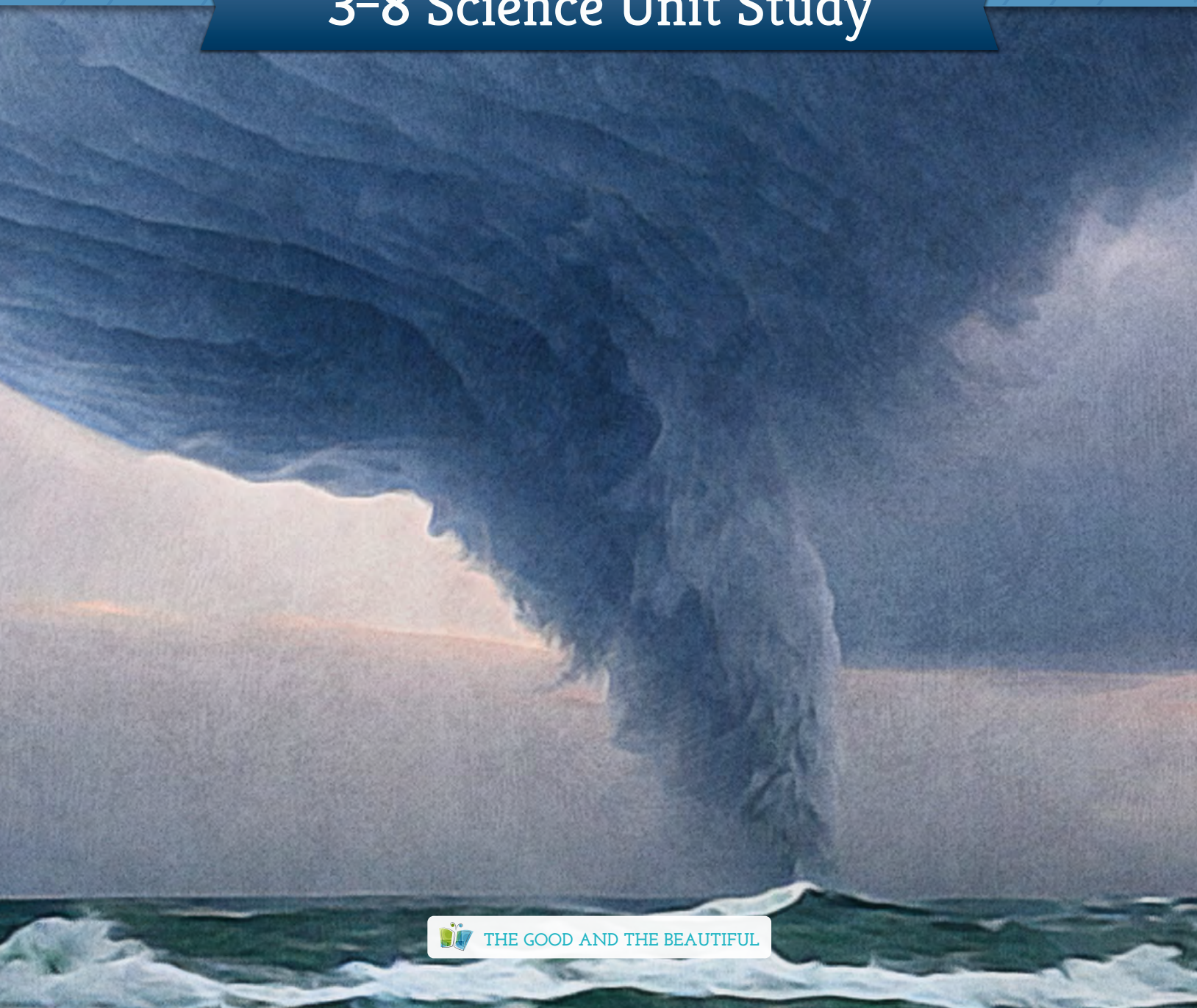
WEATHER AND WATER

3–8 Science Unit Study



THE GOOD AND THE BEAUTIFUL

WEATHER AND WATER

CREATED BY THE GOOD AND THE BEAUTIFUL TEAM

Table of Contents

The Good and the Beautiful CURRICULUM

Unit Information

Student Journal

All The Good and the Beautiful science units include activities in a student journal. Each student should have his or her own student journal, and the parent or teacher will direct the student regarding when to complete the activities in the lessons. Student journals can be purchased by going to **goodandbeautiful.com/science** and clicking on the *Weather and Water* unit link.

Science Wall

All The Good and the Beautiful science units include vocabulary words to be placed on your science wall, which is a wall or trifold presentation board in your learning area on which you can attach the vocabulary words and other images. ***Cut out the vocabulary word cards at the beginning of the unit.*** The course will indicate when to place them on the wall.

Lesson Preparation

All The Good and the Beautiful science units include easy-to-follow lesson preparation directions at the beginning of each lesson.

Activities and Experiments

Many of The Good and the Beautiful science lessons involve hands-on activities and experiments. An adult should always closely supervise children as they participate in the activities and experiments to ensure they are following all necessary safety procedures.

Experiment Videos

Go to **goodandbeautiful.com/sciencevideos** and click on the *Weather and Water* link or use the Good and Beautiful Homeschool app to see videos of experiments used in this unit. This is a convenient way to watch experiments that may be more complicated. Children often learn best through hands-on experience; therefore, this unit includes a supply list and instructions for all experiments, and you may choose to do as many as you wish.

Unit Videos

Some lessons include videos that were created by The Good and the Beautiful. Have a device available that is capable of playing the videos from **goodandbeautiful.com/sciencevideos** or on the Good and Beautiful Homeschool app.

Content for Older Children

Some lessons include extra content that is more applicable for older children (grades 7–8). Parents or teachers may choose to skip this content if instructing only younger children.

Content for Younger Children

Some lessons include extra content that is more applicable for younger children (grades 3–6). Parents or teachers may choose to skip this content if instructing only older children.

Versions

New discoveries are being made on an ongoing basis. This course is reviewed and revised periodically to keep information as up to date as possible. This version is the first edition of this unit.

Read-Aloud Book Pack

The books below are optional read-aloud books that complement this unit. These books can be purchased as a book pack by going to **goodandbeautiful.com/science** and clicking on the *Weather and Water* unit link.

Wild, Wild Wind
By Shannen Yauger

The Schoolhouse Blizzard
By Shannen Yauger

Changing Weather: The Story of June Bacon-Bercey
By Ashlee Klemm

Correlated Books

The Good and the Beautiful Library has several books that correlate well with the *Weather and Water* unit. It can be a wonderful experience for children to read books at their levels that are related to the subjects they are learning. The library includes both fiction and nonfiction books organized according to reading level. Find the Correlated Books by going to **goodandbeautiful.com** and clicking on the *Weather and Water* unit product page.

GRADES 7–8
LESSON EXTENSIONS

How the Extensions Work

Each lesson has an optional lesson extension for children in grades 7–8. Complete the lesson with all the children, and then have the older children complete the self-directed lesson extension. These extensions are located in the *Grades 7–8 Student Journal*.

Answer Key

The answer key for the lesson extensions can be found on the free Good and Beautiful Homeschool app in the science section. Visit **goodandbeautiful.com/apps** for information on accessing the app. The app can be accessed from a computer, phone, or tablet.

Flexibility

The amount of time it will take to complete each lesson extension will vary for each child. The average time is about 10–15 minutes per extension. Parents, teachers, and children may choose to omit parts of the lesson extension if desired. Encourage the children to stretch their capabilities, but also reduce work if needed.

Taking Notes

Some of the grades 7–8 lesson extensions have the children summarize the material read. Teach the children to look for key information, summarizing the most important points. Students can also add notes with their thoughts and the facts that are most interesting to them.

Optional Grades 7–8 Reading Book

We recommend *The Beauty of Weather* by Elle Staples and Shannen Yauger as extra reading for students in grades 7–8. This book can be purchased by going to **goodandbeautiful.com/science** and clicking on the *Weather and Water* unit link.

The Beauty of Weather
By Elle Staples and Shannen Yauger

Supplies Needed

This section is divided into supplies needed for activities and supplies needed for experiments. If you would prefer to watch the experiments instead of perform them, you can watch all the experiments at **goodandbeautiful.com/sciencevideos**. The activities, however, are not filmed.

Lesson 1

- none

Lesson 2

- none

Lesson 3

- 1 jar of hot water with a lid
- 2 pennies per child
- 1 eye or medicine dropper per child

Lesson 4

- scissors
- stapler or glue stick

Lesson 5

- 1 clean, empty bottle
- 1 scrap of paper, wadded up small enough to fit in the bottle opening, per child
- 12" balloon
- 1 empty, clear, sturdy plastic bottle (like a sports drink bottle)
- scissors or a nail
- tape

Lesson 6

- 2 paper plates
- scissors
- construction paper
- drinking straw
- straight pin
- pencil with fresh eraser
- a small ball of clay about the size of a cherry
- compass or phone with a compass app

Lesson 7

- light-blue, dark-blue, green, gray, and black crayons or colored pencils
- 1 glass of ice water, per person
- 2 similar-sized glass jars or plastic containers filled with water, 1 with a lid that fits securely
- dry-erase marker

Lesson 8

- scissors
- sheet of blue or other dark cardstock or cardboard
- glue stick
- paint stir stick or something similar to make a handle (optional)

Lesson 9

- wide-mouthed glass jar (the wider, the better)
- very hot water
- blue food dye (optional)
- a metal pie pan
- ice cubes
- clock or watch
- empty 2-liter plastic bottle with straight sides, if possible (optional)
- scissors (optional)
- permanent marker (optional)
- ruler (optional)
- 1 or 2 handfuls of small stones (optional)
- 2 binder clips (optional)

Lesson 10

- blank sheets of paper
- scissors

Lesson 11

- aluminum pie pan
- thumbtack
- pencil with a fresh eraser
- Styrofoam® plate
- tape
- small piece of wool fabric
- very dark room
- metal fork (optional)
- fluorescent lightbulb (optional)

Lesson 12

- plastic water bottle
- dish soap
- glitter or food dye (optional)

Lesson 13

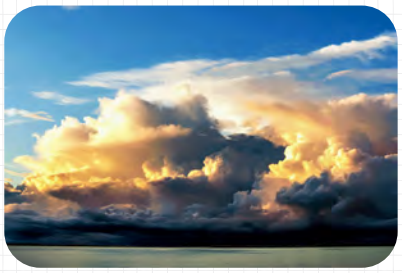
- 1 dice
- 1 game piece or small object, such as a coin, eraser, or small toy

Lesson 14

- colored pencils, pens, or crayons
- glue stick for each child in grades 3–6

Vocabulary

Instructions: Cut out the vocabulary cards in this section. Place them on your science wall when prompted to do so in the lessons. Review the vocabulary words several times during this unit and, if desired, at various times throughout the school year.



Weather

the state of the atmosphere over a short period of time

Meteorology

a branch of science that focuses on the atmosphere, weather, and weather forecasting

Climate

the weather conditions of a particular region over a long period of time

Introduction to Weather

Objective

Give the children an overview of the wonders of weather and explain why studying it is so important.

