohio State University, 1996.

What's Next?

In the next section, you'll learn about five unique properties of water. These properties make water useful to people.





Section 3
Unique Properties of Water

Introduction
In the last activity, you learned that water boils at 212°F or 100°C. Water freezes at 32°F or 0°C. This section will teach you more about the five properties of water that make it unique. These properties directly affect our lives in many ways.

Property 1
Water can **dissolve** many substances. Dissolve means that a solid or another liquid becomes part of a liquid and is no longer visible. Water is called the **universal solvent** because it dissolves so many things. That makes it the perfect substance to have in our bodies to carry nutrients to and from our cells. Water also occurs in plants, where it helps carry nutrients from the soil to the leaves. This helps plants to grow. Water is used in the production of many different items because it is a good **solvent.** This means that it dissolves other substances. You know from taking a bath when you're really dirty that water washes away dirt.

Property 2
Water can **absorb** a lot of heat before changing temperature. This property is useful in our bodies. Because our bodies are about two-thirds water, this keeps us at a nearly constant temperature no matter how much we run and play. Water's ability to absorb heat is also important in Earth's climate. The temperature of the oceans changes much less and more slowly than the temperature of the air. This helps keep the climate stable. You can explore water's ability to absorb heat by completing Activity 4 below.

Property 3
Water is **transparent.** That means that light can pass through it. This property allows plants to grow deep in the ocean and in the bottom of riverbeds. All green plants use light as their energy source. They could not live in water if it was not transparent.

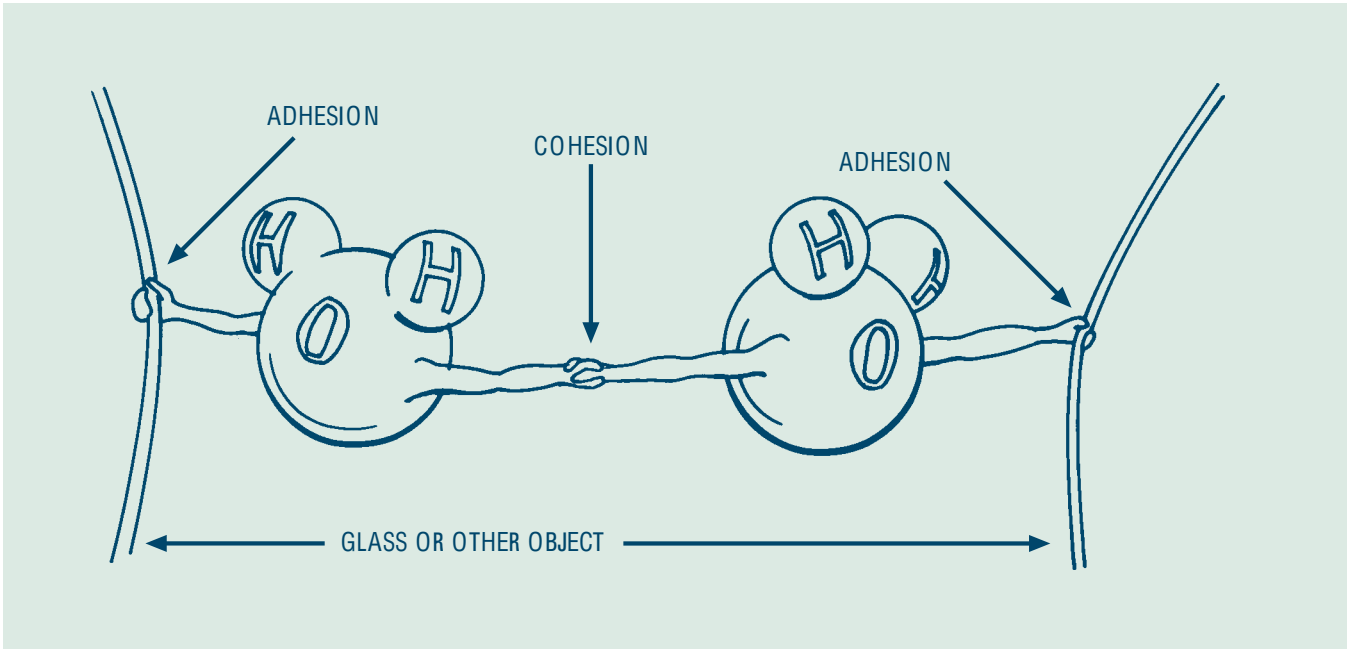
Property 4

Water is most **dense**, or compacted, at 39°F (equal to 4°C). It is less dense at temperatures above and below 39°F. The temperature of ice cubes is 32°F (0°C). This means that ice is less dense than water. That's why ice cubes float in a glass of water and why icebergs float in the ocean.

