

SCHOOL LAUNCH · EARTH SCIENCE K-8

GRADE 1 EARTH SCIENCE: ROCKS, WATER AND WEATHER

A year of true stories about the ground under our feet and the sky over our heads, from Mary Anning hunting fossils on the beach at Lyme Regis and Luke Howard giving the clouds their names to Wilson Bentley photographing a snowflake and Apollo 11 landing on the Moon, each one read aloud, looked at closely and then tried at home with an egg carton, a jar of water, a ruler and a field notebook.

First edition

■ *"In the beginning God created the heaven and the earth." (Genesis 1:1, KJV)*

COURSE GUIDE

This course follows the ground, the water and the sky through one school year. Each unit begins with a **true story**: a girl named Mary Anning finding a giant sea creature in the cliffs at Lyme Regis, a quiet man named Luke Howard giving names to the clouds in 1802, a Vermont farmer named Wilson Bentley taking the first photograph of a single snowflake in 1885, Roy Chapman Andrews finding dinosaur eggs in the Gobi Desert in 1923, and the men of Apollo 11 landing on the Moon on July 20, 1969. Children remember stories, and a story gives every new word a place to live.

Every lesson follows the same simple path. First comes **the story**, read aloud. Then **look closely**: a picture study of a real painting, drawing or photograph. Then **observe and measure**: count the pebbles, compare bigger and smaller, hold up a ruler, read a picture chart, mark the rain in a jar. Last comes **make and do**: the child builds, sorts, molds or tests something with his or her own hands and draws it in the field notebook. Young scientists are not asked to memorize answers first; they are shown how to look, and then they tell what they saw.

The year moves from the ground up into the sky. Units 1 and 2 are about rocks, sand and soil: collecting, sorting by size and testing which soil holds water. Unit 3 follows water as it runs downhill, fills a gutter river and rounds the stones in a stream. Units 4 and 5 look up at clouds, rain and wind, Unit 6 watches the Moon change shape, and Unit 7 goes back to Mary Anning's beach to hunt for fossils. In Unit 8 the child becomes a weather watcher, keeping a thermometer, a rain gauge and a month-long weather chart. An optional **Field Lab** takes the notebook outdoors for a rock walk, a rain gauge week, a wind watch and a night of moon watching.

The whole course rests on the first verse of the Bible: "In the beginning God created the heaven and the earth." (Genesis 1:1) The rocks, rivers, clouds and wind are His handiwork, made in order and kept in order. Four units close with a Bible story where the same things appear: the wise man who built his house upon a rock, Israel crossing the Jordan River, Elijah's little cloud like a man's hand, and Jesus speaking to the wind and the waves until there was a great calm. The child learns that looking carefully at creation is one way of honoring the Creator.

WHO IT IS FOR

Written for children in grade 1 (about ages 5–8) with a parent or teacher who reads every lesson aloud. The child does not need to read or write on his or her own; answers are told, pointed to, drawn, sorted or counted, with numbers under 20. The parent leads the stories and the picture study, handles anything hot or sharp, and goes along on every outdoor walk. Nothing needs to be bought beyond ordinary household things: egg cartons, clear jars, a ruler, modeling clay, flour and a notebook.

HOW TO USE THIS COURSE

The weekly rhythm. The year has 32 lessons, one a week, in eight units of four, plus the optional Field Lab. Session 1 (30–40 minutes) is the warm-up, the story, the key words and the picture study. Session 2 (30–40 minutes) is the make-and-do activity, the worked example, the practice and a page in the field notebook. In the last week of each unit, add a short third sitting for the unit review and the unit project. For a one-quarter version, follow the ★ **quarter path**: ten lessons marked ★ (1.1, 2.1, 3.1, 3.2, 4.1, 5.1, 5.2, 6.1, 7.1 and 8.1) that keep the heart of the year.

The field notebook. Use one sketchbook or primary composition book for the whole year. Every lesson ends with something drawn or recorded: a rock, a cloud, a windsock, a moon shape, a tally of rainy days. The parent writes the date and the child's own words under each drawing. By spring the notebook is a record of everything the child has seen with his or her own eyes.

Experiments and safety. A grown-up pours all hot water, handles matches or anything sharp, and goes along on every outdoor walk. Stay well back from streams, ditches and running gutters after rain; watch the water from the curb, never from in it. Take rocks and shells only where collecting is allowed, never from national parks or private land without permission, and wash hands after handling soil, fossils or flour. Check food allergies before the cookie moon phases, and never look at the Sun, even through a magnifier.

Worked examples and practice. Each lesson has one very simple worked example, such as counting pebbles, comparing bigger and smaller, reading a picture chart or measuring with hands and a ruler. Do it together first. Then the five practice items are mostly oral: the child points, sorts, matches, counts or draws. Answers for the parent are printed with every lesson, so you never need to guess.

Unit reviews and unit projects. Each unit ends with an oral review of 6–8 short questions (20 points) that you ask aloud while the child tells back what he or she remembers. Then comes a unit project that pulls the unit together: a labeled egg-carton rock collection, soil jars, a cloud journal, a windsock and wind chart, a moon calendar, clay fossils and a month of weather. Keep these in one box or folder for the year.

A word about time. This course is written from a Christian view of creation (Genesis 1:1) and the Flood (Genesis 6–9). Children will see words such as “Jurassic” or “Ice Age” on museum signs, in books and on Mary Anning’s own Jurassic Coast, so the course teaches them as museum words, so students can read any sign or textbook. Wherever they come up, a  **Thinking About Time** box sets out three things in plain words: what the sign says, what we observe, and how Christians read it.

SCOPE AND SEQUENCE

Unit 1: Rock Collecting (1–4)

Mary Anning on the beach at Lyme Regis; starting an egg-carton rock collection; sorting rocks by size from boulder to sand; and labeling a collection like a real museum.

Unit 2: Sand and Soil (5–8)

Sand grains under a magnifying glass; clay you can mold; testing which soil holds water; and the wise man who built his house upon a rock.

Unit 3: Rivers and Puddles (9–12)

Where a river starts and why water runs downhill; watching a gutter river after rain; why river stones are smooth and round; and Israel crossing the Jordan River.

Unit 4: Clouds and Rain (13–16)

Luke Howard gives the clouds their names; making a cloud in a jar; building a rain gauge; and Elijah's little cloud like a man's hand.

Unit 5: Wind (17–20)

Making a windsock; finding which way the wind blows; how windmills put the wind to work; and Jesus calming the wind and the sea.

Unit 6: The Moon (21–24)

Keeping a moon phases calendar; cookie moon phases; Apollo 11 and the first footsteps on the Moon; and making craters with flour and pebbles.

Unit 7: Fossil Hunters 🦕 (25–28)

Mary Anning's ichthyosaur; pressing a fossil print in clay; seashells found far from the sea; and Roy Chapman Andrews's dinosaur eggs in the Gobi Desert. A 🕒 Thinking About Time box explains the museum word "Jurassic."

Unit 8: Weather Watchers (29–32)

Reading a thermometer; dressing for the weather; Wilson Bentley and the first snowflake photograph; and keeping a whole month of weather on one chart.

Unit 9: Field Lab (optional) (Optional)

Four outdoor lessons that put the year's skills to work: a backyard rock walk, a week with the rain gauge, a wind watch and a night of moon watching with a parent.

MATERIALS

- **Field notebook (a sketchbook or primary composition book):** One for the whole year: drawings of rocks, clouds, moon shapes and weather, with the date and the child's words written by the parent.

- **A magnifying glass:** For sand grains, soil, rocks, fossils and snowflakes. A simple plastic one is fine.
- **Two or three cardboard egg cartons and a marker:** For the rock collection in Unit 1, the soil samples in Unit 2 and the Field Lab rock walk.
- **Clear jars or plastic cups with straight sides:** For the soil test, the cloud in a jar and the rain gauge. A jar with a lid is useful for shaking soil and water.
- **A ruler and a simple outdoor thermometer:** For measuring rocks, rain and temperature. A thermometer with large, clear marks is easiest for young eyes.
- **Modeling clay or homemade salt dough:** For molding clay, pressing fossil prints and making river stones round.
- **Flour, cocoa powder, a baking pan and a few pebbles:** For the Moon crater lesson. Do it outside or over a sheet for easy cleanup.
- **Sandwich cookies, a flashlight and a ball:** For the moon phases lessons. Check for food allergies first.
- **Household craft supplies:** Paper, crayons, glue, tape, string, scissors, a paper cup and a lightweight plastic bag or crepe-paper streamers for the windsock.
- **Optional: one of the books or resources listed in a unit:** Never required. See the list in each unit.

GRADING

There are no letter grades in Grade 1. A young child shows what he or she has learned by telling it back in his or her own words (oral narration), by pointing, sorting and counting, and by the pages of the field notebook. The parent keeps a simple checklist for each unit. The weights below show how much of the checklist each part makes up.

- Oral narration (telling back the story and the picture study): 30%
- Make-and-do activities (taking part, careful looking and measuring): 30%
- Field notebook (a dated drawing for each lesson): 20%
- Unit reviews and unit projects (asked aloud): 20%

No grades. Mark each checklist item Not yet, Growing or Got it. A unit is finished when most items read Got it; anything marked Not yet is simply tried again another week.

- Look for careful looking, not right words. A child who says “the little rocks are rounder” has done good science, even without the word “erosion.”
- The unit review is 20 points only to help the parent see what stuck. Ask the questions aloud, let the child point or draw, and write down the answers in the child’s own words.
- A field notebook page is complete when it has a date, a drawing and one sentence the child said about it.
- Keep the unit projects in one box or folder. At the end of the year, let the child show them to family and tell the story behind each one.

A NOTE TO PARENTS

You do not need to be a scientist to teach this course. Read the story aloud, look at the picture together, and then go and find the real thing: a rock, a puddle, a cloud, the Moon. Ask “What do you see?”, “Which one is bigger?” and “How could we find out?” Those three questions are most of what a good science teacher does.

Young children learn best with their hands and their eyes. Let the activities be messy, let the child hold the ruler even when it slips, and let the weather chart have a few blank days. Short, happy lessons done every week will carry a child farther than long ones done now and then. If a lesson runs long, stop and finish it tomorrow.

Above all, the course hopes to teach a child to wonder and to give thanks. The same God who “giveth snow like wool” (Psalm 147:16) made the rocks under our feet and the Moon over our house. When your child holds up a smooth stone or points at a new cloud, you are both looking at His handiwork.

CONTENTS

Unit 1: Rock Collecting

- 1.1 Mary Anning's Beach (Lyme Regis, 1811) ★
- 1.2 Egg-Carton Rock Collection
- 1.3 Sorting by Size: Boulder, Cobble, Pebble, Sand
- 1.4 Labeling a Collection

Unit 2: Sand and Soil

- 2.1 Sand under a magnifier ★
- 2.2 Clay you can mold
- 2.3 Which soil holds water?
- 2.4 The wise man built upon a rock (Matthew 7:24-27)

Unit 3: Rivers and Puddles

- 3.1 Where a River Starts ★
- 3.2 A Gutter River after Rain ★
- 3.3 River Stones Are Rounded
- 3.4 The Jordan River (Joshua 3)

Unit 4: Clouds and Rain

- 4.1 Luke Howard Names the Clouds (1802) ★
- 4.2 Cloud in a Jar
- 4.3 A Rain Gauge
- 4.4 Elijah's Little Cloud (1 Kings 18:44)

Unit 5: Wind

- 5.1 A Windsock ★
- 5.2 Which Way? Wind Vanes and Wind Direction ★
- 5.3 Windmills
- 5.4 Jesus Calms the Wind (Mark 4:39)

Unit 6: The Moon

- 6.1 Moon Phases Calendar ★
- 6.2 Oreo Moon Phases
- 6.3 Apollo 11 (July 20, 1969)
- 6.4 Craters with Flour and Pebbles

Unit 7: Fossil Hunters

- 7.1 Mary Anning's Ichthyosaur ★
- 7.2 Make a Fossil Print in Clay
- 7.3 Shells Far from the Sea
- 7.4 Dinosaur Eggs in the Gobi Desert

Unit 8: Weather Watchers

- 8.1 A Thermometer ★
- 8.2 Dress for the Weather
- 8.3 Snowflakes (Wilson Bentley, 1885)
- 8.4 A Month of Weather

Unit 9: Bonus: Field Lab (optional)

9.1 Backyard Rock Walk

9.2 Rain Gauge Week

9.3 Wind Watch

9.4 Moon Watch Night

★ quarter path ·  Thinking About Time box

ROCK COLLECTING

“In the beginning God created the heaven and the earth” (Genesis 1:1). The earth He made is full of rocks: great boulders, smooth pebbles and tiny grains of sand. In this unit your child becomes a rock collector. They will learn to walk slowly, look closely, gather with care and keep good records, the way real scientists do.

We begin on a windy English beach with Mary Anning, the girl from Lyme Regis who hunted for stones under falling cliffs. Then your child builds an egg-carton rock cabinet like the old collections of Ferrante Imperato and Ole Worm, sorts rocks by size with the same words geologists use (boulder, cobble, pebble, sand), and gives every rock a number and a label. By the end of the unit your child will own a real, labeled rock collection to keep adding to all year.

BEFORE YOU BEGIN

- Can count objects to 12
- Can compare two things and say which is bigger or smaller
- Can hold a crayon and draw a simple shape
- Can follow a grown-up on a short walk outdoors

MASTERY CHECKLIST

- I can tell the story of Mary Anning and her beach at Lyme Regis.
- I can look closely at a rock and tell its color, shape and feel.
- I can keep a rock collection with one rock in each cup.
- I can name the rock sizes from smallest to biggest: sand, pebble, cobble, boulder.
- I can make a label that tells a rock’s number, what it looks like, where and when it was found, and who found it.

OPTIONAL BOOKS AND RESOURCES

- **Mary Anning, from the Natural History Museum (London)** (<https://www.nhm.ac.uk/discover/mary-anning-unsung-hero.html>): Free. An article for grown-ups with pictures of Mary Anning’s portrait and some of her finds. A parent can read parts aloud and show the pictures (Lesson 1.1).
- **Lyme Regis Museum** (<https://www.lymeregismuseum.co.uk/>): The museum stands where Mary Anning’s family home once was. Its website has pictures of the town, the beach and the cliffs Mary walked.

1.1 MARY ANNING’S BEACH (LYME REGIS, 1811) ★

OBJECTIVES

- Tell the story of Mary Anning, the girl who hunted for stones on the beach at Lyme Regis.
- Explain why storms and falling cliffs made Lyme Regis a good place to find rocks.
- Look at a rock closely and name its color, shape and feel.

Warm-up. Hide one small rock in a sock. Let your child reach in without looking. Ask: Is it smooth or bumpy? Heavy or light? Round or pointy? Then take it out and look. Did your hands tell you the truth?

Video. Coming soon. Mary Anning and the beach at Lyme Regis for young children: search Natural History Museum (London), Lyme Regis Museum, Dorset coast footage of the cliffs and beach, SciShow Kids or Homeschool Pop (Alternate) on rock collecting.

KEY TERMS

rock

A hard, solid piece of the earth. Rocks can be as big as a mountain or as small as a pebble.

cliff

A tall, steep wall of rock or earth, often beside the sea.

tide

The sea coming up the beach and going back down again, twice each day.

collector

A person who finds things, keeps them with care and learns about them.