Preparation:

- ☐ Cut out the meteorology timeline cards found at the end of this lesson.

Activity Supplies:

- none

☐ Wonder of Weather Video

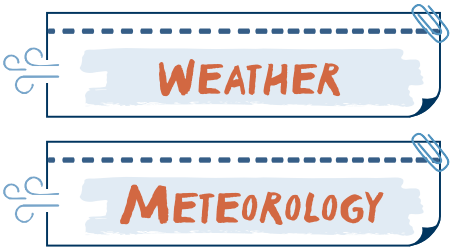
Watch the video "Wonder of Weather" at goodandbeautiful.com/sciencevideos or from the Good and Beautiful Homeschool app.

☐ Weather: A Daily Reminder of God

Read to the children: ***Weather*** brings us precipitation, fresh water, rainbows that remind us of God's promises to protect us, and the occasional storm. Weather can be beautiful and sometimes thrilling, but it is also vital and beneficial to the earth and its inhabitants. No matter if the weather is sunny, rainy, or stormy, it is always occurring as a daily reminder of God's love for us.

☐ Science Wall: Vocabulary Words

Place the vocabulary cards WEATHER and METEOROLOGY on your science wall. Read and discuss the words and definitions.



☐ The Impact of Weather

Read to the children: Weather is constantly changing, and it's this change that often fills us with wonder or awe. I'm sure you've had a day when the weather started out one way in the morning but ended the day completely different. Can you remember a day like that? What was it like?

Weather doesn't just affect our lives. It affects all living creatures on Earth. Its impact can be the difference between a great day and a very hard day—or sometimes between life and death. This is why people

devote their lives to studying ***meteorology***. We call them "meteorologists." Meteorologists help us to know what kind of weather we can expect each day so that we may prepare and plan.

☐ Meteorology Timeline Activity

Read to the children: Like all the sciences, meteorology has come a long way since people first began to study it. Let's look at some interesting moments in meteorology's history.

Mix up the timeline cards, and then randomly read and discuss the cards. Depending on students' ages and interest levels, your discussion may be quite brief or in-depth. Here are some sample discussion prompts: How would ____ make a difference? What else was going on in the world then? Do we see any ____ today? What questions might be left to discover?

After all cards have been read, place them in order chronologically.

☐ Wonderful Weather

Have the children turn to the "Wonderful Weather" page in Lesson 1 of their student journals and complete the page. Have each child share the topic that interests him or her most and the questions about that topic. Help the children with ideas if needed.

☐ The Scientific Method

Read to the children: In your student journal activity, you were a question-asker, just like scientists. The *scientific method* is the approach all scientists use to do experiments in a way that lets them find answers. Whether in a fancy laboratory or in a home kitchen, this method works. We will be using the scientific method in this unit to find our own answers. Let's review the steps of the scientific method using an everyday question: what is the weather today?

1. **Observe.** (What do you notice?)
   - ↳ You look out a window and see that the sky is darker than normal for 2:00 p.m. The trees are swaying a little, and you do not see anyone playing or working outside.
2. **Ask a question.** (Consider what you observed to form a good question.)
   - ↳ You wonder what type of weather is happening or might happen. Are there any signs of precipitation or wind?
3. **Make a hypothesis.** (A hypothesis is the best guess to answer your question.)
   - ↳ As the sky gets darker still, you decide that a severe storm is starting and you need to share this information with your family.
4. **Test your hypothesis.** (This is the step where you experiment!)
   - ↳ Once you ensure your family is aware of a pending storm, you continue to observe the changing weather outside. The clouds continue to darken as rain falls heavily, and lightning can be seen in the distance.

5. Evaluate the results.

After observing the storm for another five minutes, your family checks a cell phone to confirm that a severe thunderstorm has entered your area and will be clearing up in the next 10–15 minutes.

Was your hypothesis correct or incorrect? What did you learn? Often this is when scientists go back to step one and repeat the process.

Many times you'll make a hypothesis or prediction and discover after testing that you were incorrect. That's okay! The results provided an answer and made way for you to think up the next possibility. American inventor Thomas Edison once said in an interview:

> "I never allow myself to become discouraged under any circumstances. I recall that after we had conducted thousands of experiments on a certain project without solving the problem, one of my associates, after we had conducted the crowning experiment and it had proved a failure, expressed discouragement and disgust over our having failed 'to find out anything.' I cheerily assured him that we had learned something. For we had learned for a certainty that the thing couldn't be done that way, and that we would have to try some other way. We sometimes learn a lot from our failures if we have put into the effort the best thought and work we are capable of."

☐ Weather Observation

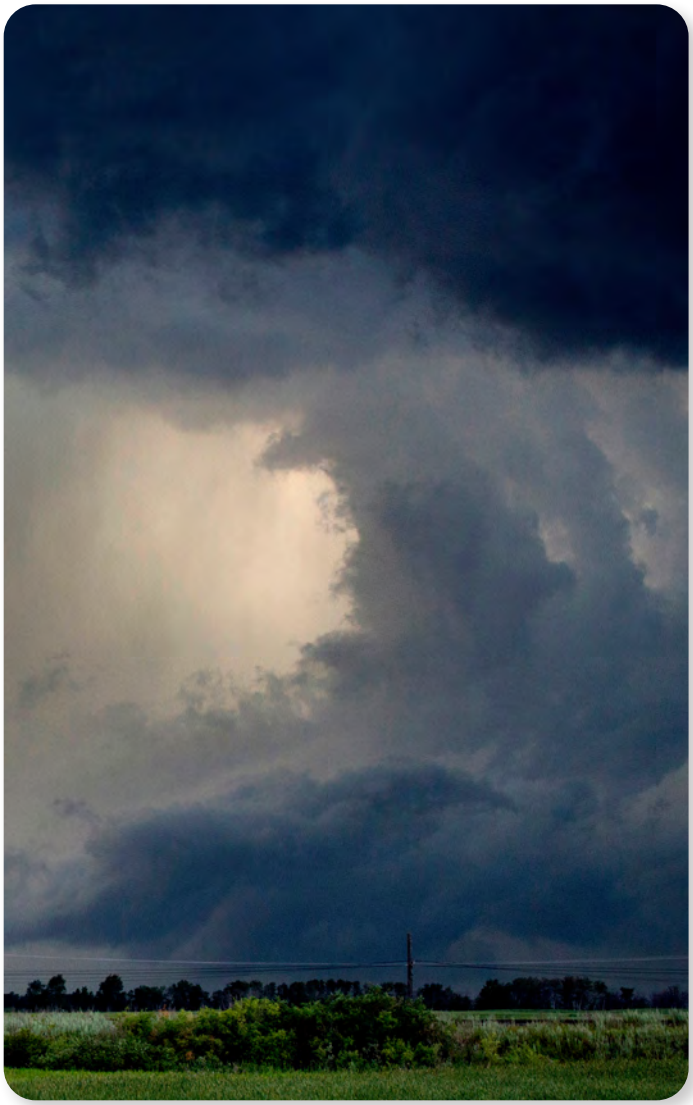
Read to the children: We are going to take a few moments to observe weather firsthand. We will be going outside, or observing from a window, to really notice the weather. We will be doing this a few times throughout this unit, and hopefully we can experience a few different types of weather.

Once outside (or looking through the window) ask the children what they are seeing and hearing using these questions or any of your own. Is the sun out, or is it cloudy or partly cloudy? Is there any precipitation (rain, snow, etc.) falling, or has any fallen recently? Do you see any clouds in the sky? If so, what color, shape, and size are they?

☐ Lesson 1 Extension

7–8

Have children grades 7–8 complete the self-directed Lesson 1 extension titled "Meteorological Pioneers" in their student journals.



Babylonian Weather Predictions

Babylonians made short-term weather predictions by watching cloud patterns.

650 BC

Aristotle's Weather Treatise

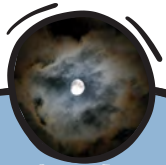
A set of four books called *Meteorologica* was the weather authority for nearly 2,000 years.

340 BC

Chinese Weather Calendar

Created by 300 BC, the calendar divided the year into 24 sections—each marking a different type of weather.

300 BC



Weather Lore

People relied on traditions and myths to predict the weather. Many persist today, such as "If a circle forms 'round the moon, 'twill rain soon."

300 BC–AD 1400

First Hygrometer

The first known hygrometer (an instrument that measures moisture in the air) was designed by Nicholas Cusa around 1450.

1450

First Thermometer

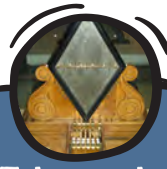
The first known thermometer (an instrument that measures air temperature) was designed by Galileo Galilei around 1592.

1592

First Barometer

The first known barometer (a tool that measures air pressure) was designed by Evangelista Torricelli in 1643.

1643



Telegraph Invented

The telegraph allowed scientists to share weather data. At about the same time, the first weather maps were drawn, and moving storms could be identified and studied.

1850

Radiosonde Invented

Launching weather balloons with radiosondes, instruments that measure pressure, temperature, and relative humidity, was a big step in meteorology.

1920

First Weather Satellite

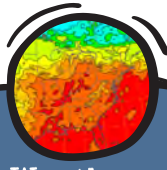
TIROS was the first to launch, and it operated for 78 days. It took pictures of Earth's cloud cover.

1960

Digital Thermometers

Mercury thermometers were the standard until they were replaced with safer digital thermometers.

1973



Weather Supercomputers

Incredibly fast supercomputers compile large amounts of data to make more accurate weather forecasts.

2009

Water and Our World

Objective

Help the children understand the properties and importance of water.

Preparation:

- ☐ None

Experiment Supplies:

- 1 jar of hot water with a lid
- 2 pennies per child
- 1 eye or medicine dropper per child

☐ Wonderful Water

Read to the children: Today we are going to learn about Earth's most abundant resource. What do you think it might be? [water]

Bring out a hot, but not too hot to touch, lidded jar of water. Have the children touch it and discuss how warm it feels to them.

Tell me what you already know about water. **Point to the jar of water as needed.** What does water smell like? [odorless in the pure state at room temperature] What does water taste like? [tasteless in its pure form—treated water has a taste; water also picks up minerals that can add taste to the water] What does water look like? [transparent (clear) and colorless in its pure form] Water is the only commonly available natural resource that is a transparent, colorless, odorless, and tasteless liquid.

Water as a liquid and as ice covers more than 70% of the surface of the earth. Where have you seen water? [Answers might include puddles, creeks, lakes, oceans, etc.] There is water in many places, but most of the earth's water—97% in fact—is held in the oceans.