Property 5

Water molecules tend to stick together. This is caused by the attraction between the hydrogen atoms in water. Hydrogen atoms are positively charged and the oxygen atoms are negatively charged. You may have heard the expression, "Opposites attract." This applies in water molecules. Because water molecules have a charge, they are called **polar**. The positive, or hydrogen, side of one molecule is attracted to the negative, or oxygen, side of the neighboring molecule. These attractive forces between water molecules are called **cohesive forces**. They cause raindrops to form. A raindrop is a collection of billions of water molecules that are temporarily attached to each other. Cohesion also causes water to flow. When water molecules get together, they want to stay together. You'll see cohesive forces for yourself when you complete Activity 5 below.

Adhesion is the attraction between water molecules and other substances, such as glass. Adhesive forces make it difficult to pour every last drop of water out of a container. Adhesive forces are also the result of molecular charges.



Water molecules have cohesive forces that make them stick to each other and adhesive forces that make them stick to other objects, such as a glass.

Activity 4: Water Holds and Absorbs Heat

This experiment will demonstrate water's ability to hold and absorb heat.

1. Pour 1/3 cup of hot tap water into a bowl. Use a thermometer to measure the temperature. Record it here.

_____ °F

2. Measure out 1/3 cup of very cold tap water. Take and record the temperature.

_____ °F

3. Predict what the water temperature will be when you mix the cold water into the hot water.

_____ °F

4. Pour the cold water into the hot water, swirl gently with the thermometer, and record the temperature.

_____ °F

5. Describe the results. Was your prediction in question 3 correct? Water can absorb a lot of heat energy before changing temperature.

_____

_____

_____

Adapted from "Water Wise: Lessons in Water Resources," Cornell University Cooperative Extension, 1989.

Activity 5: The Forces of Water

This activity is a fun way to learn about the forces that hold water drops together and make water flow.

1. Draw a long wavy line on a piece of paper. Lay a piece of waxed paper over it. Use a medicine dropper to put a single drop of water at the start of your line. Now use a toothpick to guide the drop along the line. After a few minutes, describe how the drop behaved.

_____

_____

_____

_____

2. Wipe the first drop off the waxed paper. Place a ruler on the waxed paper. Use the medicine dropper to place another drop of water next to the ruler at one of the inch marks. Now use two toothpicks to see how far you can stretch the drop before it breaks into more than one drop.

_____ inches

Now try to push the drops back together again using the two toothpicks.

3. Put a penny on the waxed paper. Using a medicine dropper, slowly place water drops on the surface of the penny. Count the drops as you set them on the penny. How many drops can you put on before water spills over the sides?

_____

Draw the shape of the water on the penny here.

4. What might cause water to behave the way it did? What properties of water did you observe?

_____

_____

_____

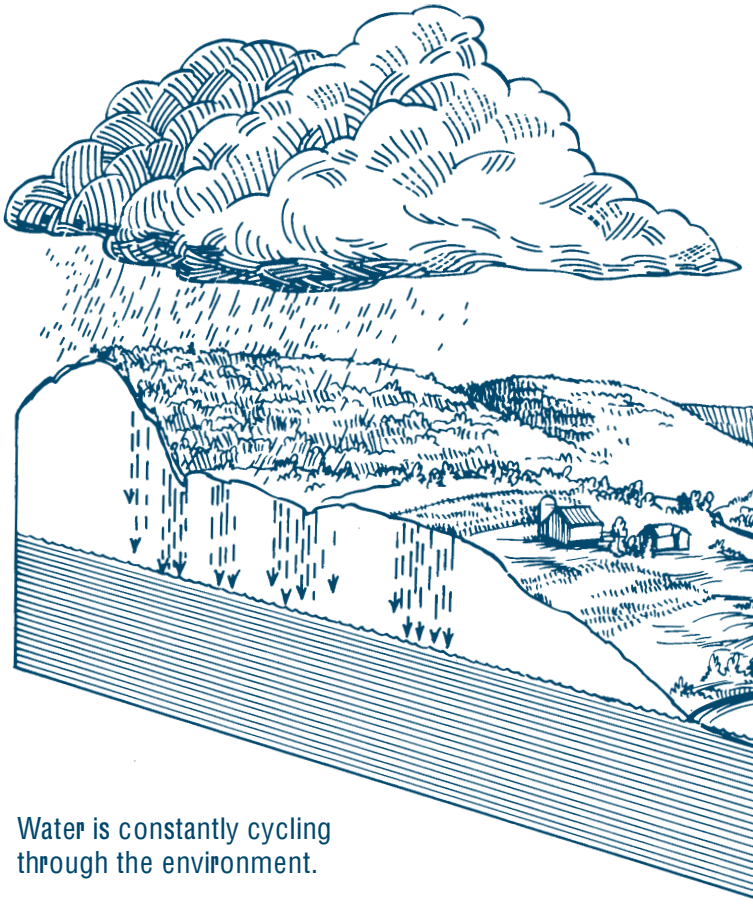
_____

_____

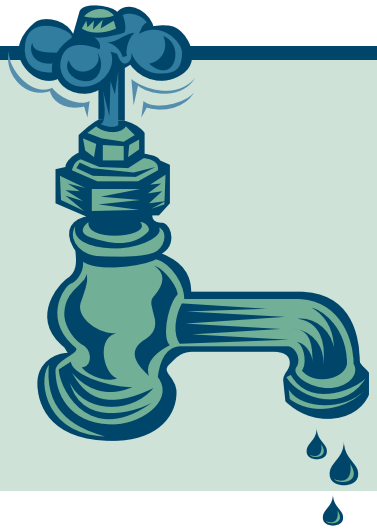
Adapted from "Classroom Gems," Science and Environmental Education-North, P.O. Box 619, Harbor Springs, MI 49770

What's Next?