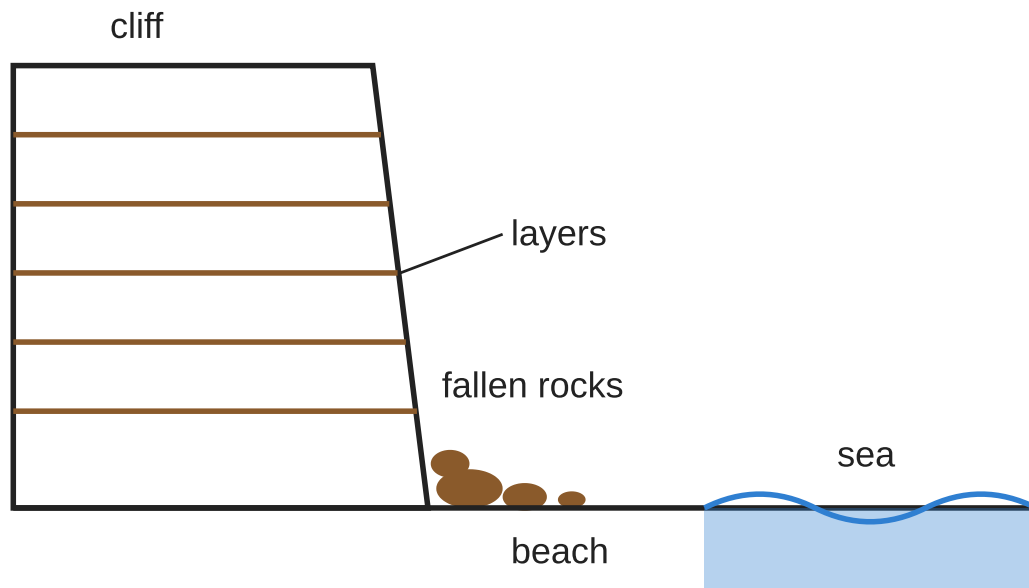
CORE IDEAS

The story. Long ago, in a little seaside town in England called Lyme Regis, there lived a girl named Mary Anning. Her family was poor. Her father made furniture, and he also hunted for strange stones on the beach. He took Mary and her brother Joseph with him. After their father died, the family needed money. So Mary kept on hunting. She and her family sold the best finds to visitors. People called them “curiosities,” or “curies” for short.

How they figured it out. Mary learned to watch the cliffs. Behind the beach stand tall gray cliffs made of rock, layer on top of layer. In stormy weather, rain and waves knock pieces of the cliff down onto the beach. So after a storm, Mary went out early to look at the fresh rocks. She had to hurry, because the tide would come back in and cover them. In 1811 her brother Joseph found a strange, big skull in the rocks. Not long after, Mary found the rest of the creature’s bones. You will hear that whole story later this year.

The big idea. A rock collector is a careful looker. Mary had a hammer, a basket and sharp eyes. She walked slowly. She picked up rocks and turned them over. She noticed their color and shape. She felt if they were smooth or rough, heavy or light. Some rocks had curly shapes inside them. Mary brought her finds home and cleaned them with care. That is what scientists do: they look closely, they gather, and they take good care of what they find.

God's handiwork. God made the earth, and He filled it with rocks of every color and shape. You do not need to live by the sea to find them. Rocks wait for you in the garden, by the road, in a creek and at the park. Go on a slow walk like Mary. Pick up one rock. Look at it. Feel it. Ask, "What can you tell me?" The Bible says, "speak to the earth, and it shall teach thee."



At Lyme Regis, storms knock rocks down from the cliff onto the beach. Mary looked at the fallen rocks before the tide came back.

PICTURE STUDY



Mary Anning with Her Dog Tray, Unknown artist, before 1842 · Oil painting · Natural History Museum, London

This painting shows Mary Anning when she was grown up, still hunting for stones on her beach. We do not know for sure who painted it. Her little dog Tray went with her on her walks along the shore. The tall cliff behind her is near Lyme Regis.

Look closely

- Find Mary's hands. What is she holding? What do you think she used it for?
- Find her dog Tray. Where is he?
- Look behind Mary. What do you see? Is it high or low?
- Look at her clothes. Do they look good for a windy, cold beach?

Talk about it

1. Why did Mary need a hammer and a basket?
2. If you went rock hunting with Mary, what would you bring?
3. Why do you think someone wanted to paint a picture of Mary?

Safety first. Rock hunt with a grown-up. Never climb on cliffs or stand right under them, because rocks can fall. At a beach or creek, stay with your grown-up and watch the water. Do not hammer rocks yourself; a grown-up may break one open while everyone wears safety glasses. Wash hands after the hunt.

MAKE AND DO: MY FIRST ROCK HUNT

You will go on a slow rock hunt like Mary Anning. You will bring home three rocks and look at each one like a real scientist.

You will need

- A small basket, bag or bucket
- A grown-up to go with you
- An old toothbrush and a bowl of water
- A towel
- A magnifying glass, if you have one
- Paper and crayons

Steps

1. Walk slowly with your grown-up in the yard, a park path or by a creek. Look down.
2. Pick up any rock you like. Turn it over. Look at its color. Feel it.
3. Choose three rocks to take home. Put them in your basket. Leave the rest where they were.
4. At home, scrub each rock gently with the toothbrush in the water. Dry them on the towel.
5. Look at each rock with the magnifying glass. Do you see sparkles, stripes, spots or holes?
6. Draw your three rocks. Color them the way they really look.
7. Tell your grown-up which rock is your favorite and why.

Tips

- Wet rocks show their colors better. Dip a dry rock in water and watch it change.
- Take only small rocks, and only where you are allowed. Some parks ask you to leave rocks where they lie.

Check your work

- I can tell one thing Mary Anning did.
- I can tell the color and feel of my rock.
- I can take care of a rock by cleaning it gently.

FIELD NOTEBOOK

1. Draw Mary Anning on her beach with her basket, her hammer and her dog Tray. Draw the cliff behind her.
2. Draw your favorite rock as big as the page. Color it carefully. Your grown-up can write one word that tells how it feels.
3. Draw a cliff with stripes, and draw some rocks that fell down onto the beach.

From history. Mary Anning lived in Lyme Regis all her life. Her little dog Tray went with her on her walks along the beach, and he is in the painting with her. Today the Lyme Regis Museum stands where Mary's family home used to be, and people from all over the world still come to that beach to hunt for interesting stones.

WORKED EXAMPLES

Example 1. Mary found 4 curly stones and 3 long pointed stones in one morning. How many stones did she find in all?

1. Put out 4 buttons or beans for the curly stones. Count them: 1, 2, 3, 4.
2. Put out 3 more for the pointed stones. Keep counting: 5, 6, 7.
3. The last number you said is how many there are in all.

Answer: Mary found 7 stones in all.

PRACTICE

1. **EASY** Tell it back: What was the name of the girl who hunted for stones on the beach? What town did she live in?
2. **EASY** Point to the cliff in the picture of the beach. Then point to the rocks that fell down.
3. **EASY** Hold one of your rocks. Say three words that tell about it.
4. **MEDIUM** Count the rocks in your basket. Now take away the one you like least. How many are left?
5. **MEDIUM** Why did Mary go out right after a storm, and why did she have to hurry?

COMMON MISTAKES

- Thinking all rocks look the same. Look closely: rocks have many colors, shapes, stripes and sparkles.
- Thinking a cliff is a safe place to climb. Rocks fall from cliffs, which is exactly why Mary found new ones on the beach.
- Thinking only grown-up scientists can find something important. Mary and her brother were children when they made their first big find.

Make it a game • Mystery Rock. Put five different rocks on the table. One player secretly picks one and gives clues: "My rock is gray. My rock is smooth. My rock has a white stripe." The other player points to the rock as soon as they know which one it is. Take turns being the clue giver.

Scripture. "Or speak to the earth, and it shall teach thee: and the fishes of the sea shall declare unto thee." (Job 12:8, KJV)

God's world is full of lessons. When we look closely at a rock or a shell, as Mary did, the earth itself teaches us about the One who made it.

Practice answers

1. Mary Anning. She lived in Lyme Regis, by the sea in England.
2. The cliff is the tall striped wall of rock. The fallen rocks are the pieces lying at the bottom of the cliff, on the beach.
3. Answers will vary, such as gray, smooth and heavy, or brown, bumpy and small.
4. One less than you started with. For example, if you had 3 rocks, 2 are left.
5. Storms knocked new rocks down from the cliff onto the beach. She had to hurry before the tide came in and covered them.

1.2 EGG-CARTON ROCK COLLECTION

OBJECTIVES

- Explain what a collection is and why each rock needs its own place.
- Make a rock collection in an egg carton with one clean rock in each cup.
- Count the cups and rocks in a collection.

Warm-up. Dump a handful of buttons, coins or beads in one messy pile. Ask your child to find one special button fast. Then put the same things into the cups of a muffin tin, one in each cup. Now find it again. Which way was easier?

Video. Coming soon. Starting a rock collection for kids: search Smithsonian National Museum of Natural History, USGS education, SciShow Kids, Homeschool Pop (Alternate) or Science Max for rock collecting, egg-carton collections and museum drawers.

KEY TERMS

collection

A group of things you gather and keep with care, such as rocks, shells or leaves.

specimen

One thing in a collection that a scientist keeps and studies, like one rock.

row

Things in a straight line, side by side. An egg carton has two rows of cups.

CORE IDEAS

The story. Long ago in Naples, a city in Italy, lived a man named Ferrante Imperato. He loved God’s creation. He filled a big room with stones, shells, plants, birds and fish. In 1599 a book about his collection was printed, and it had a picture of his room. Look at that picture. The walls are covered with cabinets. The cabinets have many little doors and boxes. Each thing has its own place.

How they figured it out. Why so many little boxes? Collectors learned that rocks in one big pile get mixed up. They bump and rub. Small pieces chip off. And soon you forget which rock came from where. But when each rock has its own little space, it stays safe. You can find it again. Museums still keep rocks this way today, in drawers with small trays inside. Each rock they keep is called a **specimen**.

The big idea. A **collection** is a group of things you gather and keep with care. An egg carton is a perfect first rock cabinet. Each cup is like a tiny drawer. Most egg cartons have 2 rows of 6 cups. That makes 12 cups, so you have room for 12 rocks. Choose rocks small enough to fit in a cup. Choose rocks that are different from each other: a white one, a striped one, a sparkly one, a rough one. A good collection shows how many kinds of rocks God made.

Try it and see. Wash your rocks and let them dry. Put one rock in each cup. Close the lid and give the carton a gentle shake. Open it. Every rock is still in its own place! Now you are a collector, just like Ferrante Imperato. Keep your carton. In the next lessons you will sort your rocks and give each one a label.

PICTURE STUDY



*The Natural History Room of Ferrante Imperato, Unknown engraver, for Ferrante Imperato's book *Dell'Historia Naturale*, 1599 · Engraving (a print made from a carved metal plate) · Printed in Naples, Italy; copies are kept in many libraries*

This is one of the oldest pictures of a natural history collection. Ferrante Imperato kept his treasures in Naples. People came to his room to see them. His ceiling was covered with sea creatures, and his walls were full of little boxes and drawers.

Look closely

- Look up at the ceiling. What animal is the biggest one there?
- Find the cabinets with many little doors. How many little doors can you count in one row?
- Find the people. What are they doing?
- Look for shelves with books and jars. Why might a collector need books?

Talk about it

1. Why did Ferrante Imperato use so many little boxes instead of one big box?
2. What would you put on your ceiling if you had a room like this?
3. How is your egg carton like his cabinets?

Safety first. Collect only small rocks, where a grown-up says you may. Keep small rocks away from babies and toddlers, who might put them in their mouths. A grown-up helps with the water when washing rocks.

MAKE AND DO: MAKE AN EGG-CARTON ROCK COLLECTION

You will make your own rock cabinet out of an egg carton and fill it with 12 different rocks. You will use this collection for the rest of the unit.

You will need

- A clean, empty cardboard egg carton with 12 cups
- 12 small rocks that each fit in a cup
- A bowl of water and an old toothbrush
- An old towel
- Crayons or markers and stickers to decorate the lid

Steps

1. Go on a rock walk with your grown-up. Look for small rocks that are different from each other.
2. Bring home more than 12 if you can, so you can choose the best ones.
3. Scrub each rock gently in the water with the toothbrush. Set them on the towel to dry.
4. Lay all your rocks out. Pick 12 that look different from each other.
5. Put one rock in each cup. Count them as you go: 1, 2, 3, all the way to 12.
6. Decorate the lid. Write “My Rock Collection” and your name on top (your grown-up can help).
7. Close the lid, shake it gently, and open it again. Are all the rocks still in their own cups?

Tips

- If you cannot find 12 different rocks, that is fine. Leave some cups empty and fill them on your next walk.
- A plastic egg carton is stronger and can be washed. A cardboard one is easier to write on.

Check your work

- I can tell what a collection is.
- I put one clean rock in each cup.
- I can count the rocks in my collection.

FIELD NOTEBOOK

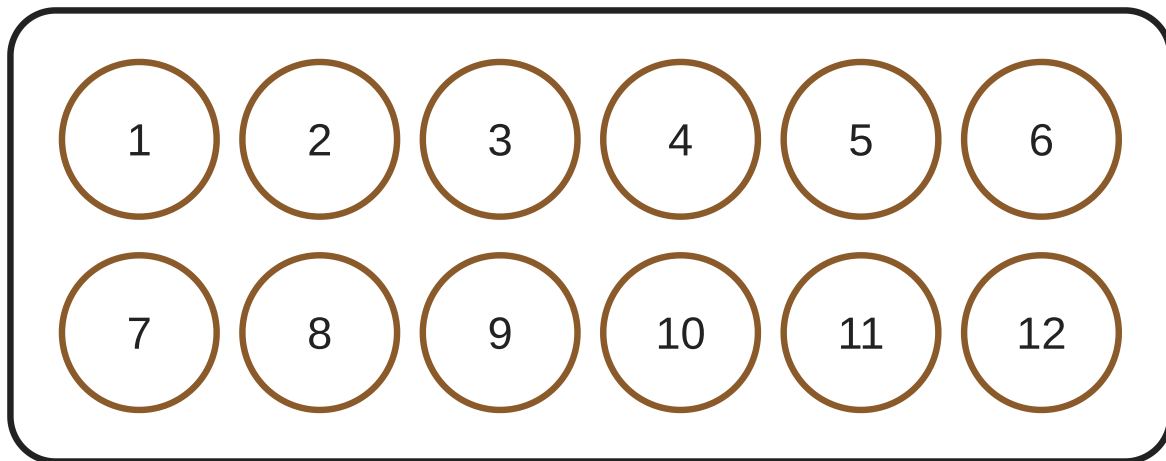
1. Draw your egg carton from the top, with a circle for each cup. Draw each rock in its cup.

2. Draw one wall of Ferrante Imperato's room with many little boxes.
3. Draw the rock you almost picked but left out. Tell why you chose a different one.

From history. Rooms like Ferrante Imperato's were called "cabinets of curiosities." Many collectors in Europe kept them, and some of these old collections later grew into the first public museums. Today the Smithsonian's National Museum of Natural History in Washington, D.C., keeps rocks, minerals and gems in drawers and cases so that scientists and visitors can study them.