☐ Water Influences the Weather

Read to the children: ***Heat capacity*** is the number of heat units needed to raise the temperature of an object by one degree Celsius. Water is a substance that has a high

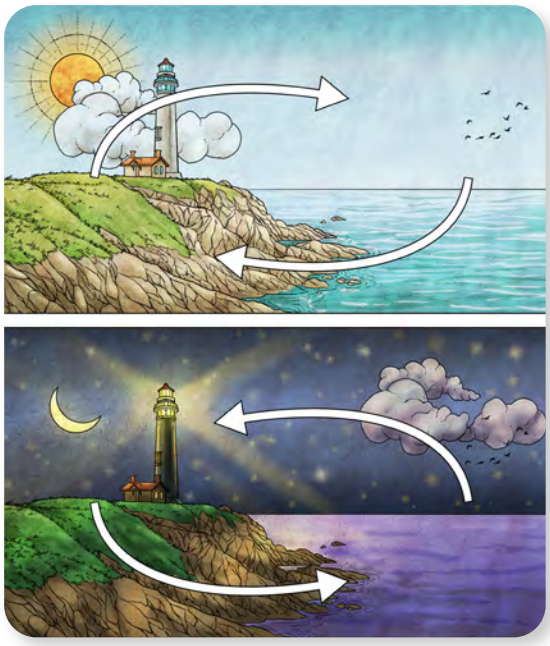
heat capacity, which means it has the amazing ability to absorb and retain a lot of heat before it begins to get hot physically. Compared to the substances that make up land and air, the high heat capacity of water means that it can gradually warm and cool down, which is why temperature change between seasons is gradual.

Feel the jar. Is it still warm? It's still warm because of the great heat capacity of the water inside the jar. This same principle is how the oceans are able to influence the weather.

If the ocean water is warm, it will warm the air above it, creating wind. Wind, in turn, influences the weather on both sea and land.

Land also influences air temperature. Things get especially interesting where land and water meet. During the day, the sun heats the land, making it warmer than the water. The warm land heats the air above it, causing the air to rise. The relatively cool air above the water rushes in to fill the space. What do you think happens at night? [The heat capacity of the water is greater than the land, so generally the opposite effect takes place.]

Look at the images below. They show us the movement pattern of air near oceans and lakes. The breezes that are created from this pattern of air movement are called sea and land breezes. Notice how clouds form where the warm, moist air is rising.



☐ Waterdrop Experiment

WATCH ONLINE

Have the children turn to the "Waterdrop Experiment" page in Lesson 3 of their student journals. Then have the children complete the experiment below or watch the video titled "Waterdrop Experiment" at goodandbeautiful.com/sciencevideos or on the Good and Beautiful Homeschool app. An answer key can be found at the end of the lesson.

Read to the children: Water has so many unique and fascinating characteristics. This amazing resource has the tendency to seek other particles from different substances. This attraction is called ***adhesion***. Water molecules also like to cluster together with one another. This type of attraction is called ***cohesion***. Let's see these properties in action!

In this experiment we will put drops of water on a dry penny and drops of water on a wet penny to test adhesion and cohesion. We will count drops and observe how many drops each penny can hold.

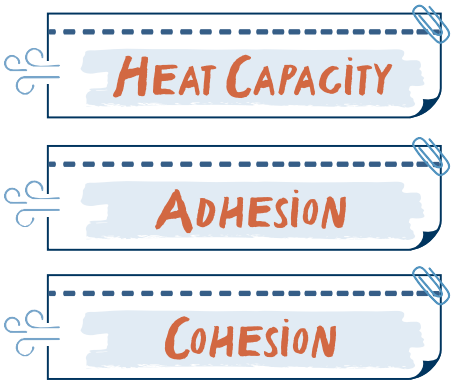
In their student journals, have the children write their predictions for how many drops they believe will stay on top of the dry penny or wet penny before the water overflows. Have the children squeeze drops of water from the eye or medicine dropper carefully onto each penny and count the drops. Have them record their numbers in their journals.

Did you see how the water formed a little dome on top of the penny before it overflowed? Which penny held more? [the dry penny] This showed cohesion in action!

The cohesive and adhesive nature of water is why we have rain. Micro water droplets inside clouds come together to form larger, heavier drops of water, which fall as rain.

Science Wall: Vocabulary Words

Place the vocabulary cards HEAT CAPACITY, ADHESION, and COHESION on your science wall. Read and discuss the words and definitions.



Weather Observation

Read to the children: We are going to take a few moments to observe weather firsthand. We will be going outside, or observing from a window, to really notice the weather.

Once outside ask the children what they are seeing and hearing using these questions or any of your own. Is the sun out, or is it cloudy or partly cloudy? Is there any precipitation falling, or has any fallen recently? What season is it where you live? Are you experiencing any weather that is specific to this season?

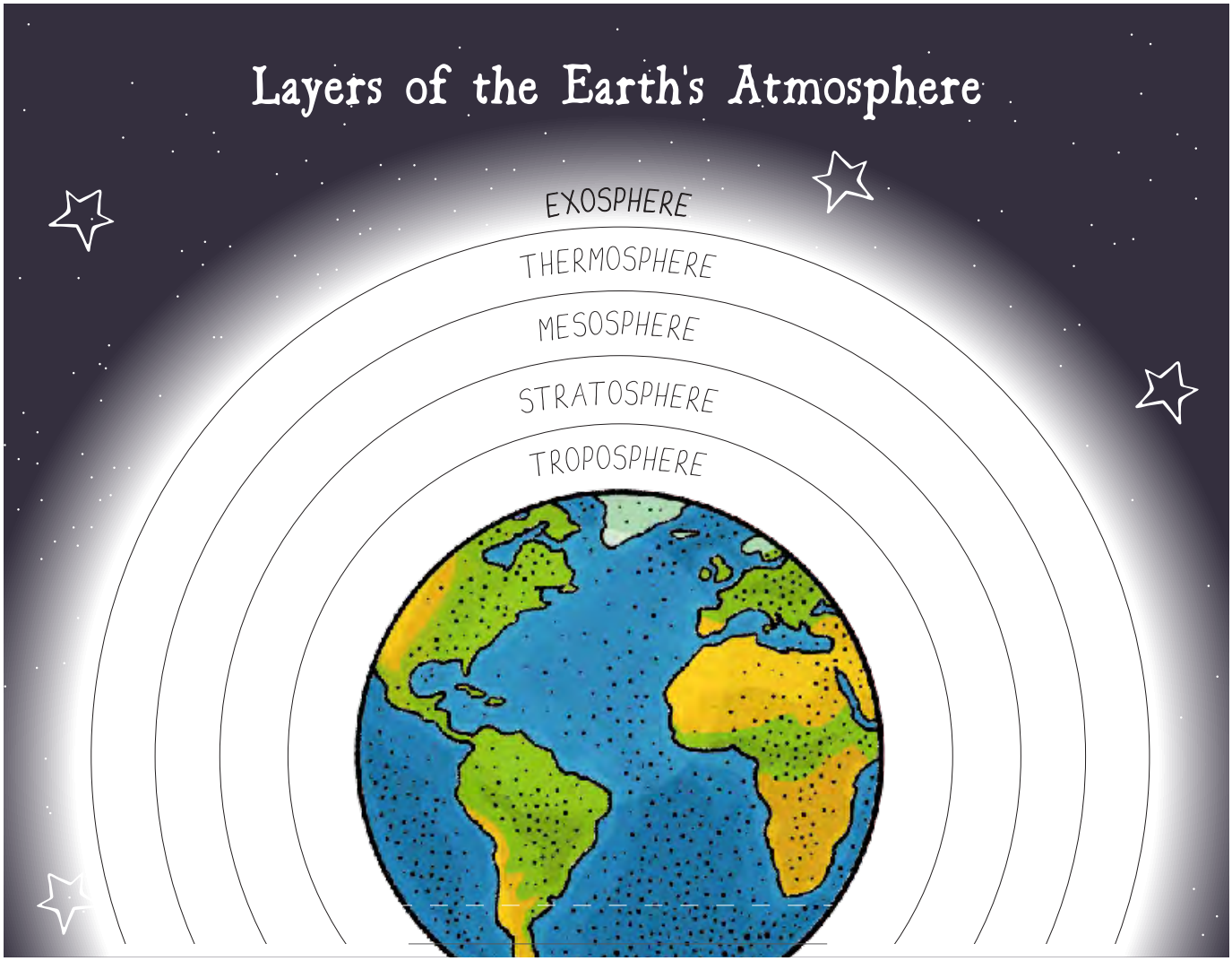
Lesson 3 Extension

7–8

Have children grades 7–8 complete the self-directed Lesson 3 extension titled "Dangerous Droughts" in their student journals.

EXAMPLE OF COMPLETED FLIP BOOK

Note: Do not cut this out. This is an example of the completed Amazing Atmosphere Flipbook.



OUR AMAZING ATMOSHPERE FLIP BOOK

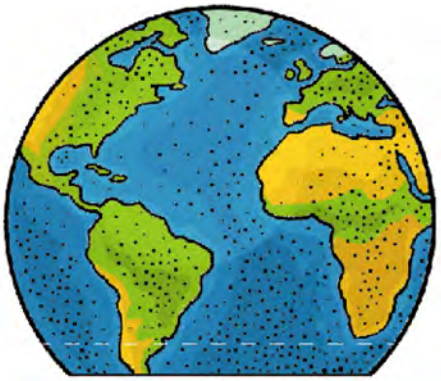
Directions: For each layer cut around the solid line; then fold on the dashed line. Do not cut or fold the exosphere layer. Starting with the exosphere page, attach one layer on top of the next by gluing or stapling it in the designated space.

TROPOSPHERE

The layer closest to Earth's surface is called the *troposphere*. *Tropo-* is from the Greek word tropos, meaning "a turn or change." This region extends about 8 to 14.5 km (5 to 9 mi) and contains almost all of the day-to-day weather we experience. The air in this layer rides on currents that descend when air is cooled and rise once the air is warmed. The process constantly repeats itself, hence the name TROPOsphere, which literally means "sphere of change."

ATTACH THE EARTH HERE.

FOLD HERE



STRATOSPHERE

The next layer is the *stratosphere*. This layer begins where the troposphere ends and extends to about 50 km (31 mi) above sea level. Unlike the troposphere, where temperature decreases with height, the temperature within the stratosphere steadily increases. This is because the stratosphere contains a special gas known as ozone. Ozone absorbs UV rays from the sun, warming the air. The result is a region with air layered like blankets on top of each other—a "sphere of layers." Weather balloons carrying radiosondes are released by meteorologists every day. These instruments travel all the way to the stratosphere before returning to Earth, collecting data along the way.

ATTACH THE TROPOSPHERE LAYER HERE.

MESOSPHERE

The *mesosphere*, or "middle sphere," begins directly above the stratosphere and extends to about 85 km (53 mi) above sea level. Because it's a hard region to sample or measure, meteorologists still have a lot of unanswered questions about the mesosphere. This is where most meteors are vaporized, leaving long trails behind them. When we see them from Earth, we call them "shooting stars" or "falling stars." The air in this region is extremely thin and cold, with an average temperature of -90 °C (-130 °F), and the top of the mesosphere is the coldest part of our atmosphere.

ATTACH THE STRATOSPHERE LAYER HERE.

OUR AMAZING ATMOSHPERE FLIP BOOK

THERMOSPHERE

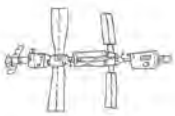
Above the mesosphere and extending to about 600 km (372 mi) high is the *thermosphere*—the "hot layer." Temperatures here can exceed 500 °C (900 °F). This is due to oxygen molecules absorbing rays from the sun, warming the air. Because there are not many molecules or atoms in this region, absorption of even small amounts of energy from the sun makes a huge difference. When air molecules interact with charged particles from the sun, incredible aurora displays are produced. These dazzling displays are seen from Earth as dancing waves of blue, purple, green, yellow, or red. Also found in this layer are satellites.