Now you have experienced some things that are unique about water. In the next section, you will learn about the water cycle and the processes within it.



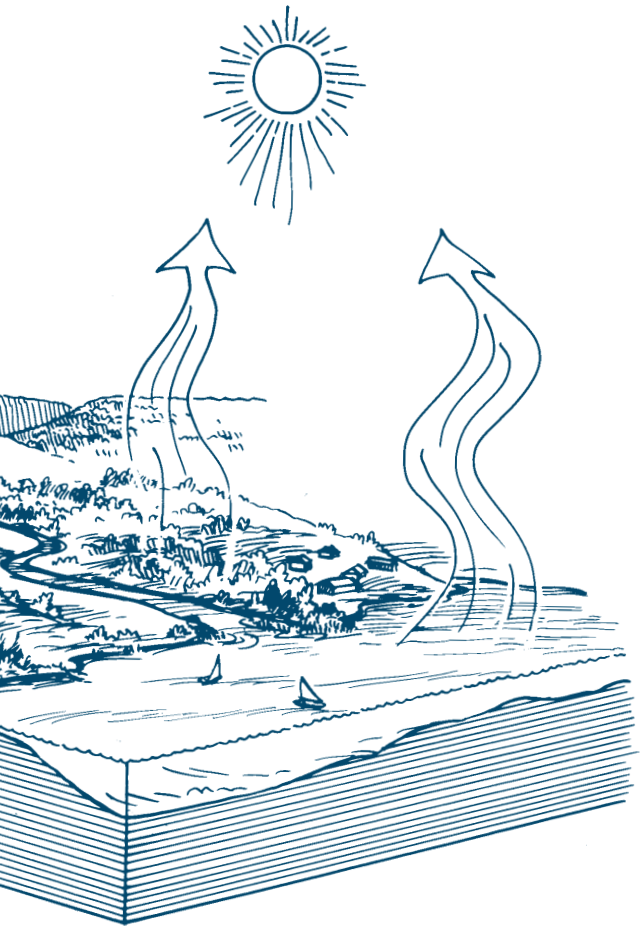
Water is constantly cycling through the environment.



Section 4
The Water Cycle

Introduction

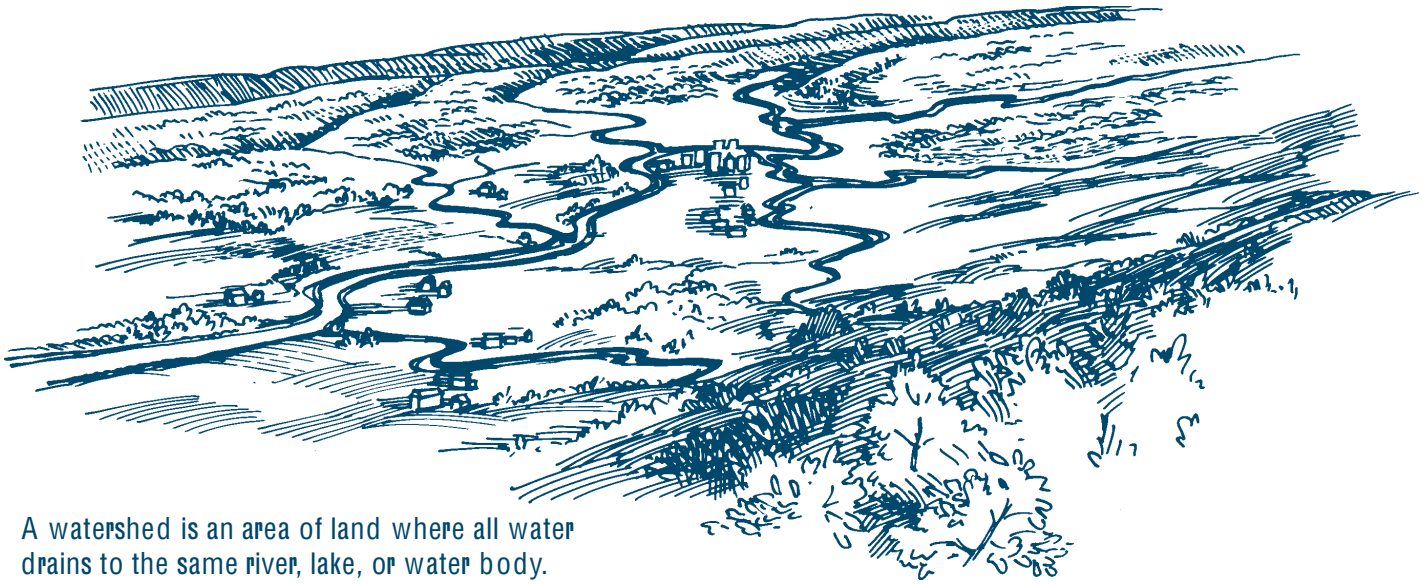
The water cycle, also known as the hydrologic cycle, drives life on Earth. Without the water cycle, there would be no green plants, no rain, no birds, no people, no life. The **water cycle** is a continuous process through which water is circulated between and within the ground, water bodies, plants, animals, and the atmosphere.