WORKED EXAMPLES

Example 1. Look at the egg carton picture. How many cups are in it?



An egg carton has 2 rows of 6 cups. Count them all to find 12.

1. Count the cups in the top row: 1, 2, 3, 4, 5, 6. There are 6.
2. Count the cups in the bottom row and keep counting: 7, 8, 9, 10, 11, 12.
3. The last number you said tells how many cups there are.

Answer: There are 12 cups: 2 rows of 6. The carton holds 12 rocks.

PRACTICE

1. **EASY** Point to one row in your egg carton. How many cups are in that row?
2. **EASY** You have put rocks in 5 cups. Point to the empty cups and count them. How many are empty?
3. **EASY** Tell it back: Who was Ferrante Imperato, and what did he keep in his room?
4. **MEDIUM** Find two rocks in your collection that look very different. Show them and tell one way they are different.
5. **MEDIUM** Why is it better to keep each rock in its own cup instead of all in one bag?

COMMON MISTAKES

- Choosing 12 rocks that all look the same. A good collection shows many different kinds.
- Putting rocks away wet or muddy. Clean, dry rocks keep their colors and do not make the carton soggy.
- Thinking a collection is just a pile. A collection is kept in order, with each thing in its place.

Make it a game · Which Cup?. Look carefully at your full egg carton for one minute. Close your eyes while your grown-up takes out one rock and hides it. Open your eyes and point to the empty cup. Then describe the missing rock before you get to see it. Take turns.

Scripture. “O LORD, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches.” (Psalm 104:24, KJV)

“Manifold” means many and of many kinds. Your egg carton holds only a few of the riches God put in the earth, and every one is different.

Practice answers

1. 6 cups.
2. 7 cups are empty (12 cups take away 5 full ones).
3. He was a man in Naples, Italy, long ago who kept a big collection of stones, shells, plants and animals in a room with many little boxes and cabinets.
4. Answers will vary, such as one is white and one is black, or one is smooth and one is rough.
5. The rocks will not bump and chip, they will not get mixed up, and you can find each one again.

1.3 SORTING BY SIZE: BOULDER, COBBLE, PEBBLE, SAND

OBJECTIVES

- Name four sizes of rock from biggest to smallest: boulder, cobble, pebble, sand.
- Sort rocks by size using hands and everyday things to compare.
- Tell how big rocks break into smaller pieces.

Warm-up. Set out a dried pea, a tennis ball (or an orange) and a basketball (or a big pot). Ask your child to line them up from smallest to biggest. Then hand over a rock and ask: Which one is your rock closest to in size?

Video. Coming soon. Rock sizes for kids (boulder, cobble, pebble, sand) and how rocks break down: search USGS education, SciShow Kids, Homeschool Pop (Alternate), Science Max, and nature footage of stony beaches, rivers and big boulders.

KEY TERMS

boulder

A very big rock, bigger than a basketball. Some boulders are as big as a car or a house.

cobble

A rock about the size of a tennis ball up to a basketball. You need two hands to hold a big one.

pebble

A small rock that fits in your hand, from about the size of a pea up to a tennis ball.

sand

Tiny grains of rock, so small they look like sugar or salt.

CORE IDEAS

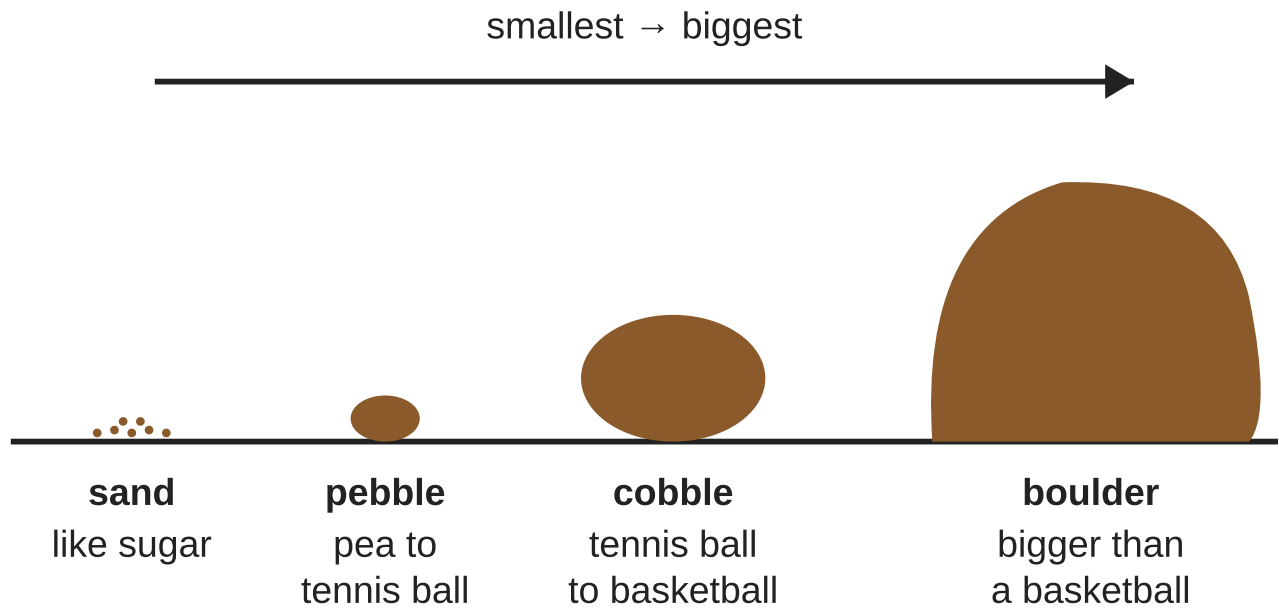
The story. Go to a stony beach or a creek bed, and you will find rocks of every size. There are big ones you could sit on. There are round ones as big as your fist. There are little ones you can toss into the water. And under your feet there are tiny grains of sand. Long ago, people used many different words for these sizes, and it got confusing. One person's "stone" was another person's "rock."

How they figured it out. In 1922 an American geologist named Chester Wentworth wrote down a list of size names so that scientists everywhere could use the same words. A **geologist** is a scientist who studies rocks and the earth. Geologists still use his size names today. Four of the names are easy to remember: **boulder**, **cobble**, **pebble** and **sand**.

The big idea. We sort rocks by how big they are. **Sand** is tiny grains, like sugar or salt. A **pebble** fits in your hand. It is about the size of a pea up to the size of a tennis ball. A **cobble** is from about a tennis ball up to a basketball. A big cobble needs two hands. A **boulder** is

bigger than a basketball. You cannot carry a boulder at all! Size is what matters, not color or shape. A round gray rock and a sharp pink rock are both pebbles if they are pebble size.

Try it and see. Big rocks do not stay big forever. Waves crash. Rivers roll rocks along and knock them together. Ice cracks them. Little by little, a boulder breaks into cobbles, cobbles break into pebbles, and pebbles wear down into sand. Rub two rocks together over a dark paper and look. The tiny bits that fall are like sand! Now sort your own rocks into piles by size. God, who made the great mountains, also made every grain of sand on the shore.



Four rock sizes, from smallest to biggest: sand, pebble, cobble, boulder.

PICTURE STUDY



Pegwell Bay, Kent: A Recollection of October 5th 1858, William Dyce, 1858–1860 · Oil on canvas · Tate Britain, London

William Dyce was a Scottish painter. On an autumn day he went to the beach at Pegwell Bay in England with his family. The tide was out, and his family hunted for shells and stones among the rocks. Dyce painted the scene very carefully, rock by rock. He even painted a comet that people could see in the sky that year.

Look closely

- Find the people with baskets. What are they looking for?
- Look at the ground. Can you find big rocks, middle-sized rocks and tiny ones?
- Look at the tall white cliffs. Can you see lines or layers in them?
- Look up in the sky. Can you find the faint comet with its tail?

Talk about it

1. Which rocks on this beach do you think are cobbles? Are there any boulders?
2. Why do you think the beach has so many rocks of different sizes?
3. How is this family like Mary Anning?

Safety first. Keep pebbles and sand away from little brothers and sisters who put things in their mouths. Do not throw rocks or sand. Never try to lift a rock that is too heavy; boulders are for looking at and sitting on. Near a creek or beach, stay with your grown-up.

MAKE AND DO: THE GREAT SIZE SORT

You will sort a pile of rocks into four groups by size, just like a geologist.

You will need

- A pile of mixed rocks from the yard, driveway, creek or garden (a grown-up may add a bag of gravel)
- A cup of sand
- Four paper plates or sheets of paper
- A marker
- A dried pea, a tennis ball (or an orange) and a basketball (or a big ball) to compare
- A colander or kitchen strainer

Steps

1. Write one word on each plate: SAND, PEBBLE, COBBLE, BOULDER. Your grown-up can help you write.
2. Put the pea, the tennis ball and the basketball next to the plates. They are your size helpers.
3. Pick up one rock at a time. Is it smaller than the tennis ball? Then it is a pebble. Bigger than the tennis ball but smaller than the basketball? It is a cobble.
4. Pour some sand and small gravel into the colander over a bowl and shake. The tiny grains that fall through are sand. Put a spoonful on the SAND plate.
5. Look outside for a boulder: a rock bigger than the basketball. You cannot bring it in! Draw it on the BOULDER plate instead, or set a photo there.
6. Count the rocks on each plate. Which plate has the most?

Tips

- Some rocks are in between. That is fine. Pick the plate they are closest to.
- Use your hands too: a pebble fits inside your closed fist, and a big cobble needs two hands.

Check your work

- I can name the four sizes from smallest to biggest.
- I sorted my rocks onto the right plates.
- I can tell how a boulder can turn into sand.

FIELD NOTEBOOK

1. Draw a size ladder: one grain of sand, one pebble, one cobble and one boulder, from smallest to biggest. Write the name under each.
2. Draw yourself standing next to a boulder. Make the boulder bigger than you, or as big as you saw.

3. Draw a big rock breaking into smaller and smaller pieces, with sand at the end.

From history. Chester Wentworth was an American geologist who studied how rock pieces are carried and sorted by water. In 1922 he wrote out a list of size names built on an earlier list by another geologist, Johan August Udden. Their list also has in-between names, like “granule” for bits a little bigger than sand. Geologists all over the world still use it.

WORKED EXAMPLES

Example 1. You have three rocks: one as big as a tennis ball, one as small as a pea, and one as big as an orange. Put them in order from smallest to biggest.

(Use the map or drawing “Use the size ladder to help you put rocks in order.” shown earlier in this lesson.)

1. Find the smallest one first. A pea is very small, so the pea-sized rock goes first.
2. Compare the other two. A tennis ball is a little smaller than most oranges, so the tennis-ball rock goes next.
3. The orange-sized rock is the biggest, so it goes last.
4. Check by holding each one in your hand. The smallest hides inside your fist.

Answer: Pea-sized rock, then tennis-ball rock, then orange-sized rock.

PRACTICE

1. **EASY** Say the four sizes from smallest to biggest.
2. **EASY** Point to a pebble in your collection. How do you know it is a pebble?
3. **EASY** Match: Which size word goes with a rock as big as a car?
4. **MEDIUM** Count the rocks on your PEBBLE plate and on your COBBLE plate. Which plate has more? How many more?
5. **MEDIUM** Tell how a boulder can turn into sand.

COMMON MISTAKES

- Thinking sand is not rock. Most sand is tiny pieces of rock (some beach sand also has bits of broken shell).
- Sorting by color or weight instead of size. Size words tell only how big a rock is.
- Thinking a rock stays the same forever. Water, ice and bumping slowly break rocks into smaller pieces.

Make it a game • Size Freeze. The grown-up calls out a size word. For “boulder,” stand tall and make yourself as big as you can. For “cobble,” crouch and hug your knees. For

“pebble,” curl into a small ball. For “sand,” wiggle your fingers and sprinkle down to the floor. Then the grown-up holds up a real rock, and you show its size with your body.

Scripture. “Who hath measured the waters in the hollow of his hand, and meted out heaven with the span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance?” (Isaiah 40:12, KJV)

We measure rocks with our small hands. God measures the oceans and weighs the mountains. He knows every boulder and every grain of sand.

Practice answers

1. Sand, pebble, cobble, boulder.
2. It fits in my hand. It is about the size of a pea up to a tennis ball.
3. Boulder.
4. Answers will vary. For example, 9 pebbles and 3 cobbles: the pebble plate has 6 more.
5. Waves, rivers and ice knock and grind it. It breaks into cobbles, then pebbles, and the pebbles wear down into tiny grains of sand.

1.4 LABELING A COLLECTION

OBJECTIVES

- Tell why scientists put a number and a label on every specimen.
- Make a label for each rock that tells its number, what it looks like, where it was found and when.
- Match a rock to its label by its number.

Warm-up. Put three plain, unmarked jars or cups upside down on the table and hide a raisin under one. Mix them around. Which one has the raisin? Now put a sticker with a star on the raisin cup and mix them again. How did a little mark help?

Video. Coming soon. How museums label and catalog rocks and fossils, for kids: search Smithsonian National Museum of Natural History behind-the-scenes collections, Natural History Museum (London), USGS, SciShow Kids or Homeschool Pop (Alternate) on making a rock collection.

KEY TERMS

label

A small card or tag with words that tell about a thing.

record

Writing that helps us remember what we found and learned.

location

The place where something was found.

CORE IDEAS

The story. Long ago in Copenhagen, a city in Denmark, lived a doctor and teacher named Ole Worm. He collected stones, shells, bones, horns, plants and tools from faraway lands. He kept them in a room on shelves and in boxes. After he died, a book about his collection was printed in 1655. Its picture shows boxes with words written on them. The words told what kind of thing was inside each box.

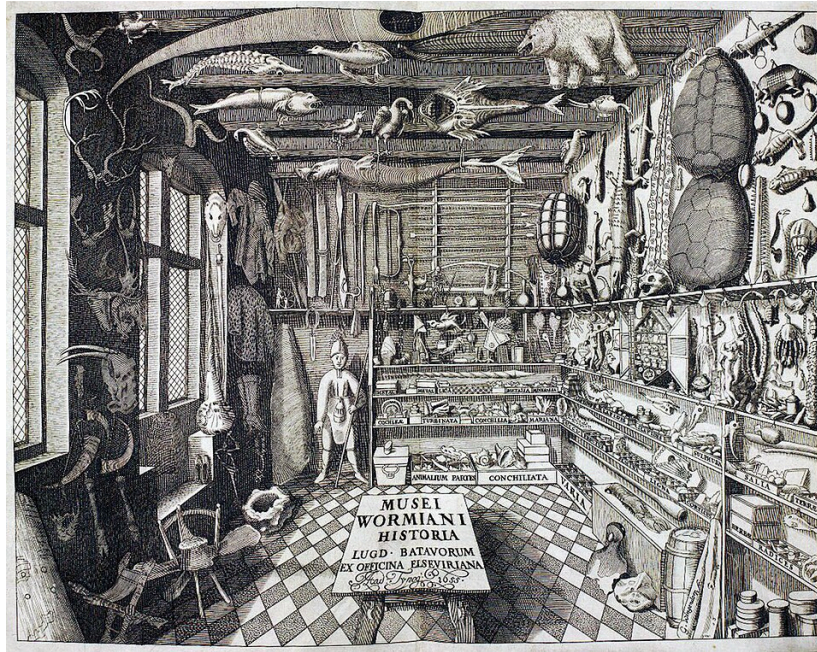
How they figured it out. Collectors learned something important. A rock with no label is just a rock. Later on, no one remembers where it came from. But a rock with a label is a **record**. It tells a story. Scientists in museums today give every specimen a number. They write down the number, what the thing is, its **location** (where it was found), the date, and who found it. The place matters most of all. It tells what that beach, creek or hill is made of.