ATTACH THE MESOSPHERE LAYER HERE.

Our Amazing Atmosphere

EXOSPHERE

The uppermost limit of our atmosphere is the *exosphere*, the "outer sphere." This is where the International Space Station is often in orbit. In this region, the air is so thin that it is almost just like outer space. There's no defined limit to the exosphere. Instead, it gradually fades into space.



ATTACH THE THERMOSPHERE LAYER HERE.

Air

Objective

Help the children learn about the composition and characteristics of air.

Preparation:

- ☐ None

Activity Supplies:

- 1 clean, empty bottle
- 1 scrap of paper, wadded up small enough to fit in the bottle opening, per child

Experiment Supplies:

- 12" balloon
- 1 empty, clear, sturdy plastic bottle (like a sports drink bottle)
- scissors or a nail
- tape

☐ Air Is Matter

Lay the clean, empty bottle down on its side and place one piece of the wadded-up paper just outside the bottle, resting on the edge of the opening/mouth. Have one child take a turn trying to blow the paper into the bottle. Have each child try if desired.

Read to the children: What happened during that activity? [The paper would not go in.] Why wouldn't the paper go in the bottle? [Because the bottle was full of air, and none of the air could get out when we were blowing on the opening, so the paper wouldn't fit.] We cannot see the air that fills this bottle, but this activity illustrates that it is there because nothing else will fit in the bottle unless some of the air is able to come out.

☐ Composition of Air

Cup your hands together, as if to catch something in the air, and have the children do the same. Read to the children: At first glance it may seem like we didn't catch anything, but inside our hands is the same thing taking up space inside that bottle—air—more molecules of air than we have time to count. Only two gases make up 99% of the air. Can you guess what they might be? Oxygen makes up about 21% of our air, and nitrogen about 78%. The remaining 1% is made up of small amounts of gases like carbon dioxide and water vapor. These air molecules are held near the earth by the same force that holds you near the earth—gravity. As gravity pulls air toward the earth, the air exerts a force on whatever it touches. When that force pushes on a surface, it produces ***air pressure***. Air pressure is greatest at sea level and decreases as ***altitude*** increases.

Just how great a force can the air exert? The air inside a 549 m^2 (1800 ft^2) home weighs approximately 1,151 kg (3,341 lb). That's a little heavier than a large female hippopotamus, and that air is constantly pushing

☐ Make a Wind Vane

Read the directions below aloud and assist the children as needed.

1. Write the four cardinal directions (north, east, south, and west) on the bottom side of the paper plate, as shown in the image to the right.

2. Cut an arrow point and tail out of the construction paper, making each about 2 inches in length.
3. Cut two ½" slits at each end of the straw, across from each other.

4. Slide the arrow point and tail into the slits, one on each end of the straw.
5. Insert the pin through the center of the straw and then into the eraser tip of the pencil, making sure to leave space for the straw to spin.
6. Poke the point of the pencil through the center of the paper plate and then into the ball of clay. You may test the wind vane at this point by gently blowing the arrow point to ensure it can spin freely.
7. Place the structure on a second paper plate and tape the plates together, with the clay ball secured between them.

Take your wind vane outside and align the word NORTH written on the plate in the direction north using the compass. Watch the arrow spin as wind moves it and discover the direction the wind is blowing.

☐ Lesson 7 Experiment Preparation

The "Water Evaporation in (Slow) Action Experiment" in the next lesson, Lesson 7, will need to be prepared 24 hours prior to beginning the lesson. Fill the two glass jars or plastic containers with water. Place a lid securely on one of the jars. Using the dry-erase marker, draw a line on each jar at the water level. Set the jars on a windowsill or outside in the sun on a day with no rain. Show the children the jars with water, explaining that you will be conducting an experiment on the water in the jars in the next lesson.

☐ Lesson 6 Extension

7–8

Have children grades 7–8 complete the self-directed Lesson 6 extension titled "Global Wind Systems" in their student journals.

"The HMS 'Prince' Before the Wind" by Jan Karel Donatus van Beecq (1638–1722), c. 1700s

Clouds and Weather Fronts

Objective

Help the children gain an understanding of the composition and types of clouds.

Preparation:

- ☐ Cut out the "Misty Mystery Clues" and sort them into piles by color.

Activity Supplies:

- scissors
- sheet of blue or other dark cardstock or cardboard
- glue stick
- paint stir stick or something similar to make a handle (optional)

☐ Make a Cloud Viewer

Have the children turn to the "Make a Cloud Viewer" page in Lesson 8 of their student journals and read the information about each cloud type. Then have them cut out the pictures and follow the instructions to create a cloud viewer. Weather permitting, go outside to see if you can identify any of the clouds in the sky.

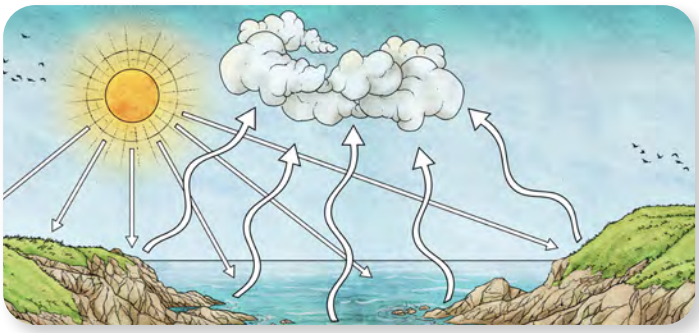
Note: It is incredibly dangerous to look directly at the sun. Discuss with children the importance of looking at clouds that aren't near the sun to protect their eyes.

☐ How Are Clouds Formed?

Read to the children: In the last lesson, we learned about the water cycle. Through the water cycle, water makes its way into the air as water vapor. How many forms of water in the air can you name? [rain, snow, ice, hail, fog, clouds, etc.]

Water vapor is an important part of the formation of all these things, including clouds. **Study the image to the right with the children as you read the steps on how most clouds are formed.**

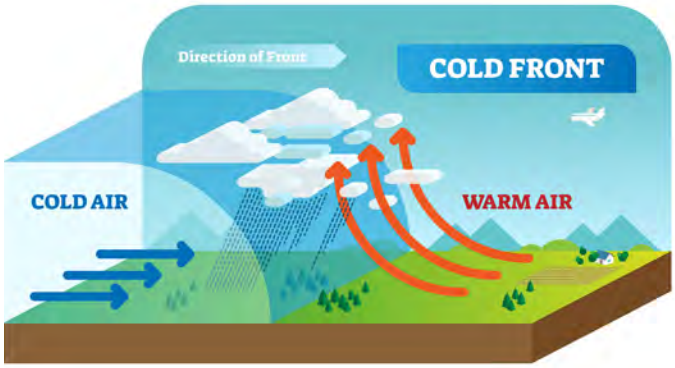
1. Warm air close to Earth's surface, which can hold a lot of water vapor, rises.
2. As the air rises, it begins to cool.
3. Cool air cannot hold as much water vapor as warm air. As a result, the water vapor collects on dust particles in the air and turns back into microdroplets as the air cools. When many water microdroplets come together, they form a cloud.

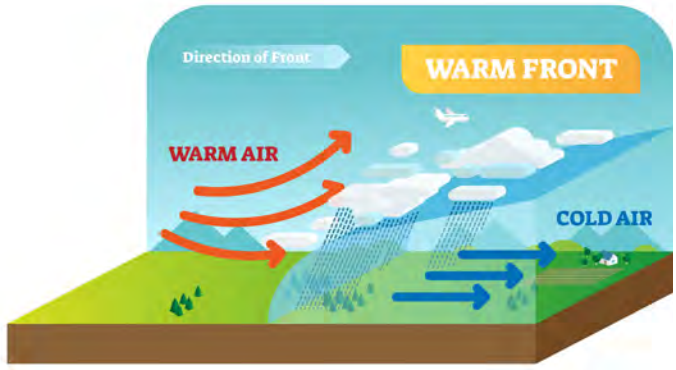


Weather Fronts

Read to the children: Characteristics, such as wind, temperature, and humidity, can be used to describe air masses. A ***weather front*** is a boundary separating air masses with differing characteristics.

If a mass of cold, dense air pushes under a mass of warm air, the front is cold and often creates cumulus clouds. If a mass of warm, not dense air pushes up and over a mass of cold, dense air, the front is warm. Many different clouds are made this way, including altocumulus, altostratus, stratus, and stratocumulus.





Science Wall: Vocabulary Word

Place the vocabulary card WEATHER FRONT on your science wall. Read and discuss the word and definition.

Misty Mystery

Have the children turn to the "Misty Mystery" page in Lesson 8 of their student journals and follow the directions in the next column to complete the page.

1. **Place the piles of "Misty Mystery Clues" on the table.**
2. **Pick a color to start.**
3. **Starting with Clue #1 on top of the pile, have the children read the clue and circle the correct answer in the corresponding colored number box in their student journals. For example, if the card reads "High in the sky" and has a light-blue "1" by it, they would circle "high" in the light-blue box on the journal page.**
4. **Cross out any types of clouds that the clue doesn't match under "type" at the top of the box. The children may use their "Cloud Viewer" to help identify the different types of clouds if needed.**
5. **Choose another color and continue reading each clue in numeric order. Complete the boxes on the journal page until the children are able to identify each cloud type, circle the cloud type, and draw the shape of the cloud at the bottom of the box. Look at the photographs of each type of cloud on the Clue Cards for a hint.**

Lesson 8 Extension

7–8

Have children grades 7–8 complete the self-directed Lesson 8 extension titled "Unusual Cloud Formations" in their student journals.

Rain and Rainbows

Objective

Help the children understand how rain develops, how rainbows are created, and what rainbows teach us about color.

Preparation:

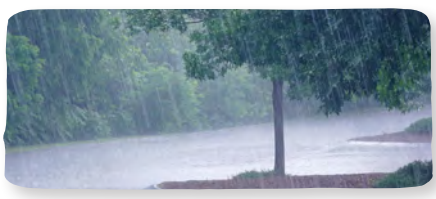
- ☐ None

Activity Supplies:

- wide-mouthed glass jar (the wider, the better)
- very hot water
- blue food dye (optional)
- a metal pie pan
- ice cubes
- clock or watch
- empty 2-liter plastic bottle with straight sides, if possible (optional)
- scissors (optional)
- permanent marker (optional)
- ruler (optional)
- 1 or 2 handfuls of small stones (optional)
- 2 binder clips (optional)

☐ What Is Precipitation?