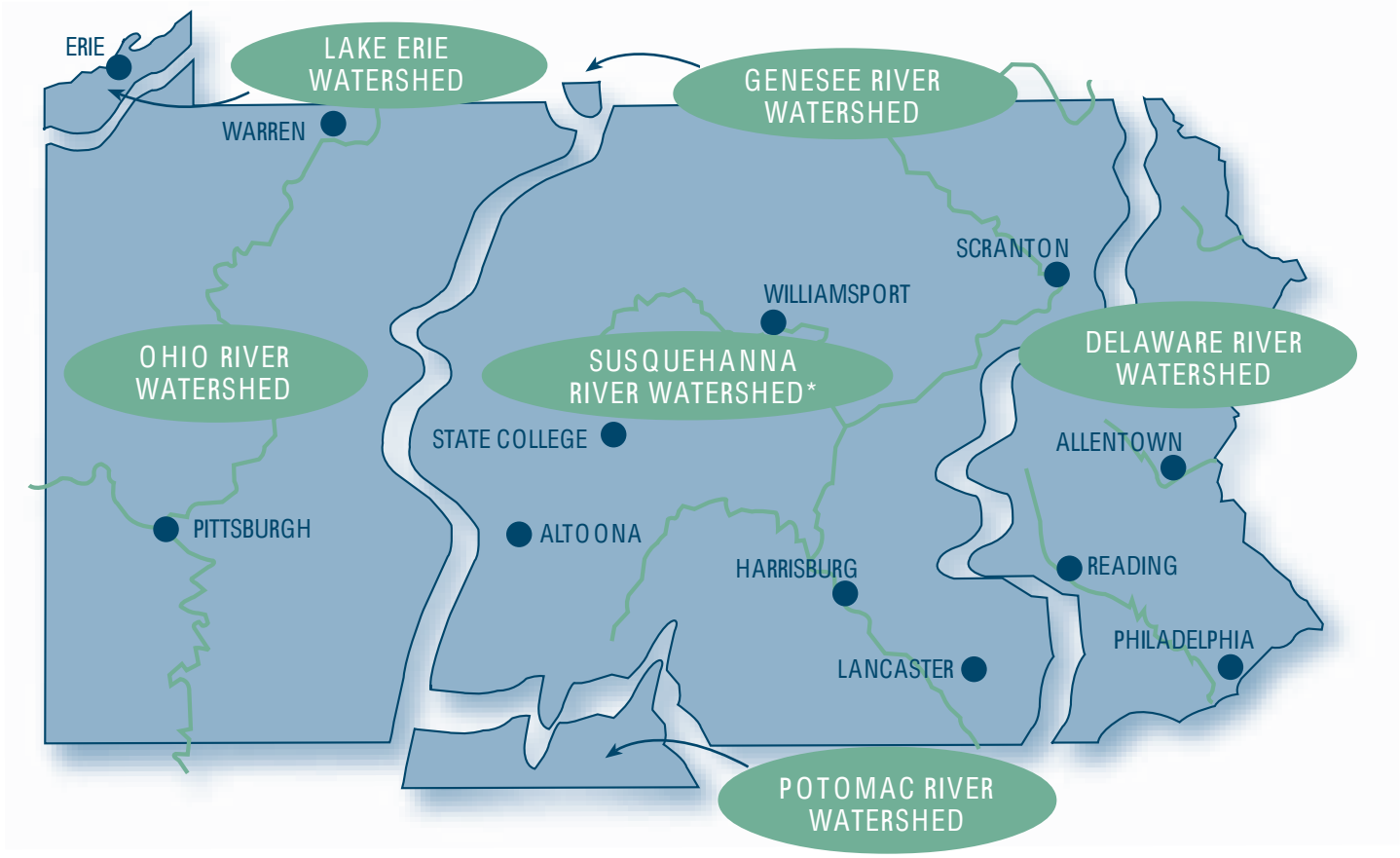
The amount of water on Earth never changes. The water you drank yesterday was around when the dinosaurs were alive. It was around when the Constitution of the United States was signed. It will be around when your great-great-great-grandchildren are alive. Only the form of water changes, from solid to liquid to gas.

The water cycle starts with ocean water that evaporates in the hot tropical regions of the world. Winds move this mass of moisture over land, where clouds form and **precipitation** occurs as rain or snow. Several things can happen to precipitation when it reaches Earth's surface.