The big idea. Now you can label your egg-carton collection. Write a small number in the bottom of each cup, from 1 to 12. Then make a little card for each rock. Each card has the same number as its cup. On the card, write what the rock looks like, where you found it and

the day you found it. Add your name too, because you are the finder! If a rock falls out, you can match its card and put it back in the right cup.

God's handiwork. In the garden of Eden, God brought the animals to Adam to see what he would call them. Naming things and keeping track of them is good work that God gave to people. When you label your rocks, you are doing that same kind of work. Your collection now shows how many different rocks God made in the places you have walked.

PICTURE STUDY



*The Museum of Ole Worm, Unknown engraver, frontispiece of *Museum Wormianum*, 1655 · Engraving (a print made from a carved metal plate) · Printed in Leiden; copies are kept in many libraries*

This picture was printed at the front of a book about Ole Worm's collection. It shows his room packed from floor to ceiling. Ole Worm loved to study real things, not just read about them, and he kept each kind of thing in its own place.

Look closely

- Find the boxes on the shelves. Can you see words written on them?
- Look up at the ceiling. What is hanging there?
- Find antlers and horns on the walls. How many can you count?
- Look for shells and stones. Where did Ole Worm keep them?

Talk about it

1. Why did Ole Worm write words on his boxes?
2. If your rocks had no labels, what would you forget?
3. What would you label first if this were your room?

MAKE AND DO: LABEL MY ROCK COLLECTION

You will give every rock in your egg carton a number and a label card, just like a museum.

You will need

- Your egg-carton rock collection
- A marker
- 12 small cards (index cards cut in half work well)
- A pencil and crayons
- A zip bag or envelope to keep the cards in, or tape to stick them inside the lid

Steps

1. With your grown-up, write a number in the bottom of each cup, 1 to 12. Start at the top left, like reading a book.
2. Take rock number 1 out and look at it. Say its color, size word (pebble or cobble) and how it feels.
3. On card number 1, write: the number, what it looks like, where you found it, the day you found it, and your name. Your grown-up can write the words while you tell them.
4. Draw a tiny picture of the rock on the card.
5. Put the rock back in cup 1. Do the same for every rock.
6. Keep the cards with the carton. Tape them inside the lid or keep them in a bag.
7. Mix up three rocks on the table. Can you put each one back in its right cup by reading its card?

Tips

- If you do not remember where you found a rock, write “place not known.” An honest record is better than a guess.
- Use the same order on every card so your labels are easy to read.

Check your work

- Every rock has a number that matches its cup.
- Every card tells what, where, when and who.
- I can put a mixed-up rock back in its right cup.

FIELD NOTEBOOK

1. Copy one of your label cards neatly into your notebook, with a drawing of the rock beside it.
2. Draw a map of your yard or street and put a small number where you found each rock.
3. Draw Ole Worm’s room with your own rocks on one of his shelves.

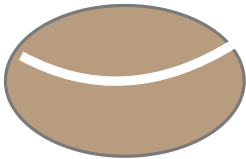
From history. In England, a doctor named John Woodward collected thousands of rocks and fossils and wrote careful lists telling what each one was and where it was found.

When he died in 1728, he left his collection to Cambridge University. It is still kept there today, in its old wooden cabinets, at the Sedgwick Museum, and scientists can still read his records.

WORKED EXAMPLES

Example 1. Read the label card in the picture. What number is the rock? Where was it found? Which cup does it go in?

No. 7
What: gray pebble, smooth, white stripe
Where: Miller Creek
When: May 3
Found by: Sam



A good label tells the number, what, where, when and who.

1. Find the number at the top of the card. It says No. 7.
2. Find the line that starts with “Where.” It says Miller Creek.
3. The rock’s number tells its cup. Number 7 goes in cup 7.

Answer: It is rock number 7. It was found at Miller Creek. It goes in cup 7.

PRACTICE

1. **EASY** Point to the place on the label card that tells where the rock was found.
2. **EASY** Your grown-up holds up rock number 4. Point to the cup where it belongs.
3. **EASY** Tell it back: Who was Ole Worm, and what did he write on his boxes?
4. **MEDIUM** Count your label cards. Count your rocks. Are the numbers the same? If not, how many cards are missing?
5. **MEDIUM** Why should a label tell where a rock was found?

COMMON MISTAKES

- Writing only the rock's color. A good label tells what, where, when and who.
- Giving two rocks the same number. Each specimen gets its own number.
- Guessing where a rock came from when you do not remember. Write "place not known" instead; scientists must be honest in their records.

Make it a game · Rock Detective. Take three rocks out of their cups and put them on the table. Your grown-up reads one label card aloud without saying the number: "Gray pebble, smooth, white stripe, found at the creek." Point to the rock that matches. Then check the number on the card and put the rock back in its cup. Switch so you read the card and your grown-up finds the rock.

Scripture. "And out of the ground the LORD God formed every beast of the field, and every fowl of the air; and brought them unto Adam to see what he would call them: and whatsoever Adam called every living creature, that was the name thereof." (Genesis 2:19, KJV)

God gave Adam the job of naming the creatures. Naming and labeling the things God made is good and careful work, and you are doing it too.

Practice answers

1. The line that starts with "Where": Miller Creek.
2. Cup number 4.
3. He was a doctor and teacher in Denmark long ago who kept a big collection. He wrote words on his boxes that told what was inside.
4. They should be the same, with one card for every rock. If there are 12 rocks and 10 cards, 2 cards are missing.
5. So we remember its place. The place tells what that beach, creek or yard is made of, and without it the rock cannot teach us as much.

UNIT 1 REVIEW

This is an oral review. Read each question aloud and let your child answer in their own words, pointing to rocks and pictures when they wish. Give full points for a clear answer, even if the words are not exact. The review is worth 20 points.

1. (3 pts) Tell me about Mary Anning. Where did she live, and what did she look for?
2. (3 pts) Why did Mary look for rocks after a storm? Why is it not safe to climb a cliff?
3. (3 pts) What is a collection? Why does each rock get its own cup?
4. (2 pts) Point to one row of your egg carton. How many cups in a row? How many cups in all?
5. (3 pts) Say the four rock sizes from smallest to biggest. Then show me a pebble.
6. (3 pts) How can a big boulder turn into sand?
7. (3 pts) Pick up one of your rocks and read me its label. What four things should a good label tell?

UNIT PROJECT: MY LABELED ROCK COLLECTION

Finish your egg-carton rock collection with 12 rocks, one in each numbered cup, and a label card for every rock. Decorate the lid with your name. Add a page from your notebook with your size ladder (sand, pebble, cobble, boulder) and a drawing of your favorite rock. Then give a short “museum tour” to your family: show three rocks and tell what, where, when and who for each one.

- **Collection:** The carton holds clean rocks, one in each cup, and the rocks show many different colors, shapes or feels.
- **Labels:** Every rock has a card whose number matches its cup, telling what, where, when and who.
- **Sizes:** The size ladder shows sand, pebble, cobble and boulder in the right order, and the child can sort a rock by size.
- **Telling:** The child gives a clear museum tour of three rocks, speaking about each one in their own words.

Answer key

1. She lived in Lyme Regis, a town by the sea in England. She hunted for interesting stones on the beach and sold them to visitors.
2. Storms knocked new rocks down from the cliffs onto the beach. Rocks can fall from cliffs, so we stay away from them.
3. A collection is a group of things you gather and keep with care. Each rock gets its own cup so it does not get chipped or mixed up and you can find it again.
4. 6 cups in a row; 12 cups in all.
5. Sand, pebble, cobble, boulder. A pebble fits in the hand, from about a pea to a tennis ball.
6. Waves, rivers and ice knock and grind it, breaking it into cobbles, then pebbles, and then tiny grains of sand.

7. What the rock looks like, where it was found, when it was found and who found it (plus a number that matches its cup).

SAND AND SOIL

In Unit 1 you collected rocks and sorted them from big boulders down to tiny sand. Now we kneel down and look at the smallest bits of all. With a magnifier you will see that sand is made of thousands of little rock grains. You will mold clay, the tiniest bits of rock, into a pot like a real potter. Then you will do a fair test to find out which soil holds water best, the way George Washington Carver studied soil to help farmers.

At the end of the unit you will hear the story Jesus told about two builders: one who built his house on the rock and one who built on the sand. You will build little houses of your own and send a pretend storm to see which one stands. All through the unit you will remember that God made the ground under our feet, sends the rain to water it and gives us good soil to grow our food.

BEFORE YOU BEGIN

- Can sort rocks by size: boulder, cobble, pebble, sand (Unit 1)
- Can count objects to 20
- Can compare two numbers and say which is more
- Can use a ruler to measure in inches with help

MASTERY CHECKLIST

- I can use a magnifier and tell that sand is made of tiny grains of rock.
- I can say that clay is made of the smallest bits of rock and that wet clay can be molded.
- I can name things people make from clay.
- I can do a fair test and tell which soil lets water through and which soil holds water.
- I can retell Jesus' story of the wise man and the foolish man and tell why the house on the rock stood.

OPTIONAL BOOKS AND RESOURCES

- **Soils 4 Kids, from the Soil Science Society of America** (<https://www.soils4kids.org/>): Free. Simple pages, pictures and experiments about soil for children and parents. A parent can pick an activity to add to Lesson 2.3.
- **USDA Natural Resources Conservation Service (NRCS)** (<https://www.nrcs.usda.gov/>): Free. The U.S. government office that helps farmers care for their soil. Parents can browse soil photos and learning materials.
- **A hand magnifier and a bag of play sand** (<https://www.usgs.gov/>): Commonly available at hardware or craft stores. A 3x to 5x magnifier is plenty. The USGS site has free photos of rocks and minerals that show what sand grains are made of.

2.1 SAND UNDER A MAGNIFIER ★

OBJECTIVES

- Look at sand with a magnifying glass and tell what you see: tiny grains of rock with different colors and shapes.
- Sort and count sand grains by color and tell which kind there is more of.
- Explain that sand is made of rock that has been broken into very small pieces.

Warm-up. Rub a pinch of sand (or salt, if you have no sand) between your fingers. Close your eyes. Does it feel smooth like flour or bumpy like tiny beads? Now pour a spoonful onto a dark plate. Can you see one single grain? Try to pick up just one with a wet fingertip.

Video. Coming soon. Sand grains under a magnifier or microscope for young children: search USGS, Smithsonian, SciShow Kids, Homeschool Pop (Alternate) and close-up nature footage of beach sand.

KEY TERMS

sand

Tiny bits of rock, smaller than a pebble but big enough to see one by one.

grain

One single tiny piece of sand.

magnifier

A curved glass that makes small things look bigger. It is also called a magnifying glass.

observe

To look very carefully and notice what is really there.

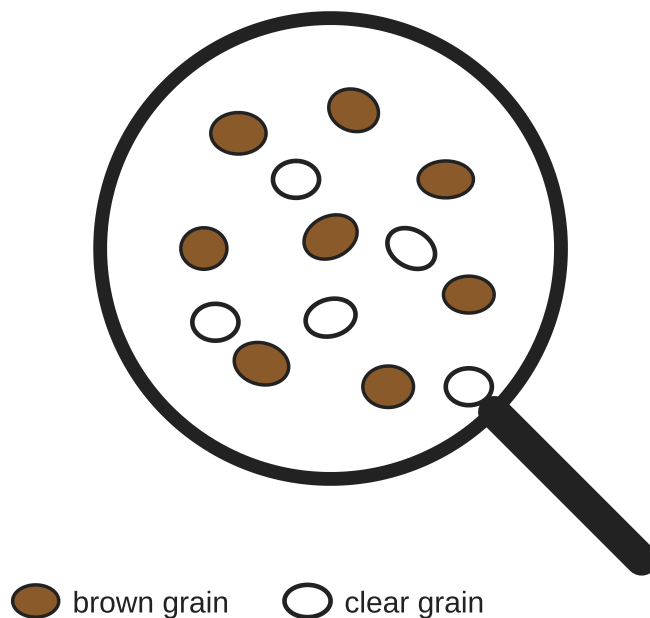
CORE IDEAS

The story. Long ago, in London, a man named Robert Hooke loved to look at small things. He used a microscope, a tube with curved glass inside that makes tiny things look very big. He looked at a flea, a fly's eye and the point of a needle. Then he drew big, careful pictures of what he saw. In 1665 he put his drawings in a book called *Micrographia*, which means "small drawings." People were amazed. Small things had been full of wonders all along!

How they figured it out. When you look at sand with only your eyes, it looks like one tan heap. But when scientists look through a magnifier, they see that sand is made of thousands of separate **grains**. Each grain is a tiny piece of rock. Many grains are clear, like little bits of glass. Some are brown, pink, black or white. Some are round and smooth. Some are sharp and pointy. Some beaches even have bits of broken shells mixed in.

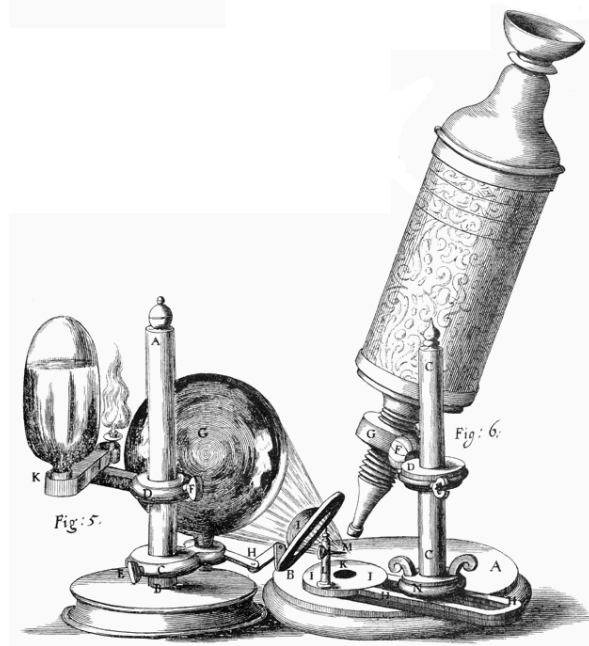
The big idea. Sand is rock in very small pieces. Waves, rivers, wind and ice knock big rocks apart. The pieces bump and rub until they are tiny. Remember the sizes from Unit 1: boulder, cobble, pebble, sand. Sand is the smallest one you can still see grain by grain. Most sand is made of a hard, clear rock-bit called quartz. Because quartz is so hard, it does not wear away to nothing.

Try it and see. Spread a little sand on dark paper. Hold the magnifier close to your eye, then bring the sand up slowly until it looks sharp. **Observe** like Robert Hooke. How many colors can you find? Are the grains round or pointy? Then draw a few grains very big in your notebook. **God's handiwork.** No two grains of sand are just the same, yet God knows each one. The Bible says His thoughts toward us are more than the sand. A whole beach is His, and so is every grain.