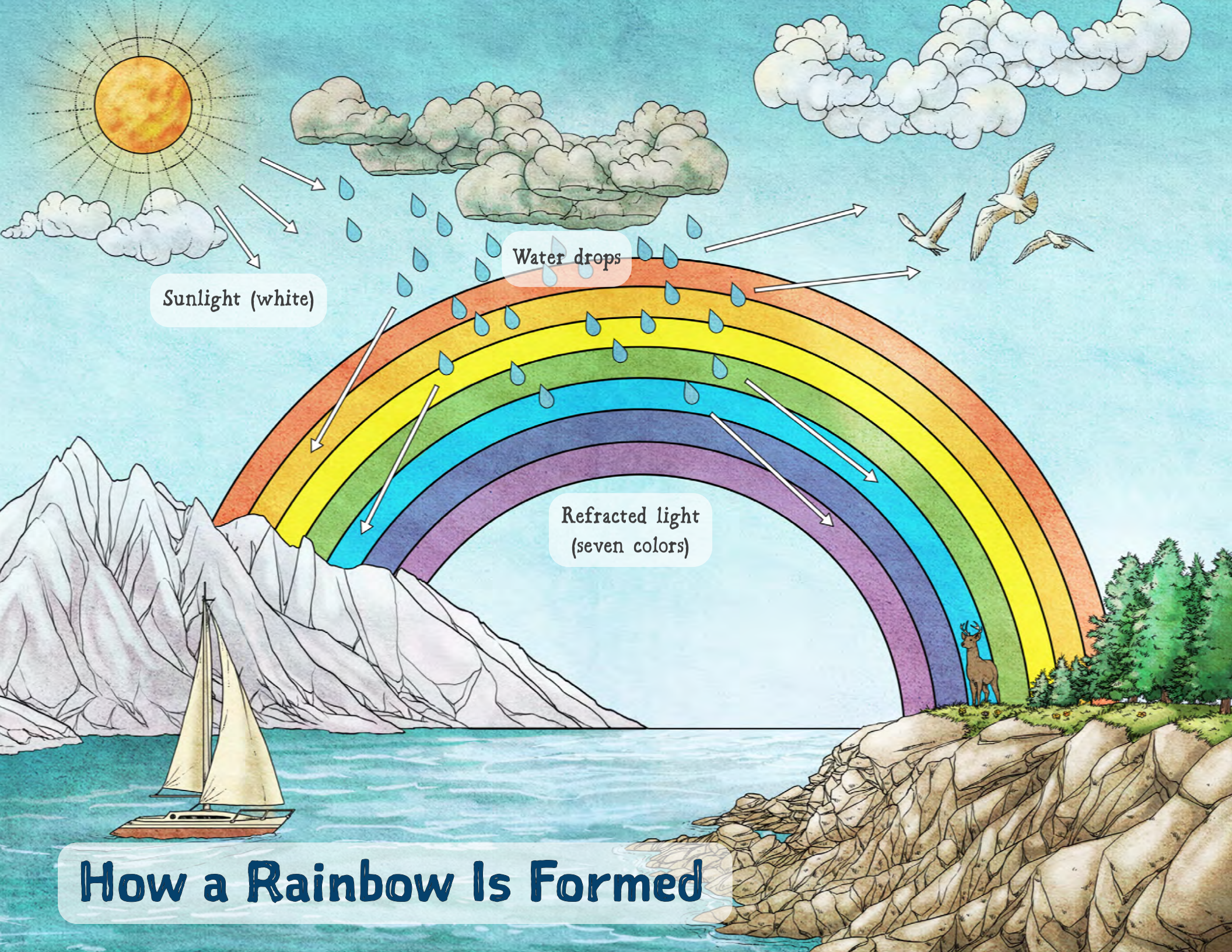
Read to the children: I'm going to describe a beautiful scene in nature to you. Close your eyes. Imagine you are outside on a warm summer day. It's midafternoon, and the air begins to feel heavy and sticky. You notice many puffy clouds in the sky, gray and full, all coming together, making it hard to tell where one ends and another begins. You're called inside to help with something. While cleaning up you hear **(tap fingers on the table slowly then quickly to sound like the pitter-patter of rain)**—it is raining. **(Continue the pitter-patter for a moment.)** The rain eventually ends, and you go back outside. Everything is wet, and the air smells different—almost sweet. The whole world seems to glisten as the sun begins to peek out from behind the parting clouds. Open your eyes. Not all rainy days are exactly like the one I described. Tell me about a rainy day that you remember. What did the air feel like? What sounds do you remember? What did it look like? What smells did you notice?



Any liquid or frozen water that comes from a cloud is ***precipitation***. Some common types of precipitation are rain, snow, sleet, and hail. In this lesson we are going to focus on one type of precipitation: rain. What do you know about rain?

☐ Making Rain Experiment

Have the children turn to the "Making Rain Experiment" page in Lesson 9 of their student journals and have them complete each section when prompted. Have the children follow the steps below to complete the experiment or watch the video titled "Making Rain Experiment" at goodandbeautiful.com/sciencevideos or on the Good and Beautiful Homeschool app.



How a Rainbow Is Formed

Snow, Sleet, Hail, and Freezing Rain

Objective

Help the children gain an understanding of snow, sleet, hail, and freezing rain.

Preparation:

- ☐ Cut out the "Precipitation Match" cards in each child's student journal. Keep the key at the end of the lesson out of view from the children.

Activity Supplies:

- blank sheets of paper
- scissors

☐ Optional Read Aloud

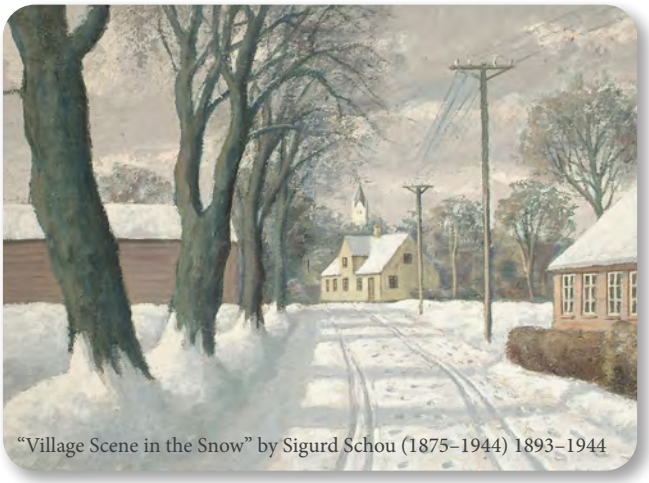
At any point in the lesson, you may read one of the books from the optional Read-Aloud Book Pack. Longer books may be split into more than one reading session. *The Schoolhouse Blizzard* by Shannen Yauger is suggested for this lesson.

☐ Beautiful Snow

Show the children the snowflakes to the right. Read to the children: These incredible photographs were all taken by Wilson Bentley, a pioneer in meteorology and photography. He spent two years fine-tuning a photography technique that captured the beauty and details of a snowflake. In 1885, at the age of 19 years old, he made the world's first photomicrograph of a snowflake. He went on to capture thousands and thousands of photomicrographs, improving his technique with each one. His photomicrographs were so well done that they are still referenced today to study ice crystal formation. **Ask the children which snowflakes are their favorites.**

Snow is formed similarly to rain but forms only when the air temperature is consistently below freezing. Water vapor freezes around dust particles and forms an ice crystal. The tiny ice crystal moves through the air and collides with other tiny ice crystals, causing them to stick together. This process continues until the crystals become too large and heavy and fall from the sky as snow.

Have the children look at the painting below. Where in this painting do you see snow? Do you think it is still snowing?



"Village Scene in the Snow" by Sigurd Schou (1875–1944) 1893–1944

☐ Make a Snowflake

Have the children turn to the "Make a Paper Snowflake" page in Lesson 10 of their student journals and, using the blank pieces of paper, follow the instructions to make a snowflake.

☐ Precipitation Match

Read to the children: Sleet, hail, and freezing rain are unique forms of precipitation that occur only in particular geographic areas and only at specific times of the year, so many people never have the chance to see or experience one or more of them. We are going to play a matching game to learn about these amazing types of precipitation. **Have the children race to see who can match their cards fastest. When a child matches the three cards for a type of precipitation (one image and two descriptions), have the child read, or read for him or her, the descriptions. If only one child is completing the lesson, have him or her race a 5-minute timer to match all the cards and then read the descriptions.**

☐ Weather Observation

Read to the children: We are going to take a few moments to observe weather firsthand. We will be going outside, or observing from a window, to really notice the weather.

Once outside, ask the children what they are seeing and hearing using these questions or any of your own. Is there any precipitation falling, or has any fallen recently? Can you feel or see any signs of wind? If so, what do you notice about the wind speed?

☐ Winter Poem

Read the poem in the blue box to the children. After you have read it, ask the children what types of precipitation they heard about in the poem and if this poem makes it seem like snow would be an enjoyable type of precipitation to experience.

Winter

By Dorothy Aldis

The street cars are like frosted cakes—
All covered up with cold snowflakes.

The horses' hoofs scrunch on the street;
Their eyelashes are white with sleet.

And everywhere the people go—
With faces tickled by the snow.

☐ Lesson 10 Extension

7–8

Have children grades 7–8 complete the self-directed Lesson 10 extension titled "Snowflake Bentley" in their student journals.

Lightning and Thunder

Have you ever seen a streak of lightning flash across the sky and heard the rumbling thunder to accompany it? This awe-inspiring spectacle is incredible. Let's see how lightning and thunder are created.

Severe Weather: Tornadoes and Tropical Cyclones

Objective

Give children an overview of tornadoes and tropical cyclones, how they are formed, and their impact on the world.

Preparation:

- ☐ None

Activity Supplies:

- plastic water bottle
- dish soap
- glitter or food dye (optional)

☐ Severe Weather Video

WATCH ONLINE

Have the children watch the "Severe Weather Video" at goodandbeautiful.com/sciencevideos or from the Good and Beautiful Homeschool app.

☐ What Is Severe Weather?

Read to the children: Weather, though incredibly beautiful, can sometimes be overwhelming and have the potential to cause damage and disruption to day-to-day life. This is what is known as severe weather. We'll discuss two common types of severe weather today: ***tornadoes*** and ***tropical cyclones***.

☐ Tornado in a Bottle Activity

Have the children turn to the "Tornado in a Bottle" page in Lesson 12 of their student journals. They will complete the page after creating a tornado in a bottle. An answer key can be found at the end of the lesson.

Fill the plastic water bottle ¾ full with water. Add two squirts of dish soap into the bottle. If desired, add the glitter or food dye (which will help the children see the tornado). Replace the cap. While holding the bottom of the bottle, swirl the tip in a circle until the water is spinning inside. Have the children take turns swirling the bottle and observing the "tornado" that is created.

Wild Weather

Work together to help the Raindrop family get home safely as they navigate some wild weather and learn about the incredible tools and equipment used to track and predict the weather!

Start

Everyone, share what your favorite season is and why.

The family drives through a sunny valley. Advance 1 space.

A rainbow emerges after the storm. Advance 1 space to enjoy it.

A sudden hailstorm begins. Draw a card and read the information out loud as the family waits for it to end.

Answer this riddle: What type of bow cannot be tied?

Snow has started falling heavily. As the family is driving more carefully, draw a card.

The snow has stopped, and the family is back on the road. Advance 1 space.

Road Trip Game

A thunderstorm forms quickly around the family. As they wait the storm out, draw a card and read the information aloud.