About 85 percent of precipitation falls directly into the oceans or some other body of water. Water in oceans, rivers, lakes, ponds, and streams is known as **surface water.**



A watershed is an area of land where all water drains to the same river, lake, or water body.



There are six major watersheds in Pennsylvania, but within each of these there are many smaller watersheds.

*Part of the Chesapeake Bay Watershed

Precipitation that falls on land may flow over the surface of the ground until it reaches a body of water. This is called **runoff.**

Water in rivers and streams continues to flow until it reaches the lowest point. All the land area that water flows over and under on its way to a waterway (a river, stream, or lake) is called that waterway's **watershed.**

Precipitation may also soak into, or **infiltrate,** the soil. This water trickles down through the soil until it reaches the **water table.** This is the upper edge of soil below which water fills all the spaces between the soil grains. This **groundwater** often remains underground for hundreds, even THOUSANDS of years. It flows, usually very, very slowly, driven by gravity along the natural slope of the land and bedrock layers.

Water from precipitation may also be absorbed by plants through their roots, pass through the tissues of the plant, and be released into the atmosphere in a process called **transpiration**. All groundwater eventually reaches the surface of the earth, given enough time. It usually surfaces as a spring that feeds into a surface water body.

Water on Earth's surface is warmed by the sun's energy and changes into water vapor through evaporation. As the water vapor rises, it cools. This causes condensation,

Transpiration Demonstration

Directions

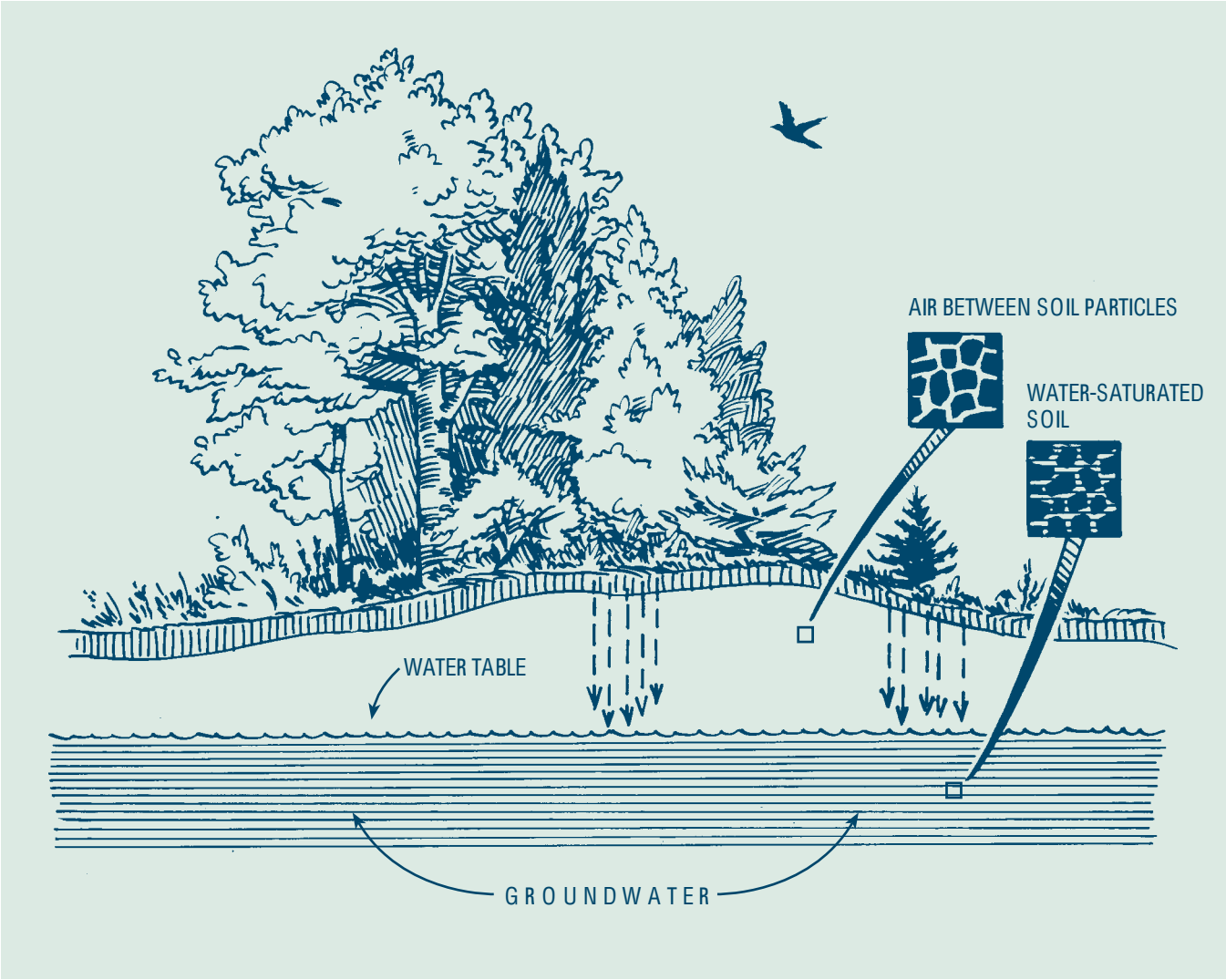
Water a potted plant (anything besides a cactus). Use a twist-tie or a rubber band to fasten a small plastic bag around a few of the plant's leaves. Set the plant in the sun or under a bright light. Check the plant every 30 minutes for several hours to see what happens. What changes do you see?