Sand under a magnifier. Count the brown grains and the clear grains.

PICTURE STUDY



Robert Hooke's Microscope (Scheme I, from Micrographia), Robert Hooke, 1665 · Engraving printed in a book · Printed in Micrographia (London, 1665); copies are kept in many libraries

Robert Hooke drew this picture of his own microscope so other people could build one too. A microscope works like a very strong magnifier. Hooke had a clever trick for light. He set a lamp beside it and put a round glass ball full of water in front of the flame. The water ball gathered the light and shone it brightly onto the tiny thing he was studying.

Look closely

- Find the long tube. Where would Hooke put his eye?
- Find the lamp with its little flame.
- Find the round glass ball. What do you think is inside it?
- Look at all the fine lines. How did the artist show shadows?

Talk about it

1. Why did Hooke need so much light to see tiny things?
2. How is a microscope like your magnifying glass? How is it different?
3. If you had a microscope, what tiny thing would you look at first?

Safety first. Never look at the sun through a magnifier, and never use it to focus sunlight on paper, skin or leaves, because it can burn. Do not rub your eyes with sandy hands. Wash hands after handling sand.

MAKE AND DO: MY SAND GRAIN CARD

You will make a little card of sand and look at it like a real scientist. You will sort the grains you see by color and count them.

You will need

- A spoonful of sand (beach sand, sandbox sand or play sand)
- A magnifying glass
- A piece of dark paper or a dark plate
- An index card and a glue stick
- A toothpick and crayons

Steps

1. Spread a thin pinch of sand on the dark paper.
2. Look with your eyes first. Say what color the sand looks.
3. Now look through the magnifier. Move it slowly until the grains look sharp.
4. Use the toothpick to push a few grains into little groups: clear grains, brown grains, dark grains and any others you find.
5. Count each group out loud. Your parent writes the numbers.
6. Rub glue on half of the index card. Sprinkle sand on it and tap off the extra.
7. On the other half, draw three grains very big, just as they look under the magnifier. Write where your sand came from.

Tips

- Hold the magnifier near your eye and move the sand, not your head.
- Sandbox sand often has more clear grains. Beach sand may have shell bits. Both are fine.

Check your work

- I looked at sand with a magnifier.
- I sorted grains by color and counted them.
- I can say that sand is tiny bits of rock.

FIELD NOTEBOOK

1. Draw a big circle like a magnifier lens. Inside it, draw five sand grains as big as buttons and color them.
2. Draw one round grain and one pointy grain. Label them “round” and “pointy.”
3. Draw where your sand came from: a beach, a sandbox or a riverbank.

From history. When Robert Hooke’s *Micrographia* came out in 1665, a London man named Samuel Pepys bought a copy. He wrote in his diary that he sat up until two o’clock

in the morning reading it, and he called it the most clever book he had ever read. Grown-ups and children in London had never seen pictures of a flea or a fly's eye so big before.

WORKED EXAMPLES

Example 1. Look at the picture of sand under a magnifier. How many brown grains are there? How many clear grains? Which kind is there more of? How many grains are there in all?

(Use the map or drawing "Count each kind, then count them all." shown earlier in this lesson.)

1. Point to each brown grain and count: 1, 2, 3, 4, 5, 6, 7, 8. There are 8 brown grains.
2. Point to each clear grain and count: 1, 2, 3, 4, 5. There are 5 clear grains.
3. 8 is more than 5, so there are more brown grains.
4. Count them all together: 8 and 5 make 13.

Answer: 8 brown grains and 5 clear grains. There are more brown grains. There are 13 grains in all.

PRACTICE

1. **EASY** What is sand made of?
2. **EASY** Point to the smallest one: a boulder, a pebble or a grain of sand.
3. **MEDIUM** You count 6 clear grains and 4 dark grains under your magnifier. How many grains is that? Which kind has more?
4. **MEDIUM** Draw one grain of sand the way it looks with just your eyes, and the same grain the way it looks under a magnifier.
5. **HARD** Tell your parent in your own words: how did big rocks become sand?

COMMON MISTAKES

- Thinking sand is one soft stuff like flour. Under a magnifier it is many separate hard grains of rock.
- Thinking all sand is the same. Sand can be tan, white, black, pink or even green, depending on the rock or shells it came from.
- Thinking a magnifier makes the sand grains really grow. It only makes them look bigger to your eyes.

Make it a game • Grain Detective. A parent hides five small things on a tray of sand: a bead, a seed, a tiny shell, a pebble and a grain of rice. Use the magnifier to find them. Each time you find one, say whether it is a rock or not a rock. Then trade places and hide things for your parent.

Scripture. “How precious also are thy thoughts unto me, O God! how great is the sum of them! If I should count them, they are more in number than the sand: when I awake, I am still with thee.” (Psalm 139:17-18, KJV)

Try to count the grains in just one spoonful of sand, and you will give up! David says God’s kind thoughts toward us are even more than all the sand.

Practice answers

1. Tiny bits of rock (most often clear quartz), sometimes with bits of shell mixed in.
2. A grain of sand.
3. 10 grains. There are more clear grains (6 is more than 4).
4. The first drawing is a tiny dot. The second is much bigger and shows its shape, color and maybe its sharp edges or smooth sides.
5. Waves, rivers, wind and ice broke big rocks into smaller pieces, and the pieces bumped and rubbed together until they were tiny grains.

2.2 CLAY YOU CAN MOLD

OBJECTIVES

- Tell that clay is made of the tiniest bits of rock, much smaller than sand.
- Compare wet clay and wet sand by molding each one and tell which keeps its shape.
- Name things people make from clay, such as pots, bricks and tiles.

Warm-up. Squeeze a lump of play dough or modeling clay in your hand, then open your hand. Look: can you see the lines of your fingers pressed into it? Now squeeze a handful of dry sand. What happens when you open your hand?

Video. Coming soon. How clay is dug, shaped on a potter's wheel and fired in a kiln, for young children: search Smithsonian, SciShow Kids, Homeschool Pop (Alternate), museum pottery demonstrations and historic brickmaking footage.

KEY TERMS

clay

Soil made of the very tiniest bits of rock. Wet clay is sticky and can be shaped.

mold

To press and shape something soft with your hands.

potter

A person who makes pots, cups and bowls out of clay.

kiln

A very hot oven that bakes clay until it is hard as stone.

CORE IDEAS

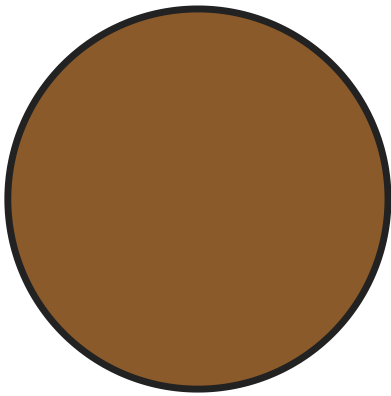
The story. In the Bible, God told the prophet Jeremiah to go down to the potter's house. Jeremiah went and watched. The potter was making a pot of wet clay on a spinning wheel. The pot did not come out right. So the potter squashed the clay and made it again into a new pot, just the way he wanted (Jeremiah 18:1–4). Wet clay can be shaped, squashed and shaped again!

How they figured it out. Sand grains are tiny, but clay bits are far tinier. They are so small that you cannot see one, even with a magnifier. Scientists looked at clay with strong microscopes. They found that each clay bit is a flat little flake, like a very thin plate. When clay is wet, the flat flakes slide over each other and stick together. That is why wet clay feels slippery and sticky. That is also why it keeps the shape you give it.

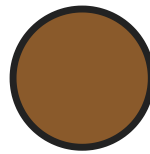
The big idea. Soil has bits of many sizes. **Sand** bits are the biggest. **Silt** bits are in the middle. **Clay** bits are the smallest of all. Wet sand falls apart when it dries, but wet clay can be **molded**. When clay dries in the air, it gets hard. When a potter bakes it in a **kiln**, it turns

hard like stone and can hold water. People have used clay to make bricks, flower pots, plates, cups and roof tiles in many lands.

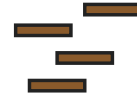
Try it and see. Find some clay. You can buy air-dry clay, or a parent can dig sticky, smooth soil from a garden or a creek bank. Roll a clay snake. Then try to roll a snake of wet sand. Which one holds together? Then make a little pinch pot, like the potter in Jeremiah's story. The Bible says God is our potter and we are the clay (Isaiah 64:8). He made us with care, and He is still shaping us.



sand
biggest



silt
middle



clay
smallest, flat

Sand is biggest, silt is in the middle and clay is smallest. Clay bits are flat like tiny plates. (Drawn much bigger than real life.)

PICTURE STUDY



The Milkmaid, Johannes Vermeer, about 1660 · Oil on canvas · Rijksmuseum, Amsterdam

Johannes Vermeer was a Dutch painter from the town of Delft. He loved to paint quiet rooms with soft light from a window. Here a kitchen maid carefully pours milk. Many of the things in her kitchen are made of clay that a potter shaped and baked.

Delft was famous for its potters. They made blue and white tiles and dishes that people bought all over the world.

Look closely

- Find the jug the maid is pouring from. It is made of baked clay.
- Find the bowl the milk is going into. What do you think she is making?
- Look along the bottom of the wall near the floor. Can you see the row of small tiles? Tiles are made of clay too.
- Find the window. Where does the light fall?

Talk about it

1. How many things made of clay can you find in the picture?
2. Why is a baked clay jug good for holding milk?
3. What things made of clay can you find in your own kitchen?

Safety first. Wash hands after working with clay or soil. If you dig clay outside, a parent should choose the spot. Do not taste clay or soil. Only a grown-up should use an oven or kiln.

MAKE AND DO: CLAY OR SAND? A PINCH POT TEST

You will mold wet clay and wet sand the same way and see which one keeps its shape. Then you will make a little pinch pot to keep.

You will need

- A lump of air-dry clay or clay soil about the size of an orange
- A cup of sand
- A small cup of water
- A ruler
- A paper plate or tray

Steps

1. Wet the sand with a little water so it is damp, like sand for a sandcastle.
2. Roll a snake of clay on the tray. Then try to roll a snake of wet sand next to it.
3. Hold each snake up by one end. Which one holds together? Measure each snake with the ruler.
4. Now roll the clay into a ball. Push your thumb into the middle, but not all the way through.
5. Pinch the sides between your thumb and fingers, turning the ball a little each time, until it becomes a small pot.
6. Smooth the outside with a wet finger. Press your initial on the bottom with a toothpick.
7. Set the pot in a dry place for a few days. Touch it each day. Is it getting harder?

Tips

- If the clay cracks, dip your finger in water and rub the crack smooth.
- Air-dried clay is hard but not waterproof. Only clay baked in a kiln can hold water for a long time.

Check your work

- I rolled a clay snake and a sand snake and saw which held together.
- I made a pinch pot.
- I can say that clay bits are the smallest bits of soil.

FIELD NOTEBOOK

1. Draw your clay snake and your sand snake. Write “held together” or “fell apart” under each.
2. Draw your pinch pot from the top and from the side.
3. Draw three things made of clay that you can find in your house.

From history. Josiah Wedgwood was an English potter from Staffordshire. He started his own pottery in 1759 and kept testing clays and glazes and writing down every result, like

a scientist. His smooth cream-colored dishes pleased Queen Charlotte so much that he was allowed to call them “Queen’s Ware.” Wedgwood also made a famous small clay medallion of a kneeling man in chains, with the words “Am I Not a Man and a Brother?” It helped people speak out against slavery.

WORKED EXAMPLES

Example 1. Sam rolled a clay snake and a wet sand snake. He measured the clay snake with a ruler: 8 inches. The sand snake broke, and the longest piece was 2 inches. Which was longer? How much longer?

1. Compare: 8 inches is more than 2 inches, so the clay snake is longer.
2. To find how much longer, count up from 2 to 8: 3, 4, 5, 6, 7, 8. That is 6 more.
3. The clay held together because its tiny flat bits stick to each other when wet.

Answer: The clay snake was longer, by 6 inches.

PRACTICE

1. **EASY** Which bits are the smallest: sand, silt or clay?
2. **EASY** Point to things in your house that are made of clay.
3. **MEDIUM** You made 3 pinch pots and your sister made 4. How many pots did you make together?
4. **MEDIUM** Sort these into two piles: wet clay and wet sand. Which one keeps a shape? Which one crumbles when it dries?
5. **HARD** Tell in your own words: why can a potter shape clay but not sand?

COMMON MISTAKES

- Thinking clay is something different from soil. Clay is a kind of soil made of the tiniest bits of rock.
- Thinking you can see clay bits with a magnifier the way you see sand. Clay bits are far too small.
- Thinking dried clay is the same as baked clay. Air-dried clay turns soft again in water; clay fired in a kiln stays hard.

Make it a game • Potter Says. A parent is the potter and calls out a shape: a snake, a ball, a bowl, a bird’s nest, a little brick. Make it from your clay before the potter counts to ten. Then squash it and wait for the next shape, just like the potter in Jeremiah’s story.

Scripture. “But now, O LORD, thou art our father; we are the clay, and thou our potter; and we all are the work of thy hand.” (Isaiah 64:8, KJV)

A potter shapes clay with care and patience. God made each of us, and He keeps shaping us to be more like Him.

Practice answers

1. Clay.
2. Answers will vary: a flower pot, a mug, a plate, a bowl, bricks or tiles.
3. 7 pots.
4. Wet clay keeps its shape. Wet sand crumbles when it dries.
5. Clay bits are tiny and flat, so when they are wet they slide and stick together and keep a shape. Sand grains are much bigger and do not stick to each other, so sand falls apart when it dries.

2.3 WHICH SOIL HOLDS WATER?

OBJECTIVES

- Do a fair test: pour the same amount of water through sand, garden soil and clay and watch where it goes.
- Read a simple picture chart and tell which soil let the most water through and which held the most.
- Explain why gardeners like soil that holds some water but not too much.

Warm-up. Hold a dry kitchen sponge over the sink and pour a little water on it. Where does the water go? Now pour the same water onto a small pile of pebbles in a strainer. Which one held the water, and which one let it run right through?

Video. Coming soon. Soil water test for kids (sand, loam and clay drainage experiment) and George Washington Carver and soil: search USDA NRCS, Smithsonian, SciShow Kids, Homeschool Pop (Alternate) and Science Max.

KEY TERMS

soil

The loose top layer of the ground where plants grow. It is made of sand, silt, clay, old bits of plants, air and water.

humus

The dark, soft part of soil made from old leaves and plants that have rotted away. It soaks up water like a sponge.

drain

When water runs down through something and out the bottom.

fair test

A test where you change only one thing and keep everything else the same.