Work together to list the 3 states of water. If you're able to list all 3 correctly, move forward 2 spaces.

The family is stuck in a heavy rainstorm. Lose a turn.

A tornado warning has been issued over the radio. Draw a card as the family seeks shelter.

The family chooses an excellent shelter location during the tornado. Advance 1 space.

Strong gusts of wind make driving unsafe. Draw a card as the family stops until it is safe to drive again.

As a group, name the 4 stages of the water cycle.

Congratulations!

You got the family home safely!

Riddle Answer:
a rainbow

WEATHER AND WATER

Grades 3-6

STUDENT JOURNAL

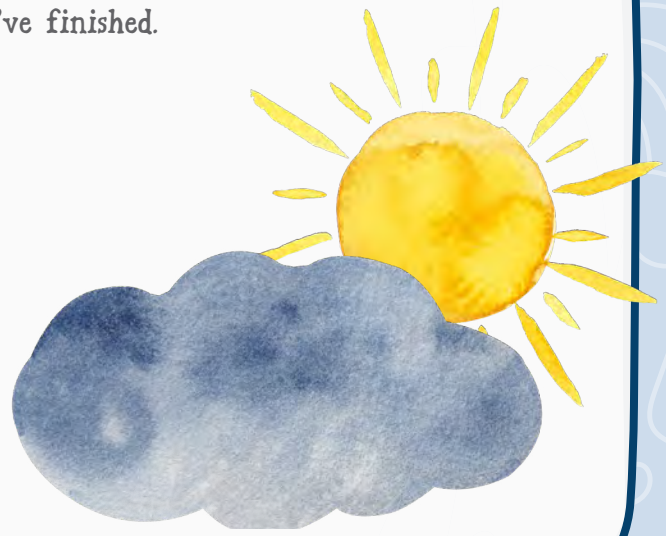
This journal belongs to:

THE GOOD AND THE BEAUTIFUL

INSTRUCTIONS

This student journal accompanies *The Good and the Beautiful Weather and Water* science unit. It contains all the worksheets and journal pages that are needed to complete the unit. Each student will need his or her own copy of the science journal.

Have each student take his or her time to create high-quality work as the activities and worksheets are completed. Students may enjoy looking back on their past discoveries when they've finished.



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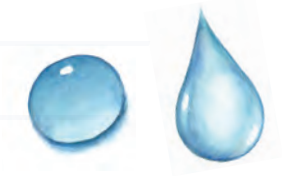
Lesson 3

WATERDROP EXPERIMENT



My Predictions:

Dry Penny

Wet Penny

My Results:

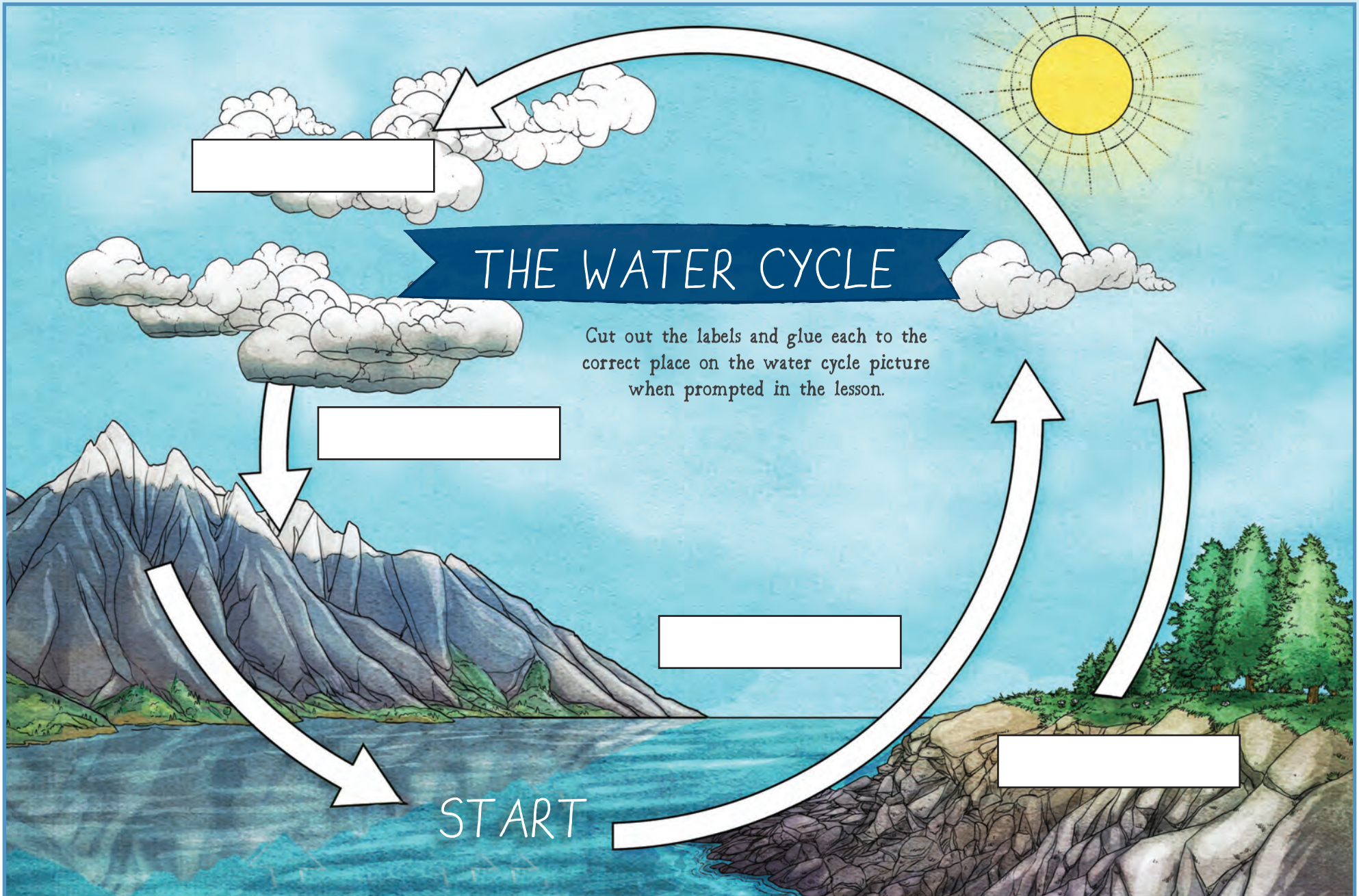
Dry Penny

Wet Penny

Lesson 6

JUNIOR METEOROLOGIST

It's time to test your meteorology skills! After reviewing the Beaufort Wind Scale chart on the next page, write the correct Beaufort number under each picture.



Evaporation | Transpiration | Condensation | Precipitation

MAKE A CLOUD VIEWER

Cut out the blue pictures of the clouds below. Then cut out the interior portion of a piece of cardstock or cardboard square so that you have a frame. Arrange the pictures around the edges of the frame and glue them down. You may add a handle to the bottom of your frame if you wish.

CUMULUS
low to middle clouds that look like large, fluffy cotton balls

STRATOCUMULUS
low clouds that look fluffy and gray; may be a sign of rain

STRATUS
low clouds that look flat, gray, and spread out; may be a sign of drizzle

CUMULONIMBUS
very low clouds that span low to high; a sign of thunderstorms

CIRROCUMULUS
high clouds that look fluffy, like cotton balls

CIRRUS
high clouds that look wispy and thin; appear during good weather

ALTOSTRATUS
middle clouds that look flat and gray; usually a sign of rain

ALTOCUMULUS
middle clouds that look small and fluffy

MISTY MYSTERY

①

Type:

Cirrus Stratus Cumulus Cumulonimbus

Clue #1: low / high

Clue #2: feathery / blanket / puffy / large & gray

Clue #3: thick / wispy

Clue #4: Draw the cloud shape below.

②

Type:

Cirrus Stratus Cumulus Cumulonimbus

Clue #1: low / high

Clue #2: feathery / blanket / puffy / large & gray

Clue #3: thick / wispy

Clue #4: Draw the cloud shape below.

③

Type:

Cirrus Stratus Cumulus Cumulonimbus

Clue #1: low / high

Clue #2: feathery / blanket / puffy / large & gray

Clue #3: thick / wispy

Clue #4: Draw the cloud shape below.

④

Type:

Cirrus Stratus Cumulus Cumulonimbus

Clue #1: low / high

Clue #2: feathery / blanket / puffy / large & gray

Clue #3: thick / wispy

Clue #4: Draw the cloud shape below.

PRECIPITATION MATCH

Freezing rain occurs when snow melts or partially melts in the air but does not refreeze until after it reaches the ground or a surface.

Sleet occurs when snow melts or partially melts in the air, then freezes again before reaching the ground.

Hail, being a solid mass of ice, can cause significant damage to homes, vehicles, and other buildings. The largest hailstone recorded fell in Nebraska and was 18 cm (7 in) in diameter!

Freezing rain can accumulate and add weight to tree branches and power lines, causing them to snap or break.

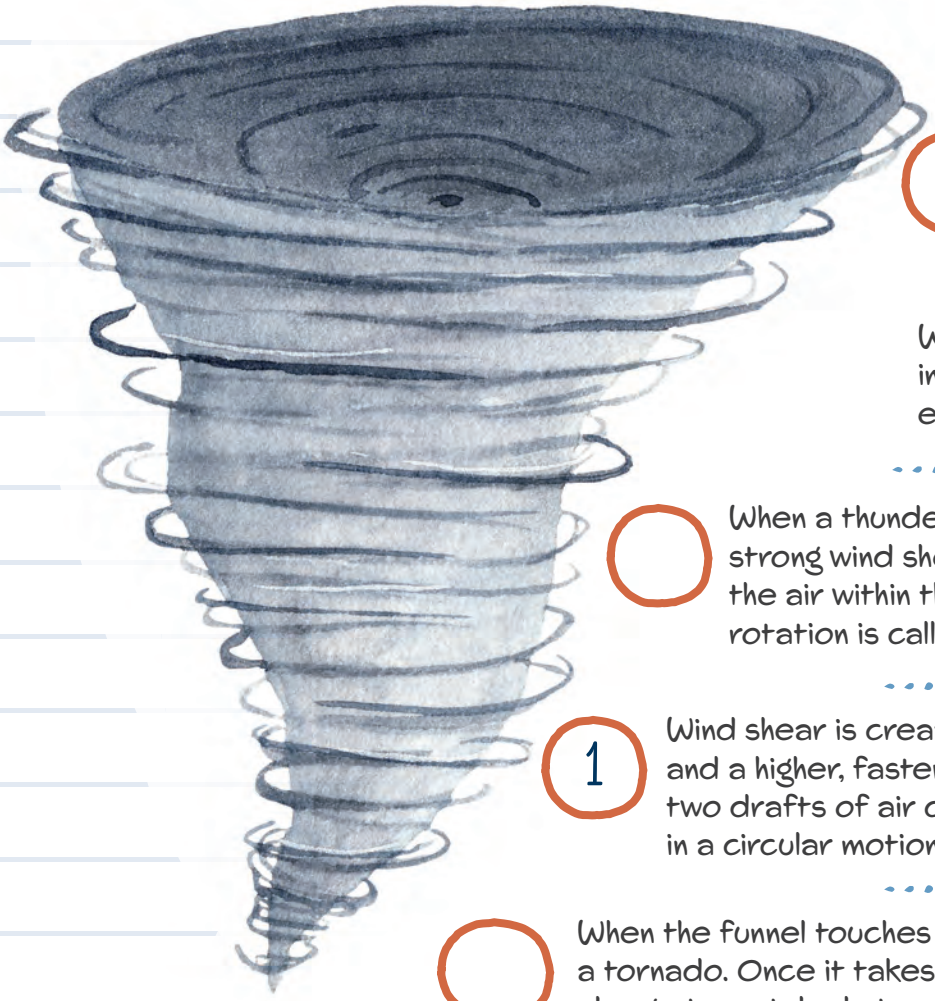
Hail forms when water droplets carried by moving air in a cumulonimbus cloud shoot up high inside the cloud and freeze around a dust particle, then fall back to the bottom of the cloud, where they collect more water before being blown back up high into the cloud to refreeze. The process repeats until hailstones become too heavy and fall to the ground.