Here's another easy experiment. Water a potted plant. Then weigh the plant and pot and record the weight. Place the plant in a sunny or bright spot. Wait three days and weigh it again. What did you find? Can you explain the change you observed?

Adapted from "4-H Water Wise Guys," Department of 4-H and Other Youth Programs, Florida Cooperative Extension Service, University of Florida. April, 1992.

which is a change back to liquid or solid form. Water vapor in the atmosphere condenses on tiny particles, such as dust, in the air. Water droplets clump into clouds. The droplets grow by combining with other droplets. When the water drops in a cloud reach a certain size, they fall to the ground as precipitation, and the water cycle begins again.

Wind, gravity, and the sun's energy drive the water cycle. Wind moves moisture in the atmosphere around the world. Gravity pulls water in the clouds toward the ground. Gravity also pulls water on the surface of the ground into the ground and moves water down slopes to the lowest point. The sun's energy heats water on the Earth's surface until it evaporates back into the atmosphere. The sun's energy also plays a



Groundwater fills the spaces between soil particles in the saturated zone. The upper edge of the saturated zone is called the water table.

role in the circulation of the oceans by making some parts of the ocean warmer than others. Without natural ocean circulation, our planet would be a very different place.

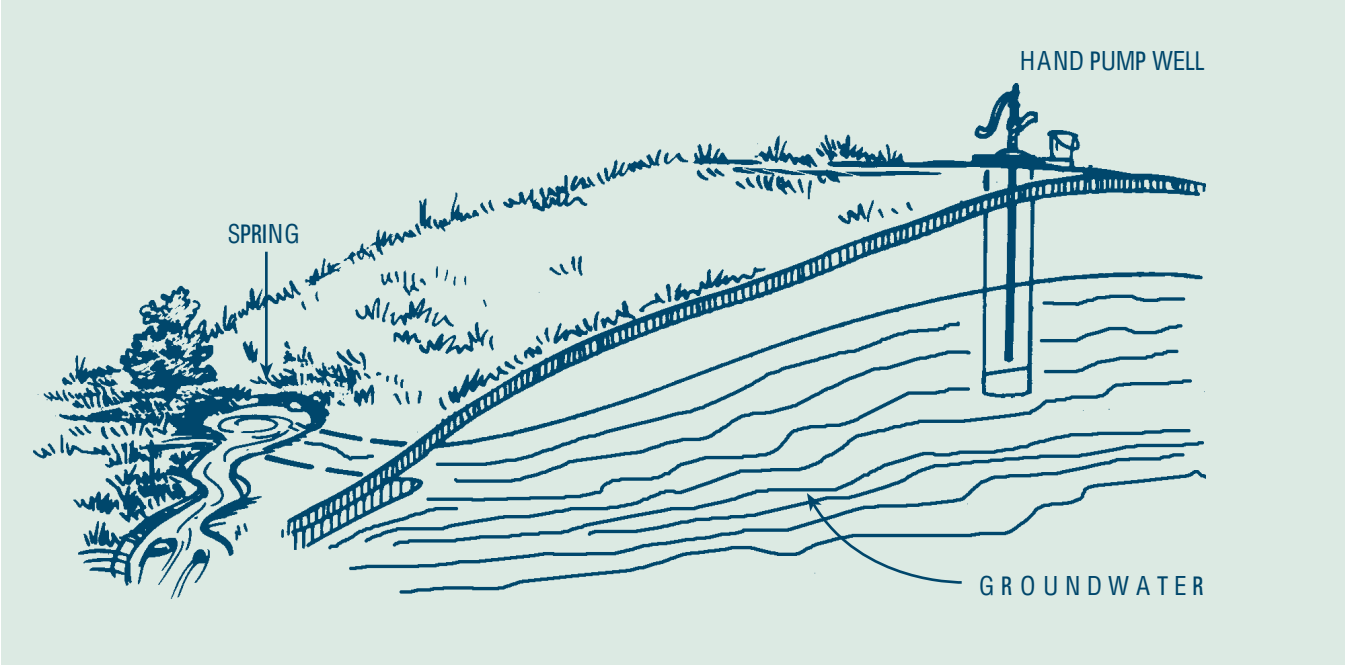
The most important thing to remember about the water cycle is that all the water we have now is all we'll ever have. Water changes from solid to liquid to gas, but our planet will never get more water or lose any. It just gets redistributed. That's why it is important to use the water we have wisely.