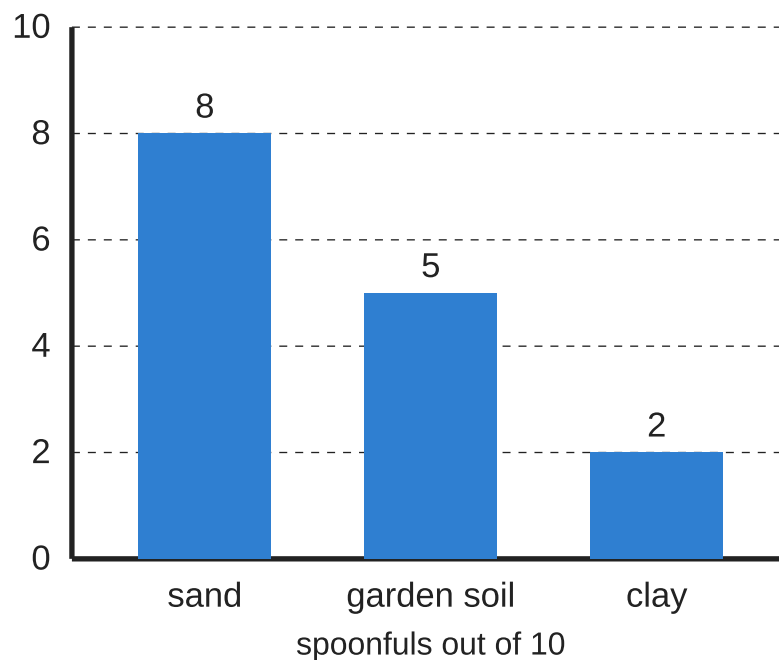
CORE IDEAS

The story. George Washington Carver was a scientist and teacher at Tuskegee in Alabama. Many farmers near him had planted cotton year after year, and their soil was worn out. Carver dug up soil, felt it, tested it and studied it. He showed the farmers how to plant peanuts and peas, which help make tired soil rich again, and sweet potatoes, a good crop to grow in place of cotton. He wanted the farmers to know their soil the way a friend knows a friend.

How they figured it out. To learn about soil, scientists do a **fair test**. They take the same amount of each soil. They pour the same amount of water on each one. They wait the same time. Only the soil is different. Then they look to see how much water **drains** out the bottom. If one soil lets more water through, it is the soil that made the difference.

The big idea. Water rushes through **sand**. The big grains have wide spaces between them, so sand dries fast. Water moves very slowly through **clay**. Its tiny flat bits pack tight, so clay holds water and can get muddy and sticky. Good garden soil is a mix of sand, silt and clay with dark **humus** in it. Humus soaks up water like a sponge. This mix holds enough water for plant roots to drink, but lets the extra drain away so the roots can breathe.

Try it and see. Fill three cups with sand, garden soil and clay soil. Pour the same water into each and catch what drips out. Which cup drips the most? Which drips the least? In the Bible, God sends the rain to water the earth so it can “bring forth and bud” (Isaiah 55:10). Soil is the good ground He made to catch that rain and feed the plants.



We poured 10 spoonfuls of water on each soil. This chart shows how many spoonfuls dripped out the bottom.

PICTURE STUDY



The Gleaners, Jean-François Millet, 1857 · Oil on canvas · Musée d'Orsay, Paris

Jean-François Millet grew up on a farm in France and loved to paint people who worked the land. Here three poor women are gleaning: picking up the bits of wheat the harvesters left behind. The Bible tells about gleaning too. Ruth gleaned in the field of Boaz (Ruth 2).

All the wheat in this picture grew out of the soil. The good field held the rain so the wheat could grow tall and ripe.

Look closely

- Find the three women. What are they picking up from the ground?
- Look far back. Find the big haystacks and the wagon. How much wheat grew in this field?
- Look at the ground. What color is the soil? Is it wet or dry?
- Find the man on the horse. What do you think his job is?

Talk about it

1. What did the soil need to grow so much wheat?
2. Why do you think Millet painted the women so big and the haystacks so far away?
3. How is this picture like the story of Ruth?

Safety first. Do this test outside or over a tray to catch spills, and wipe up water on the floor right away so no one slips. Do not drink the water that drips through the soil. Wash hands when you are done.

MAKE AND DO: THE SOIL DRIP TEST

You will do a fair test to find out which soil holds water best: sand, garden soil or clay.

You will need

- Three paper or plastic cups with a few small holes poked in the bottom by a parent
- Three clear jars or glasses the cups can sit on top of
- Sand, garden soil and clay soil (or crumbled air-dry clay)
- A measuring cup or a spoon
- Water and three labels

Steps

1. Label the cups: sand, garden soil, clay.
2. Put the same amount of each soil in its cup, about half a cup each. Set each cup on top of a jar.
3. Guess first: which jar will get the most water? Which will get the least? Say your guess out loud.
4. Pour the same amount of water slowly into each cup, one after another. Count your spoonfuls so each cup gets the same.
5. Wait while your parent counts slowly to 60, or sing a song together.
6. Lift the cups and look at the jars. Line them up from most water to least water.
7. Poke your finger into each cup of soil. Which soil feels the wettest?

Tips

- Keep the test fair: same amount of soil, same amount of water, same waiting time.
- If your clay is very hard and dry, crumble it into small pieces first.

Check your work

- I guessed before I tested.
- I kept the test fair.
- I can tell which soil let the most water through and which held the most.

FIELD NOTEBOOK

1. Draw your three jars and color in how much water each one got. Label them sand, garden soil and clay.
2. Draw a plant with long roots growing down into good soil. Draw raindrops soaking in.
3. Draw a sponge and a sieve. Write which one is like clay and which one is like sand.

From history. In 1906 George Washington Carver and his students fixed up a farm wagon into a school on wheels, called the Jesup Wagon. It carried tools, seeds and lessons

out to farm families who could not come to Tuskegee. Carver and his helpers showed them how to care for their soil and grow better crops right on their own land.

WORKED EXAMPLES

Example 1. Look at the picture chart. We poured 10 spoonfuls of water on each soil. Which soil let the most water drip through? Which soil held the most water?

(Use the map or drawing “The tallest bar shows the soil that let the most water through.” shown earlier in this lesson.)

1. Find the tallest bar. It is sand, at 8 spoonfuls. Sand let the most water through.
2. Find the shortest bar. It is clay, at 2 spoonfuls. Only a little water got through the clay.
3. If only a little dripped out, the rest stayed in the soil. So clay held the most water.
4. Garden soil is in the middle, at 5 spoonfuls.

Answer: Sand let the most water through. Clay held the most water. Garden soil was in the middle.

PRACTICE

1. **EASY** Which soil lets water run through fast: sand or clay?
2. **EASY** Point to the shortest bar on the chart. Which soil is it?
3. **MEDIUM** On the chart, sand let 8 spoonfuls through and garden soil let 5 through. How many more spoonfuls came through the sand?
4. **MEDIUM** Your brother poured 3 spoonfuls of water on the sand and 10 spoonfuls on the clay. Is that a fair test? Why or why not?
5. **HARD** Tell in your own words: why is a mix of sand, clay and humus good for garden plants?

COMMON MISTAKES

- Thinking the soil that holds the most water is always best for plants. Too much water makes mud, and roots need air too.
- Changing two things at once in a test, like more water and a different soil. Then you cannot tell which one made the difference.
- Thinking soil is just dirt. Soil is a mix of rock bits, humus, air and water, and it is full of tiny living things.

Make it a game · Sponge or Sieve?. Your parent names a thing: a towel, a colander, sand, clay, a diaper, a fishing net, a pile of leaves, a rock. If it holds water, squeeze your hands like a sponge. If water runs through it, wiggle your fingers like a sieve. Talk about any you are not sure of, then test one at the sink.

Scripture. “For as the rain cometh down, and the snow from heaven, and returneth not thither, but watereth the earth, and maketh it bring forth and bud, that it may give seed to the sower, and bread to the eater:” (Isaiah 55:10, KJV)

God sends rain, and the soil He made catches it and gives it to the plants. Then we have seeds to plant and bread to eat.

Practice answers

1. Sand.
2. Clay (2 spoonfuls).
3. 3 more spoonfuls (8 take away 5 is 3).
4. No. To be fair, each soil must get the same amount of water, so only the soil is different.
5. It holds enough water for the roots to drink, but the extra water can drain away, so the roots do not sit in mud and can get air.

2.4 THE WISE MAN BUILT UPON A ROCK (MATTHEW 7:24–27)

OBJECTIVES

- Retell Jesus’ story of the wise man and the foolish man.
- Test model houses on rock and on sand and tell which one stands when the “rain” and “floods” come.
- Explain that a house needs a strong foundation, and that obeying Jesus’ words is like building on rock.

Warm-up. Stand a small block or toy on a flat stone or a book. Now stand it on a pile of sand or sugar in a tray. Gently push the tray from side to side. Which one wobbles and falls first?

Video. Coming soon. The wise and foolish builders (Matthew 7:24–27) for young children, plus how house foundations work and flash floods in dry stream beds: search Moody Science classics, Smithsonian, USGS, Homeschool Pop (Alternate) and Science Max.

KEY TERMS

foundation

The strong bottom part that a house or building sits on.

bedrock

The hard, solid rock deep under the soil and sand.

flood

A lot of water that rises and rushes over land that is usually dry.

wise

Knowing what is right and good, and choosing to do it.

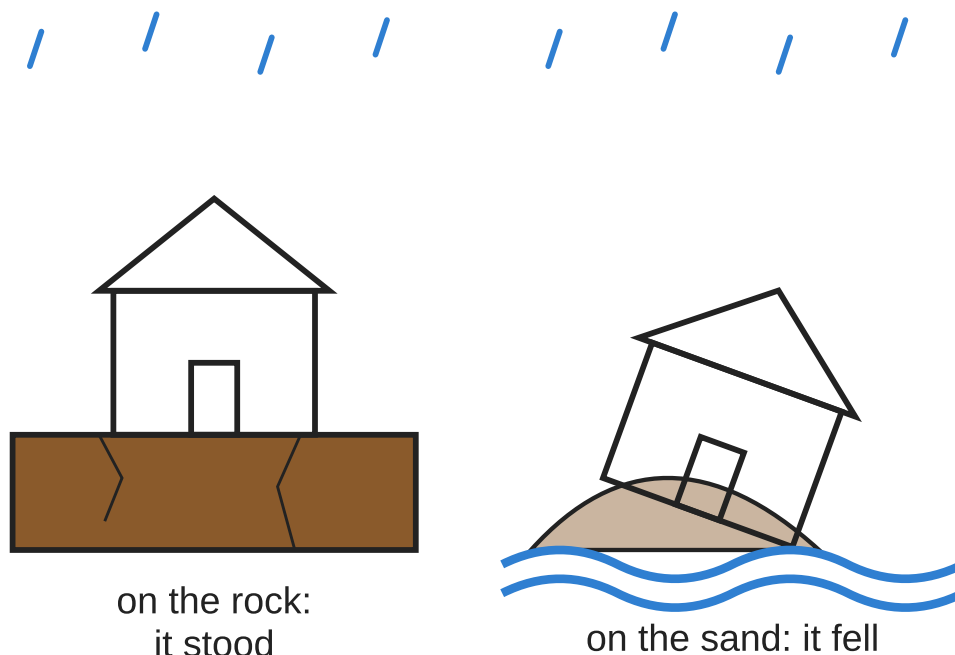
CORE IDEAS

The story. One day Jesus sat on a mountain in Galilee and taught a great crowd. At the end He told a story. A wise man built his house upon a rock. The rain came down, the floods came up and the winds blew. But the house did not fall, for it was built on a rock. A foolish man built his house upon the sand. The same rain, floods and winds beat on it, and it fell, and great was the fall of it (Matthew 7:24–27).

How they figured it out. The people who heard Jesus knew just what He meant. In their land there are dry stream beds full of sand. Most of the year they are dry and flat. It might look like a fine place to build. But after a hard rain, water can rush down them in a sudden flood. The water picks up the loose sand and carries it away. A house on that sand would wash away too. A wise builder digs down to solid **bedrock** first.

The big idea. You learned that sand is made of loose grains. Water can push them and carry them off. Clay can turn soft and slippery when it is soaked. But bedrock is one big, solid piece. Water cannot carry it away. That is why builders today still dig down and set a strong **foundation** on solid rock or packed ground before they build a tall house or a bridge.

Try it and see. Build two little houses, one on a flat rock and one on a pile of sand. Pour on “rain” and see what happens. Then remember what Jesus taught. He said the **wise** man is the one who hears His sayings *and does them*. When hard days come like storms, a life built on obeying Jesus stands firm.



The house on the rock stands. The house on the sand falls when the flood washes the sand away.

PICTURE STUDY



Dunstanburgh Castle, N.E. Coast of Northumberland. Sun-Rise after a Squally Night, J. M. W. Turner, 1798 · Oil on canvas · National Gallery of Victoria, Melbourne

Joseph Mallord William Turner was an English painter who loved the sea, storms and light. Here he painted Dunstanburgh Castle in the north of England, just after a stormy night.

The castle was built on a high ridge of hard, dark rock beside the sea. It is a ruin now, but after many, many storms its stone walls still stand on their rock.

Look closely

- Find the castle. What is it standing on?
- Find the waves. Where are they crashing?
- Look at the sky. Is the storm coming or going away? How can you tell?
- Find the small people on the shore. What might they be doing after the storm?

Talk about it

1. Why do you think the builders put the castle on rock instead of on the sandy beach?
2. How is this picture like Jesus' story of the wise man?
3. What storm sounds would you hear if you stood on that rock?

Safety first. Do the house test outside or in a tray or bathtub so water does not spill on the floor. Wipe up spills so no one slips. Real flood water is dangerous: never play in rushing water or a flooded stream.

MAKE AND DO: ROCK HOUSE, SAND HOUSE

You will build two little houses, one on rock and one on sand, and send a pretend storm to see which one stands.

You will need

- A baking pan, plastic tub or tray
- A flat rock or a brick
- Two or three cups of sand
- Building blocks, interlocking bricks or two small boxes for houses
- A cup or watering can of water
- A fan or your own breath for wind

Steps

1. Set the flat rock at one end of the pan. Make a pile of sand at the other end.
2. Build two houses that are just the same: one on top of the rock and one on top of the sand.
3. Guess first: which house will fall? Say why.
4. Make the rain: pour one cup of water over each house, slowly, from up high.
5. Make the flood: tip the pan a little so water runs past both houses.
6. Make the wind: blow on each house or turn on the fan.
7. Count how many cups of rain each house stood through before it fell. Tell what happened to the sand.

Tips

- Keep it fair: same house, same water, same wind. Only the ground under the house is different.
- Pour the water on the sand, not straight on the roof, to see the ground wash away.

Check your work

- I built one house on rock and one on sand.
- I can tell which house stood and why.
- I can tell Jesus' story of the wise man and the foolish man.

FIELD NOTEBOOK

1. Draw the wise man's house on the rock with rain falling on it. Write "It fell not."
2. Draw the foolish man's house on the sand with flood water washing the sand away.
3. Draw your own house and what it might sit on. Ask a parent what is under your house.

From history. Off the coast of England, near Plymouth, a group of rocks called the Eddystone sank many ships. People built lighthouses there to warn sailors, but the first

ones were made of wood, and one was swept away in a great storm in 1703. Then an engineer named John Smeaton built a lighthouse of heavy stone blocks that locked together like puzzle pieces, fixed firmly to the rock itself. It was finished in 1759 and stood through storm after storm. Much later, when the rock under it began to crack, people took the top part down and built it again on land in Plymouth, where it still stands.

WORKED EXAMPLES

Example 1. Ella poured cups of “rain” on two block houses. The house on the rock was still standing after 5 cups. The house on the sand fell after 2 cups. Which house stood longer? How many more cups did it stand through?