Sleet can be measured the same way snow is measured—by sliding a ruler directly downward into the sleet until the ruler reaches the ground.

Lesson 12

TORNADO IN A BOTTLE

Help! A tornado came through your journal and blew the steps of how a tornado is formed out of order! Read the mixed-up steps below as a group. Then write a number 2–4 in the orange circles next to each step to show where it takes place in the formation of a tornado. (Step 1 has been labeled for you.) Next, use your "Tornado in a Bottle" to complete the activity at the bottom of the page.



In some supercell storms, the mesocyclone pushes down through the bottom of the storm. The downward mesocyclone creates a condensation funnel full of moist air. Water vapor within the funnel condenses into tiny water droplets as the funnel extends closer toward the earth.

When a thunderstorm develops in an area with strong wind shear already present, this causes the air within the storm to rotate. The center of rotation is called a mesocyclone.

1

Wind shear is created when a lower, slower air draft and a higher, faster air draft pass by each other. The two drafts of air cause the air between them to spin in a circular motion.

When the funnel touches down on the earth, it has become a tornado. Once it takes up dust and debris, its color will change to match whatever type of ground it's spinning on.

Work with your family to spin your "Tornado in a Bottle" and see how long you can get it to spin by itself.

seconds

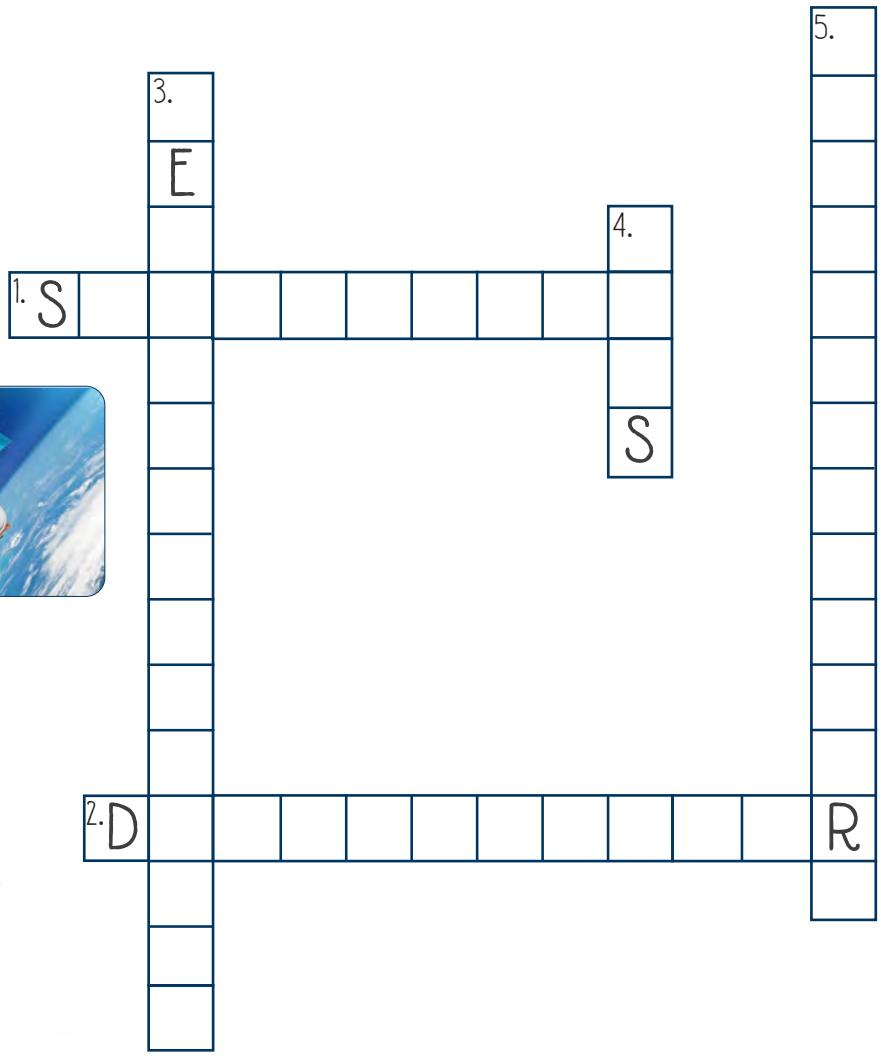
Great! Now try spinning the bottle two more times, trying to get the "Tornado" to spin by itself even longer!

seconds

seconds

METEOROLOGICAL TOOLS CROSSWORD

Use the clues and word bank below to solve the crossword puzzle.



ACROSS
1. Objects that observe the earth from space and continuously record observational information
2. Radar that is able to measure the direction and strength of the wind, rotation of thunderstorm clouds, and all types of precipitation

DOWN
3. Carry radiosondes high into the atmosphere to collect data
4. Abbreviation for stations across the country that are maintained by volunteers
5. Used to turn the immense amount of weather data into usable information to assist meteorologists

Word Bank

ASOS	SATELLITES	WEATHER BALLOONS
DOPPLER RADAR	SUPERCOMPUTERS	

WEATHER AND WATER

Grades 7-8

STUDENT JOURNAL

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THE GOOD AND THE BEAUTIFUL

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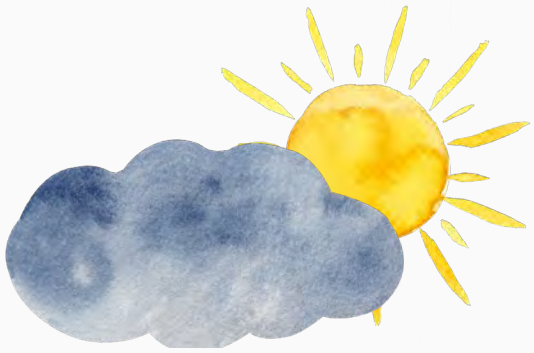

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WONDERFUL WEATHER

Rank the topics shown below by your level of interest in each, writing a **1** in the box of the most interesting topic and an **8** in the box of the least interesting topic. Once you have completed ranking all the topics **1–8**, use the blank lines to write a question you have about each topic.

Tornadoes

Weather Fronts

Clouds

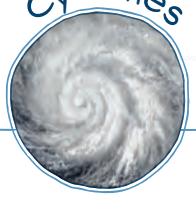
Rain

Lightning

Rainbows

Weather Forecasting

Cyclones



EXTENSION

Instructions:

1. Read each of the biographies below.
2. On the next page, write down three key facts about each of the scientists that you read about.

Meteorological Pioneers

Daniel Gabriel Fahrenheit

Born in Poland in 1686, Daniel Gabriel Fahrenheit was a Dutch physicist who made many contributions to the study of meteorology. He invented the alcohol thermometer in 1709 and created a revised version, the mercury thermometer, in 1714. The mercury thermometer was durable, inexpensive, accurate, and able to measure high temperatures. Fahrenheit is most known for the Fahrenheit temperature scale, which has a 32° freezing point and a 212° boiling point. The United States and its territories are the only places that currently use the Fahrenheit scale to measure temperature. Besides the temperature scale, Fahrenheit also discovered that water can remain in a liquid state below freezing and that the boiling point of water varies depending upon the atmospheric pressure.

Anders Celsius

Anders Celsius was born in 1701 in Sweden. He was born into a family of scientists and mathematicians, with both of his grandfathers and his father being professors at Uppsala University. Celsius studied and became an astronomer and eventually became a professor of astronomy at Uppsala University like his ancestors. He invented the Celsius temperature scale, which originally had a 0° boiling point and a 100° freezing point. He built Uppsala Observatory to continue and encourage the study of astronomy. Celsius studied the aurora borealis, or the northern lights, in great depth and published a collection of observations about his discoveries. After his death, the Celsius temperature scale was reversed to a 0° freezing point and a 100° boiling point. Today this temperature scale is used in almost every country in the world, except for a few that continue to use the Fahrenheit scale.

William Thomson

Although he was a Scottish engineer, mathematician, and physicist, William Thomson was born in Belfast, Ireland, in 1824. He became a professor of natural philosophy at Glasgow University and implemented the first physics laboratory in Britain. His interests varied from thermodynamics to electromagnetism and submarine telegraphy, for which his studies made him famous. He invented the mariner's compass, a tide machine, and depth-measuring equipment. Perhaps his most remarkable development was the Kelvin temperature scale. The most unique characteristic that sets it apart from both the Fahrenheit and Celsius scales is that it is not measured by degrees, but instead uses kelvins. Zero is the coldest possible temperature, which is also known as absolute zero, and it indicates a total absence of heat. This scale is primarily used by physicists and scientists to measure very precise temperatures. The scale was named after the Kelvin River, which is near Glasgow University. Thomson was knighted in 1892 and was given the title Baron Kelvin of Largs.

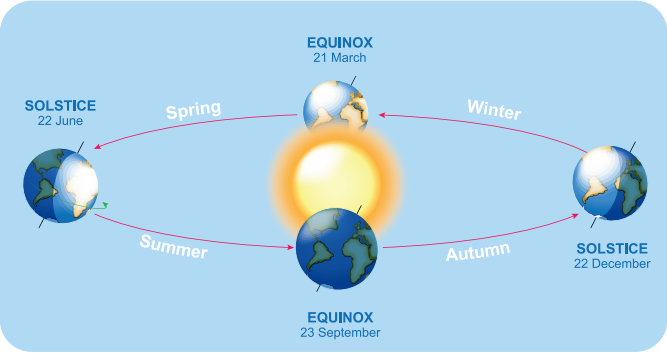
EXTENSION

Instructions:

1. Read the information below.
2. After studying the "Equinoxes and Solstices for the Northern Hemisphere" diagram at the top of the page, draw your own diagram showing the same information. Do your best to remember the names of each equinox or solstice and their appropriate dates and details. You may refer back to this page as needed.

Equinoxes and Solstices

Solstices and equinoxes are the results of the earth's tilted axis. If the earth's axis were perfectly vertical, the sun would always be above the equator, the amount of sunlight received by different parts of the earth would be unchanging, and there would be no seasons. We use solstices and equinoxes to mark the beginning of seasons.