Activity 6 will help you picture a watershed. You'll experiment with some of the parts of the water cycle. This should help you understand how water moves through the water cycle. Activity 7 will help you become more aware of clouds. You'll also learn to identify the basic kinds of clouds.

Activity 6: Make a Watershed

1. Work outside or over a sink or bathtub. Use a large piece of aluminum foil to make a "watershed." Create wrinkles and folds in the foil. Imagine them to be mountains, valleys, and plains. All parts of the foil should drain into a single low area. Make sure that all outer edges are turned upward. You might need to support your "mountains" with paper towel rolls or rulers.

2. Fill a plastic or paper cup halfway with water and mark the water level on the outside of the cup with a marker. Put this pre-measured amount of water into a sprayer bottle and use the sprayer to make



Groundwater can emerge at the land surface naturally as a spring or by human engineering through a well.

it "rain" on different parts of your watershed. You can also pour a small amount of water into your hand and let it roll off the tips of your fingers. Be sure to use all of the water you measured out. Watch how the water moves in the watershed. Catch the runoff water in the cup at the low area. How much water moved through the watershed? How much water was retained in the watershed? What do the various water bodies on the foil remind you of?

3. Now use a medicine dropper to remove water from the watershed and place it back into the cup. When you've removed as much water as you can, make another mark on the cup to indicate the new water level.

4. Now place pieces of paper towel or napkin on the high parts of your model. These imitate the effect of water storage in the ground. Slowly dribble all the water in the cup onto the high parts of the watershed. Watch how the water flows through the watershed. Now use a medicine dropper again to return as much water as possible to the cup. Compare the water levels. What does this tell you about groundwater?

5. Think about all the things that the water cycle makes possible. What are five ways the water cycle directly affects you?

Activity 7: Clouds Exploration

Introduction

You may have noticed that some clouds appear to be higher in the sky than others. Clouds look different depending on the conditions under which they were formed. There are three main types of clouds: cirrus, cumulus, and stratus.

1. **Cirrus** clouds are thin, wispy clouds that occur very high in the sky. Cirrus clouds usually mean that the weather will change soon, probably from fair weather to stormy or cloudy weather.

2. **Cumulus** clouds usually occur on bright sunny days in the afternoon. This kind of cloud results from uneven heating of the earth. Certain surfaces on the ground, such as snow-covered ground, reflect a lot of heat back to the sky. This causes water vapor to condense into tiny droplets over that spot and form a puffy cloud that looks like a giant cotton ball.

Cumulonimbus clouds are types of cumulus clouds. On hot, humid days in the summer, the sun's energy drives the uplift of air. The water vapor in the air condenses as it rises. Cumulonimbus clouds, which often develop into an anvil shape, bring violent thunderstorms.

3. **Stratus** clouds hang low in the sky and often appear as a dark, flat blanket spread

Adapted from "Water Wise: Lessons in Water Resources," E. C. Moran and M. E. Krasny, Cornell Cooperative Extension, 1989.

over the whole sky. Stratus clouds form when a large warm air mass moves up over a colder air mass. Condensation occurs throughout the air mass as it rises, so stratus clouds bring steady precipitation.