1. Compare: 5 cups is more than 2 cups, so the house on the rock stood longer.
2. Count up from 2 to 5: 3, 4, 5. That is 3 more cups.
3. The rock did not wash away, but the water carried the sand out from under the other house.

Answer: The house on the rock stood longer, through 3 more cups of rain.

PRACTICE

1. **EASY** In Jesus’ story, where did the wise man build his house? Where did the foolish man build his?
2. **EASY** Name the three things that beat on both houses.
3. **MEDIUM** Point to the house in the picture that fell. What was it built on?
4. **MEDIUM** Your rock house stood through 4 cups of rain and your sand house stood through 1 cup. How many cups is that in all?
5. **HARD** Tell in your own words: who is like the wise man, according to Jesus?

COMMON MISTAKES

- Thinking the wise man’s house had no storm. The same storm hit both houses; only the ground under them was different.
- Thinking sand is strong because each grain is hard rock. Each grain is hard, but loose grains can be pushed and carried away by water.
- Thinking the wise man is the one who only listens to Jesus. Jesus said the wise man hears His sayings and does them.

Make it a game • Rock or Sand? Your parent says a choice, such as “I heard Mom say clean up, and I did it,” or “I heard Dad say be kind, but I grabbed my brother’s toy.” If it is hearing and doing, stand tall like a house on the rock. If it is hearing but not doing, slowly tumble to the floor like the house on the sand. Then play a building round: stack blocks on a book and on a pillow and see which tower stands longer.

Scripture. “Therefore whosoever heareth these sayings of mine, and doeth them, I will liken him unto a wise man, which built his house upon a rock: And the rain descended, and the floods came, and the winds blew, and beat upon that house; and it fell not: for it was founded upon a rock. And every one that heareth these sayings of mine, and doeth them not, shall be likened unto a foolish man, which built his house upon the sand: And the rain descended, and the floods came, and the winds blew, and beat upon that house; and it fell: and great was the fall of it.” (Matthew 7:24-27, KJV)

Both men heard Jesus. Both had a storm. The difference was what they built on. Hearing Jesus and doing what He says is like building on solid rock.

Practice answers

1. The wise man built on a rock. The foolish man built on the sand.
2. The rain, the floods and the winds.
3. The house on the right. It was built on sand.
4. 5 cups.
5. The person who hears Jesus’ words and does them, not just hears them.

UNIT 2 REVIEW

This is an oral review. A parent reads each question aloud, and the child answers out loud, points or shows. Give full points for a clear answer in the child's own words. The review is worth 20 points.

1. (3 pts) What is sand made of? What did you see when you looked at sand with a magnifier?
2. (3 pts) Show me 5 clear grains and 3 brown grains on your sand card or with beans. How many is that in all? Which kind has more?
3. (3 pts) Which bits of soil are the smallest: sand, silt or clay? What can you do with wet clay that you cannot do with sand?
4. (2 pts) Name two things people make out of clay.
5. (3 pts) In your drip test, which soil let the water run through fastest? Which soil held the most water?
6. (3 pts) What makes a test fair? Tell one thing you kept the same in your drip test.
7. (3 pts) Tell Jesus' story of the two builders. Why did one house stand and the other fall? Who is like the wise man?

UNIT PROJECT: MY SAND AND SOIL COLLECTION

Make a small display of everything you learned about the ground. Put together your sand grain card from Lesson 2.1, your dried pinch pot from Lesson 2.2 and a drawing of your drip test jars from Lesson 2.3. Then make one new thing: a soil jar. Fill a clear jar halfway with garden soil, add water nearly to the top, close the lid tight and shake it hard. Let it sit for a day. Look for the layers: heavy sand at the bottom, silt in the middle, cloudy clay settling on top and bits of old leaves floating. Draw the jar and label each layer.

Finish by telling your family Jesus' story of the wise man and showing them which of your soils a wise builder would not build on, and why.

- **Observing:** The sand card and soil jar drawing show careful looking: colors, sizes and layers drawn as they really were.
- **Making:** The pinch pot is shaped by hand and dried, and the sand card is neatly glued and labeled.
- **Testing:** The drip test drawing shows the three soils and which let the most and least water through.
- **Telling:** The child tells in their own words what sand, silt and clay are and retells the story of the wise and foolish builders.

Answer key

1. Sand is tiny bits of rock. Under a magnifier you can see separate grains with different colors and shapes: clear, brown, dark, round or pointy, sometimes bits of shell.
2. 8 in all. There are more clear grains (5 is more than 3).

3. Clay bits are the smallest. Wet clay can be molded into a shape that stays, like a pot or a snake; wet sand falls apart when it dries.
4. Any two: pots, cups, bowls, plates, bricks, tiles, flower pots, jugs.
5. Sand let the water through fastest. Clay held the most water.
6. In a fair test you change only one thing. We kept the same amount of soil, the same amount of water or the same waiting time; only the kind of soil was different.
7. The wise man built on a rock and the foolish man on the sand. The rain, floods and winds beat on both. The house on the rock stood because rock does not wash away; the sand washed away and the house fell. The wise man is like someone who hears Jesus' words and does them.

RIVERS AND PUDDLES

Where does the water go after it rains? In this unit your child will follow water downhill, from a spring or a patch of melting snow, into little streams, into big rivers, and all the way to the sea. You will meet Henry Schoolcraft and his Ojibwe guide Ozawindib, who found the small lake where the mighty Mississippi begins. Then you will put on boots after a rainstorm and watch a real river run down your own street in the gutter.

Along the way your child will pick up river stones and learn why they are smooth and round, and will shake sugar cubes in a jar to see corners wear away. The unit ends at the Jordan River, where God stopped a flooding river so His people could cross on dry ground, and where Joshua set up twelve stones so children would ask, “What mean ye by these stones?”

Every lesson has a picture to study, a simple make-and-do project, and short oral practice. Keep a river page in the nature notebook all unit long, and if you can, visit a real creek or river together, always with a grown-up close by.

BEFORE YOU BEGIN

- Can count to 20 and add or take away small numbers with fingers
- Has played with water in a tub, sink or sandbox and seen that water runs and spills
- Can sort rocks by size: boulder, cobble, pebble and sand (Unit 1)
- Knows that some soils soak up water and some let it run off (Unit 2)

MASTERY CHECKLIST

- I can tell where a river starts: melting snow, rain, a spring or a lake.
- I can show that water flows downhill and that little streams join to make a big river.
- I can tell where gutter water goes after a rain: down the storm drain, to a creek, to a river and to the sea.
- I can explain why river stones are smooth and rounded.
- I can retell how God brought Israel across the Jordan River on dry ground.
- I can find the Jordan on a simple map and tell which way it flows.

OPTIONAL BOOKS AND RESOURCES

- **USGS Water Science School** (<https://www.usgs.gov/special-topics/water-science-school>): Free. Clear pages and pictures from the U.S. Geological Survey on rivers, streams, springs and where rainwater goes. Best for the parent to read first and then explain in simple words.
- **NOAA SciJinks** (<https://scijinks.gov/>): Free. Kid-friendly pages, pictures and short videos about the water cycle, rain and weather from NOAA and NASA. A good bridge to Unit 4, Clouds and Rain.

3.1 WHERE A RIVER STARTS ★

OBJECTIVES

- Name places where a river can start: melting snow, rain on the hills, a spring or a lake.
- Show that little streams join together to make a big river that flows downhill to the sea.
- Tell the story of Henry Schoolcraft and his guide Ozawindib finding the start of the Mississippi River at Lake Itasca.

Warm-up. Prop one end of a cookie sheet on a book. With a spoon, drip a few drops of water at the high end, in two or three different places. Watch closely. Which way do the drops run? Do any of the drops meet and join together? What happens to a drop when it joins another one?

Video. Coming soon. Where rivers begin for young children: snowmelt, springs and small streams joining into rivers, and the Mississippi headwaters at Lake Itasca; search USGS Water Science School, SciShow Kids, Homeschool Pop (Alternate), Minnesota state park footage and calm nature footage of mountain streams.

KEY TERMS

source

The place where a river begins, such as melting snow, a spring or a lake.

stream

A small river of moving water. People also call it a creek or a brook.

river

A big stream of water that flows downhill in a long path to the sea or a big lake.

mouth

The place where a river ends and pours into the sea or a big lake.

CORE IDEAS

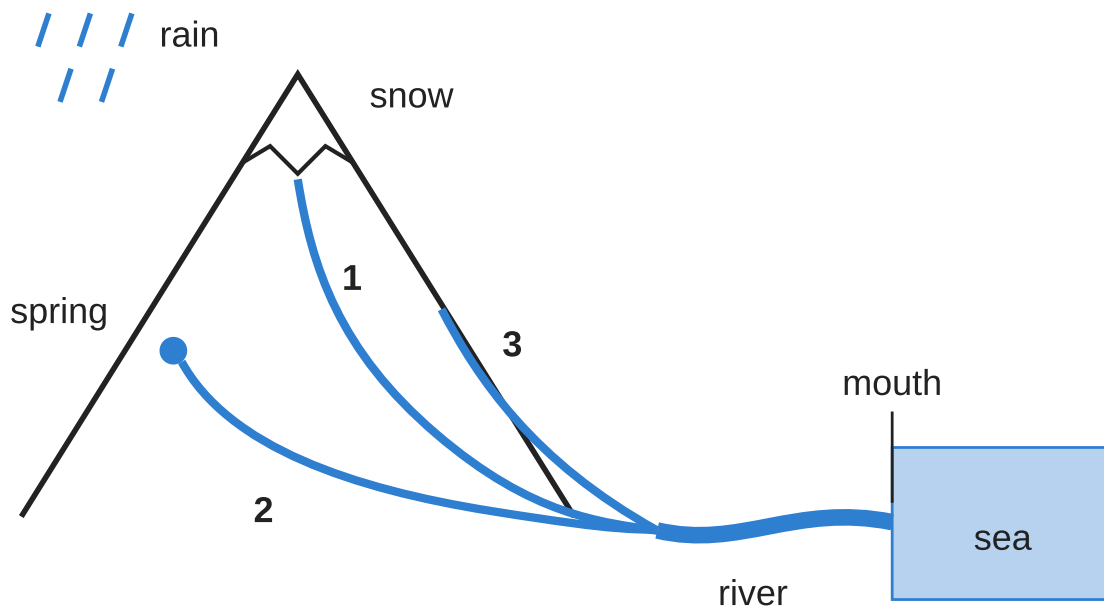
The story. In the summer of 1832, a man named Henry Schoolcraft traveled by canoe up the Mississippi River. The Mississippi is one of the biggest rivers in America. Far to the south, big boats carry corn and wheat on it. But where does such a big river begin? Schoolcraft wanted to find out. An Ojibwe guide named Ozawindib, who knew the woods and lakes of Minnesota, showed him the way. They paddled, and they carried their canoes over land between the lakes. At last they came to a clear lake in the pine woods. A little stream ran out of it. That little stream was the start of the mighty Mississippi! Schoolcraft named the lake Itasca. He made the name from two Latin words that mean “true head.”

How they figured it out. Schoolcraft went *upstream*. That means he traveled the opposite way from the way the water was flowing. As he went, the river got smaller and smaller,

because he kept passing the places where other streams flowed in. At Lake Itasca the river is so small that today children can walk across the Mississippi on a row of stepping stones!

The big idea. Water always flows downhill. So rivers start in higher places, like hills, mountains and high woods. Some rivers start where snow melts in the spring. Some start where rain runs off the hills. Some start at a **spring**, where water bubbles up out of the ground. Some start at a lake, like Itasca. The place where a river begins is its **source**. Tiny trickles join to make a **stream**. Streams join to make a **river**. The river keeps running downhill until it reaches the sea or a big lake. The place where it ends is its **mouth**.

God's handiwork. The Bible says God "sendeth the springs into the valleys, which run among the hills" (Psalm 104:10). God made water to run downhill and gather together. Little streams feed big rivers, and big rivers bring water to farms, towns, fish and birds. The next time you see a river, ask, "Where did this water start?"



Snow, rain and a spring feed three little streams. They join into one river that runs downhill to the sea.

PICTURE STUDY



Kindred Spirits, Asher B. Durand, 1849 · Oil on canvas · Crystal Bridges Museum of American Art, Bentonville, Arkansas

Asher B. Durand was an American painter who loved to paint the woods and streams of New York. His friend Thomas Cole, another painter, had died, so Durand painted this picture to remember him. It shows Cole and their friend, the poet William Cullen Bryant, standing on a rock ledge high in the Catskill Mountains.

Below them, mountain water tumbles over rocks. Streams like this one run down out of the mountains and join together to make the big rivers below.

Look closely

- Find the two men on the rock. Where are they looking?
- Find the falling water. Follow it down with your finger.
- Is the water going uphill or downhill?
- Find the tall trees and the rocks beside the water.

Talk about it

1. Where do you think this water is going?
2. Could this little stream be the start of a bigger river? Why do you think so?
3. What sounds would you hear if you stood on that rock?

Safety first. Wipe up spilled water so no one slips. If you visit a real stream, always stay with a grown-up, keep off slippery rocks and never drink the stream water.

MAKE AND DO: RAIN ON A PAPER MOUNTAIN

You will build a little mountain out of paper, make it rain, and watch where the water runs. You will see tiny streams start, join together and run downhill, just like real rivers.

You will need

- One sheet of white printer paper
- Washable markers (blue, brown and green)
- A spray bottle filled with water
- A baking pan or tray
- Two or three small plastic cups or blocks
- A towel

Steps

1. Turn the small cups upside down in the pan. They will hold up your mountains.
2. Crumple the paper into a ball. Then open it most of the way, so it is bumpy, and lay it over the cups. Now you have hills and valleys.
3. With a washable marker, color along the tops of your hills, the highest places.
4. Hold the spray bottle above your mountains and make it “rain.” Spray slowly, a few squirts at a time.
5. Watch the colored water run. Which way does it go? Put your finger on a place where two little streams join together.
6. Find the lowest place where the water gathers. That is your lake or your sea.
7. Draw your mountain and its streams in your notebook. Mark the source with an S and the mouth with an M.

Tips

- If the marker does not run, spray a little more water on that spot.
- You can also use a sheet of kitchen foil over the cups and drip water on top with a spoon.

Check your work

- I can show where my streams started.
- I can show a place where two streams joined.
- I can tell which way water always flows.

FIELD NOTEBOOK

1. Draw a mountain with snow on top, rain falling and a spring on its side. Draw streams running down and joining into one river.
2. Draw the stepping stones across the Mississippi at Lake Itasca, with yourself walking across.

3. With a parent, find the name of a creek or river near your home. Write or tell its name, and draw it.

From history. Many years after Schoolcraft's trip, a man named Jacob Brower worked hard to protect the tall pine trees and the lake where the Mississippi begins. In 1891 the land around Lake Itasca became Minnesota's first state park. Families still visit it today, and many of them take off their shoes and walk across the start of the Mississippi on the stepping stones.

WORKED EXAMPLES

Example 1. Look at the picture of the mountain. How many little streams join together to make the river?

(Use the map or drawing "Count the streams: 1, 2, 3." shown earlier in this lesson.)

1. Put your finger at the top of each blue line on the mountain.
2. Count them: 1, 2, 3.
3. Follow each line down with your finger. They all meet in one place.
4. After they meet, there is just one big river running to the sea.