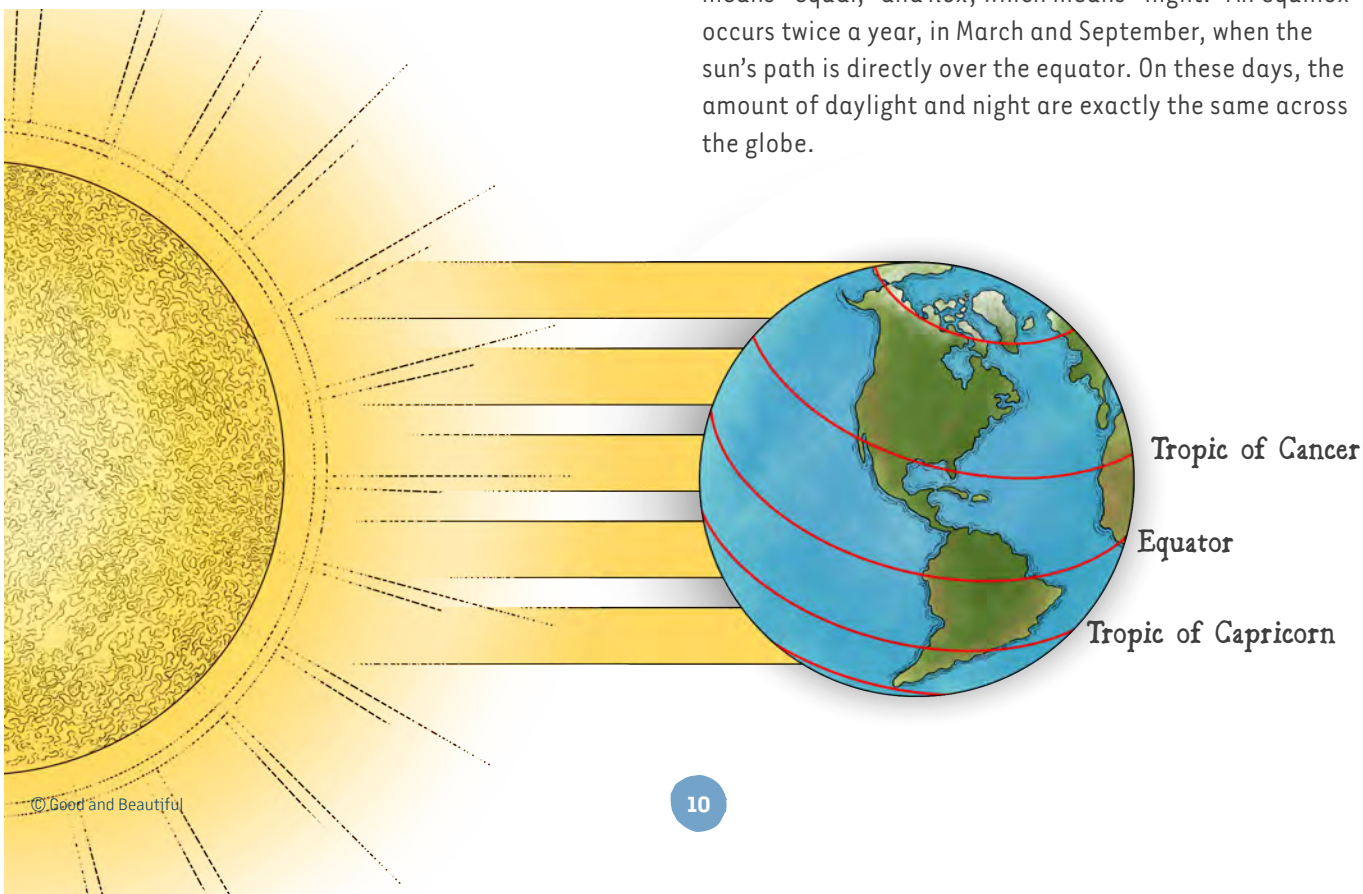
Equinoxes and Solstices for the Northern Hemisphere

Solstice

A solstice happens twice annually and creates the longest and shortest days of the year. Between June 20 and 22, the North Pole of the earth is tilted toward the sun, and the Northern Hemisphere receives the most direct sunlight. The sun is as far north from the equator as it can go and is positioned directly above the Tropic of Cancer, as seen in the image below. This creates the longest day of the year, which we call the summer solstice, and is the official start of summer in the Northern Hemisphere. Between December 21 and 22 of every year, the North Pole is tilted farthest away from the sun, with the Southern Hemisphere's Tropic of Capricorn, also seen in the image below, receiving the most direct sunlight, and the sun's path through the sky is as far south as it can be. The winter solstice marks the beginning of winter for the Northern Hemisphere. In the Southern Hemisphere, these seasons are reversed, with the summer solstice in December and the winter solstice in June.

Equinox

The word equinox comes from the Latin words *aequi*, which means "equal," and *nox*, which means "night." An equinox occurs twice a year, in March and September, when the sun's path is directly over the equator. On these days, the amount of daylight and night are exactly the same across the globe.



Lesson 5

AIR PRESSURE EXPERIMENT

My Predictions:

Experiment #1

Experiment #2

Experiment #3

My Results:

Experiment #1

Experiment #2

Experiment #3

Lesson 6

JUNIOR METEOROLOGIST

It's time to test your meteorology skills! After reviewing the Beaufort Wind Scale chart on the next page, write the correct Beaufort number under each picture.

EXTENSION

Instructions:

1. Read the information below.
2. Look at the pictures on the page. Write numbers 1–5 on the next page (one digit for each photo below). Determine which phase of the water cycle (evaporation, condensation, precipitation, sublimation, or deposition) is occurring in each photo and write it next to the photo's corresponding number.
3. Write the definition of sublimation and deposition.

Sublimation & Deposition

As you have learned, the three states of matter are solid, liquid, and gas. We usually think of the states of matter in that order, moving from one to the next, but definitely not skipping one! Water can take on all three forms: ice, water, and water vapor. Ice (solid) melts into water (liquid) and evaporates into water vapor (gas). But did you know that water can actually skip from its solid state to its gas state without ever becoming a liquid? This process is called ***sublimation***, and it occurs when snow and ice change into water vapor without melting into water first.

Sublimation can happen when certain conditions occur, such as dry winds, low humidity, higher altitudes, and strong sunlight. Without the thermal energy from the sunlight, sublimation would not be possible.

Have you ever been to the mountains on a sunny winter day? If the conditions were just right, you might be able to look at the mountains in the distance and see what appears to be "smoke" rising from the mountains. But you actually would be witnessing the process of sublimation.

The opposite of sublimation is called ***deposition***. In deposition, water vapor changes directly into snow or ice, once again skipping the liquid state. For deposition to occur, the water vapor requires higher humidity and low temperatures. Another example of deposition is when frost forms on a window. The temperature of the exterior surface of the window is lower than the freezing point of water, and the air around the window is humid from the heat inside the home. The water vapor, which is gas, skips directly to a solid form by turning into frost.

Sublimation and deposition do not happen often, but when they do, they are two further examples of the magnificent properties of water!

Lesson 9

MAKING RAIN EXPERIMENT

Start Time: _____

Procedure:

1

2

3

Conditions:

Time It Started Raining: _____

About how long did it take for it to rain?

minutes

PRECIPITATION MATCH

Freezing rain occurs when snow melts or partially melts in the air but does not refreeze until after it reaches the ground or a surface.

Sleet occurs when snow melts or partially melts in the air, then freezes again before reaching the ground.

Hail, being a solid mass of ice, can cause significant damage to homes, vehicles, and other buildings. The largest hailstone recorded fell in Nebraska and was 18 cm (7 in) in diameter!

Freezing rain can accumulate and add weight to tree branches and power lines, causing them to snap or break.

Hail forms when water droplets carried by moving air in a cumulonimbus cloud shoot up high inside the cloud and freeze around a dust particle, then fall back to the bottom of the cloud, where they collect more water before being blown back up high into the cloud to refreeze. The process repeats until hailstones become too heavy and fall to the ground.

Sleet can be measured the same way snow is measured—by sliding a ruler directly downward into the sleet until the ruler reaches the ground.

EXTENSION

Instructions:

1. Read the information below.
2. Write down three of Bentley's character traits. Record how those traits enabled him to be a good scientist.

Snowflake Bentley

Of all the things in the world, what do you love to capture with a camera? Perhaps it is family, a pet, flowers, the sunset, mountains, or the beach. To a young, humble Vermont farm boy living in the late 1800s, his favorite thing was a snowflake.

His name was Wilson A. Bentley, and he later became known as the Snowflake Man. Born in 1865 in Jericho, Vermont, he grew up in the snowbelt. Vermont winters were harsh and faced an average annual snowfall of 3 m (120 in). Because of this, he hardly attended the one-room school near his home. Instead, he was educated by his mother, who had previously been a school teacher.

An inquisitive and curious boy, Bentley was always fascinated with nature, especially butterflies, leaves, and spiderwebs. Bentley loved to learn, which he attributed to his mother, and read her entire encyclopedia set. For his 15th birthday, his parents bought him a microscope, and it was at this point that his love for snowflakes blossomed.

While others dreaded winter, Bentley looked forward to it, for it meant snowflake season. Catching a snowflake to view under a microscope was no easy task. He could not bring the snowflake indoors, as it would quickly melt, so he set up his microscope and worked in a cold room by the farmhouse. He made multiple attempts to draw what he saw, but they were just not adequate. Inspired by the encyclopedia he read, he obtained a camera from his parents to take a picture of these frozen crystals. He spent over a year experimenting with the microscope and camera to master snapping an image through the microscope. Over and over again, he faced failed attempts, but his resolve was such that he could not be conquered. He was patient and persistent, with his mind fixed on his goal.

On January 15, 1885, his hard work and determination finally paid off; he photographed his very first ice crystal and would go on to capture 5,000 more. He would wait for that perfect snowflake to land. Using a feather, he would move it to a microscope slide, and after waiting a minute and a half for the right light exposure, he would capture his snowflake. He had to wait to develop his photos until the spring brought warmer temperatures.

Within his lifetime, Bentley made incredible discoveries. He learned that no two snowflakes are the same. In 1904, he decided to donate 500 of his images of snowflakes to the Smithsonian Institute for safekeeping—making a treasured scientific and historic record. In 1931, working with physicist William J. Humphreys, he published a book called *Snow Crystals*, which contained 2,300 of his photos.

Bentley had a way with words and poetically recorded his feelings about the elegance of what he observed. It was one of his greatest desires for people to experience what he saw—the beauty in nature. He has inspired many scientists, scientific photographers, and those who simply appreciate nature, and his photos preserve the scientific study of his day—frozen in time.

Lesson 14

AROUND THE WORLD

As your parent or teacher reads aloud the information about each location, use the word bank to write in the correct phrase in each orange box below.

Crater Lake

CANADA

Oregon

UNITED STATES

New York

Niagara Falls

Arizona

Grand Canyon

MEXICO

Yucatán

Cenote in Yucatán

EXTRA NOTES