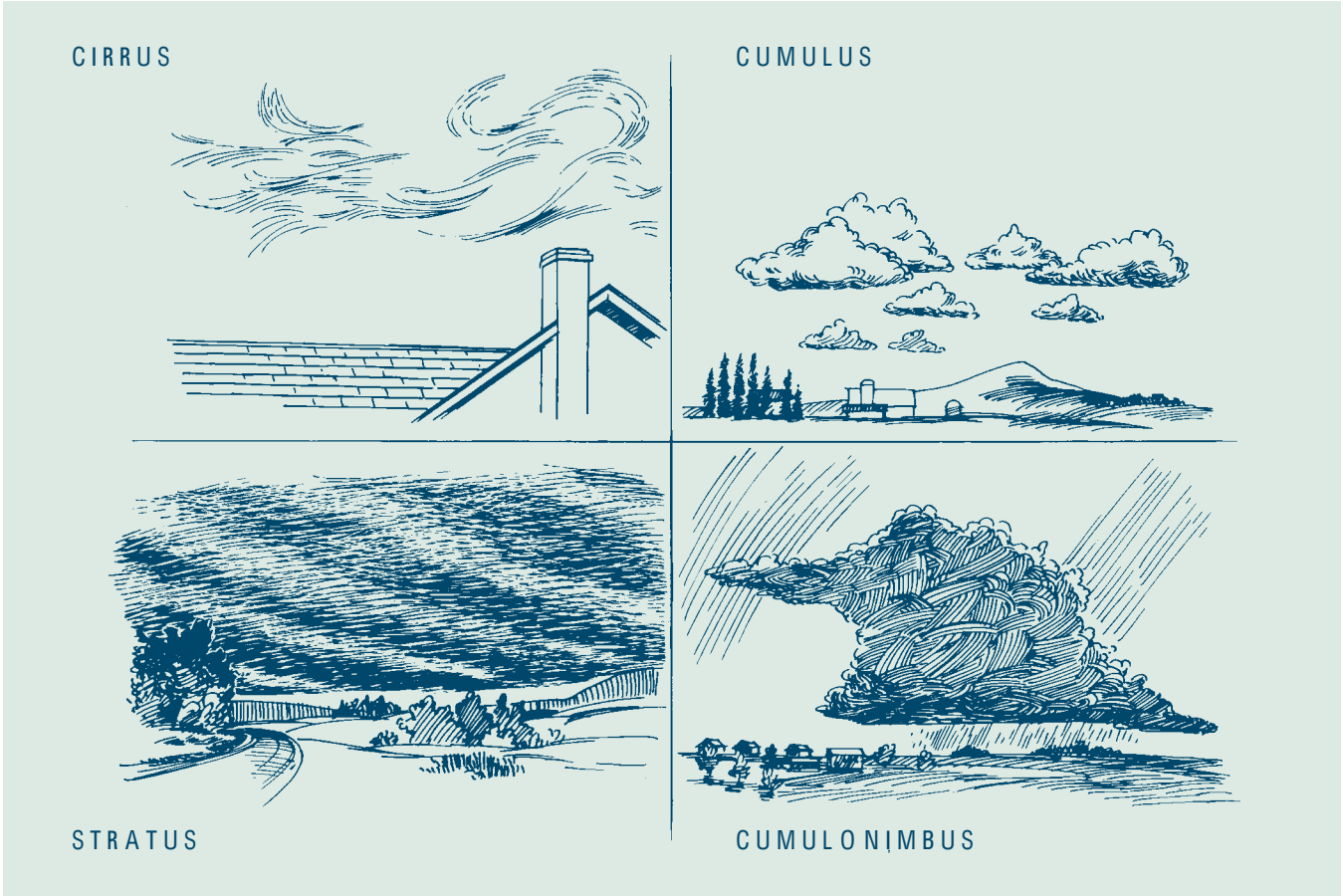
Activity

Go outside and look at the clouds. Draw a quick picture, or take a photo of them, and decide which of the above groups they belong to. Repeat this exercise once a day for a week. Try it at different times of day or when you notice a different cloud type.

Adapted from "Gee-Wow! Adventures in Water Education," Ecology Center, Ann Arbor, MI; phone (734) 995-5888.

What's Next?

Now you know about the water cycle, watersheds, water in animals, plants, and food, and the properties of water that make it unique. In the project wrap-up, you'll think of a plan to teach other people something that you've learned about water. Then you'll put your plan into action.



There are three main types of clouds: cirrus, cumulus, and stratus. Cumulonimbus is a type of cumulus cloud that brings thunderstorms.

Project Wrap-Up:
Tell Others!

Introduction

Congratulations! You now have *water wisdom.* You know more about water than many people do. Now you can spread the word to your family and friends. That's what you'll do in this last wrap-up, or project completion activity.

Think about the following questions. Talk about them with your group or an adult.

1. Why should all people know about the water cycle and groundwater?

2. What are some of the most important things you learned in this 4-H unit?

3. What are some ways you could teach other people this information?

Choose your favorite answer to question 3. Use that idea to teach other people something you learned about water. Make sure you can complete your idea with only 2 or 3 hours of work. Then make a poster or display of what you want others to know about incredible water!

4-H Activities Report

This report will help you keep a better record of your club activities. Fill it in as you complete each activity or assignment. Refer to this record when you are entering county, state, and national programs. Ask your local leader to explain these programs to you.

My 4-H Activities Report for the 20_____Club Year

Projects taken_____

_____

_____

_____

Offices held_____

Club_____

County_____

"Show-and-tells" given to

Family_____

Friends_____

Local club_____

County_____

Regional_____

State_____

News articles_____

Radio_____

TV_____

Things done to improve my health_____

_____

_____

Community service or citizenship work done

By myself_____

With club_____

Number of meetings my club(s) held this year_____

Number I attended_____

Number of new members I encouraged to join 4-H_____

Number of boys and girls I helped with projects_____

In what way?_____

_____

_____

Check those attended and tell how you helped

_____ 3- or 4-day camp

_____ 1-day camp

_____ Club or county tours

_____ Club picnic

_____ Countywide picnic

_____ 4-H Sunday

_____ County fair

_____ Achievement programs

_____ Roundup

_____ Teen Leader Retreat

_____ State 4-H Capital Days

_____ Camp Leadership Training

_____ Penn State 4-H Achievement Days

_____ Pennsylvania Farm Show

_____ National 4-H Week

_____ State Ambassador Conference

_____ Judging training

Others:

_____

_____

_____

_____

PENNSTATE

College of Agricultural Sciences
Cooperative Extension

Name _____

Address _____

_____

Name of club or group _____

Leader's or teacher's name _____

4-H Club Motto

"To make the best better"

4-H Club Pledge

I pledge
my head to clearer thinking,
my heart to greater loyalty,
my hands to larger service, and
my health to better living, for
my club,
my community,
my country, and
my world.

4-H Club Colors

Green and White