Answer: 3 little streams join to make 1 river.

PRACTICE

1. **EASY** Which way does water flow by itself: uphill or downhill?
2. **EASY** Name two places where a river can start.
3. **MEDIUM** Look at the mountain picture. Point to a source of the river. Then point to the mouth.
(Use the map or drawing "Find the source and the mouth." shown earlier in this lesson.)
4. **MEDIUM** On one side of a hill, 2 little streams run down. On the other side, 2 more streams run down. All of them join the same river. How many streams joined the river?
5. **HARD** Why is a river small near its source and big near its mouth? Tell it in your own words.

COMMON MISTAKES

- Thinking rivers start at the sea. Rivers end at the sea. They start in higher places, like hills and mountains.
- Thinking water can run uphill by itself. Water always runs downhill.
- Thinking a river is the same size all the way along. It starts small and grows as other streams join it.

Make it a game · Join the River. Each family member starts in a different corner of the room as a little stream, saying “trickle, trickle.” One person is the source and starts walking slowly toward the “sea” (the couch). Each time the river walks past a stream, that stream holds hands and joins on. Count out loud as each stream joins. When the whole river reaches the sea, everyone sits down with a splash. Then pick a new source and play again.

Scripture. “He sendeth the springs into the valleys, which run among the hills.” (Psalm 104:10, KJV)

Springs and streams do not happen by accident. God sends them, and they run among the hills to give water to every living thing.

Practice answers

1. Downhill.
2. Any two: melting snow, rain running off the hills, a spring, or a lake.
3. A source is the snow on top, the rain or the spring. The mouth is where the river pours into the sea.
4. 4 streams ($2 + 2 = 4$).
5. Because as the river runs downhill, more and more streams flow into it and add their water, so it grows bigger and bigger.

3.2 A GUTTER RIVER AFTER RAIN ★

OBJECTIVES

- Watch rainwater run downhill along a curb and describe it like a little river.
- Tell that moving water carries leaves, sand and small stones, and drops them where it slows down.
- Tell where gutter water goes: into a storm drain, through a pipe, and on to a creek or river.

Warm-up. In the kitchen sink, tip a cutting board so one end is higher. Sprinkle a little sand or a few grains of rice in the middle. Slowly pour a cup of water from the high end. What happens to the sand? Where does the water go? Where does the sand stop?

Video. Coming soon. Rainwater running down streets, gutters and storm drains for young children, and how storm drains lead to creeks and rivers; search USGS Water Science School, NOAA SciJinks, SciShow Kids, Homeschool Pop (Alternate), city “only rain down the drain” videos and rainy-day street footage.

KEY TERMS

gutter

The low edge of a street, beside the curb, where rainwater runs away.

storm drain

A grate or opening in the street or curb where rainwater goes down into a pipe.

puddle

A small pool of water that gathers in a low spot after rain.

CORE IDEAS

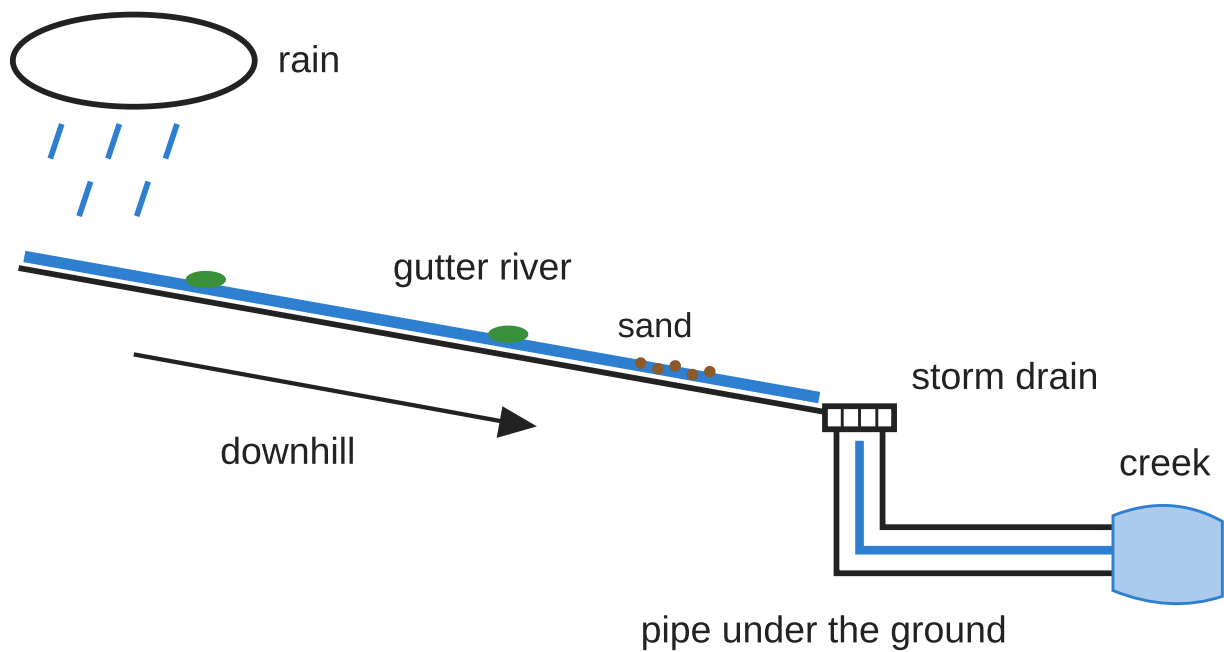
The story. It has rained all morning. Now the rain has stopped. Put on your boots and go outside with a grown-up. Stand on the sidewalk and listen. Do you hear a trickle? Look at the edge of the street, beside the curb. Water is running there like a tiny river! This low edge of the street is called the **gutter**. It is made to carry rainwater away so the street does not flood.

How we figure it out. Drop a leaf or a small stick into the gutter river and walk beside it on the sidewalk. Which way does it go? It always goes downhill. Watch it spin around a pebble and speed up where the street gets steeper. Look at what else the water carries: leaves, twigs, sand and even small stones. Where the water slows down, it drops its sand in a little fan shape. At the bottom of the hill, the water pours into a **storm drain**.

The big idea. A gutter river works just like a real river, only smaller. It starts with rain. It runs downhill. Fast water carries sand and stones, and slow water drops them. Water that

cannot run any lower gathers in a low spot and makes a **puddle**. Later the puddle dries up. Some of its water soaks into the ground, and the sun and wind lift the rest up into the air. In many towns, storm drains carry rainwater through pipes under the ground to a nearby creek or river. So the gutter river joins a real river, and the river runs on toward the sea. That is why people say, "Only rain down the drain." We keep trash out of the gutter to help keep our creeks clean.

God's handiwork. The Bible says, "All the rivers run into the sea; yet the sea is not full" (Ecclesiastes 1:7). The same water goes around and around: from clouds, to rain, to gutters and rivers, to the sea, and back up into the clouds. God made it work that way to water the whole earth.



Rain runs downhill in the gutter, down the storm drain, and through a pipe to a creek.

PICTURE STUDY



Paris Street; Rainy Day, Gustave Caillebotte, 1877 · Oil on canvas · Art Institute of Chicago

Gustave Caillebotte was a French painter who lived in Paris. In this very large painting he shows a street corner in Paris on a rainy day. People walk under umbrellas, and the paving stones of the street shine because they are wet.

Look closely

- Find the umbrellas. How many can you count?
- Look at the street. Find the wet stones that shine.
- Find the curb at the edge of the sidewalk. Where would the rainwater run?
- Look far down the street. What do you see there?

Talk about it

1. Is it still raining, or has it just stopped? What clues help you tell?
2. Where do you think the rainwater on this street goes?

Safety first. Watch gutter rivers only from the sidewalk, with a grown-up. Never stand or play in the street. Never reach into a storm drain or go near fast-moving water. Stay inside if there is thunder or lightning. Wash your hands after touching gutter water.

MAKE AND DO: MAKE A DRIVEWAY RIVER

You will make your own gutter river, float a leaf boat, and see how moving water carries sand. You will measure how far your leaf boat traveled.

You will need

- A watering can or a bucket of water
- A handful of sand or dirt
- A few leaves and small twigs
- Sidewalk chalk
- A plastic cup
- A gentle slope away from cars, such as a driveway with a grown-up watching, or a large baking sheet propped up on a book

Steps

1. Pick your slope. Draw a chalk line at the top and call it Start.
2. Put a small pile of sand a little way down the slope.
3. Lay a leaf boat at the Start line.
4. Slowly pour water from the watering can just above the Start line. Watch the water, the leaf and the sand.
5. When the leaf stops, mark that spot with chalk.
6. Count your heel-to-toe steps from Start to the chalk mark. (On a baking sheet, count your finger widths.)
7. Build a little dam of sand across the path and pour again. What does the water do at the dam?
8. Put the plastic cup at the bottom as your storm drain. What does it catch?

Tips

- Pour slowly for a gentle river and faster for a flood. Which one carries more sand?
- After a real rain, go on a gutter walk with a grown-up and compare it with your driveway river.

Check your work

- I can show which way my river ran.
- I can tell what my river carried and where it dropped the sand.
- I can count how far my leaf boat went.

FIELD NOTEBOOK

1. Draw a street after rain. Show the gutter river, a leaf boat and a storm drain.
2. Draw a puddle you have seen. Draw it again the next day. Is it bigger, smaller or gone?
3. Draw arrows showing the trip of a raindrop: cloud, street, gutter, storm drain, creek, sea.

From history. Under the very streets in Caillebotte's painting, an engineer named Eugène Belgrand built a great system of tunnels in the 1850s and 1860s. The tunnels carried rainwater and dirty water away from the city, so the streets of Paris drained

better and the people stayed healthier. Visitors can still walk through part of the Paris sewers in a museum today.

WORKED EXAMPLES

Example 1. Two leaf boats raced down the driveway river. The red leaf floated 7 steps. The yellow leaf floated 4 steps. Which leaf went farther? How many steps farther?

1. Compare the numbers. 7 is more than 4, so the red leaf went farther.
2. To find how many more, count up from 4 to 7: 5, 6, 7. That is 3 counts.
3. So $7 - 4 = 3$.

Answer: The red leaf went farther, by 3 steps.

PRACTICE

1. **EASY** Which way does the gutter river run?
2. **EASY** Name two things a gutter river can carry.
3. **MEDIUM** Look at the gutter river picture. Point to the storm drain. Where does the water go next?
(Use the map or drawing "Follow the water." shown earlier in this lesson.)
4. **MEDIUM** On the way to the mailbox you counted 5 puddles. On the way back you found 3 more that you missed. How many puddles in all?
5. **HARD** Why does a puddle form in one spot but not in another spot?

COMMON MISTAKES

- Thinking all storm drain water is cleaned first. In many towns it flows straight to a creek or river, so we keep trash and oil out of the gutter.
- Thinking a puddle just disappears. Some water soaks into the ground, and the sun and wind lift the rest into the air.
- Thinking only deep water can move things. Even shallow water carries sand and leaves when it runs fast.

Make it a game · River or Puddle?. A parent names a place, such as "a steep street," "a dip in the playground," "a sloping driveway" or "a hole in the yard." The child says "River!" if the water would run away downhill, or "Puddle!" if it would sit still in a low spot, and runs or stands still to match. Score one point for each right answer, and an extra point for telling where the river water will go next.

Scripture. "All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again." (Ecclesiastes 1:7, KJV)

The rain in your gutter joins a river, the river runs to the sea, and the water rises again to make new clouds. God made the waters to go around and around.

Practice answers

1. Downhill.
2. Any two: leaves, twigs, sand, small stones, bits of trash.
3. Into a pipe under the ground, and then to the creek.
4. 8 puddles ($5 + 3 = 8$).
5. Puddles form in low spots. The water runs downhill and gathers where it cannot run any lower. On a slope, the water keeps running away.

3.3 RIVER STONES ARE ROUNDED

OBJECTIVES

- Compare a sharp, broken rock with a smooth, rounded river stone by looking and feeling.
- Explain that rushing water rolls stones so they bump and rub until their corners wear away.
- Show how corners wear off by shaking sugar cubes in a jar.

Warm-up. Find two rocks: a sharp piece of gravel from a driveway or path, and a smooth pebble (from a garden, a creek bank or a bag of river rock). Close your eyes while a parent puts one in your hand. Feel it all over. Is it sharp or smooth? Which rock is it? Now try the other one.

Video. Coming soon. How rivers round and smooth stones for young children: rocks tumbling in streams, pebbles on riverbeds and beaches, and sugar-cube or rock-tumbler demonstrations; search USGS, SciShow Kids, Homeschool Pop (Alternate), Science Max and nature footage of rocky mountain streams.

KEY TERMS

jagged

Sharp and pointy, with rough corners and edges.

rounded

Smooth, with the corners worn off, like an egg or a ball.

tumble

To roll and bump over and over.

wear away

To rub off a little bit at a time until a part is gone.

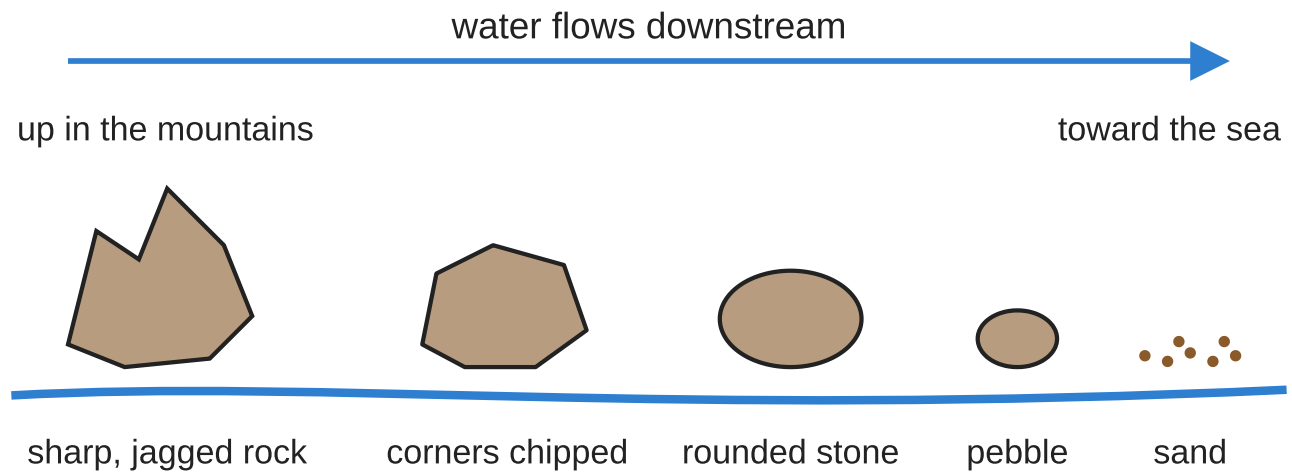
CORE IDEAS

The story. Long ago, a shepherd boy named David went out to face a giant named Goliath. David did not take a sword. He went down to a brook, which is a little stream, and he chose five smooth stones for his sling (1 Samuel 17:40). Why did David look in the brook? Because stones from a brook are smooth and round. A round stone fits well in a sling and flies well.

How they figured it out. People who study rivers have picked up stones all along a river, from the mountains down toward the sea. High in the mountains, where rocks break off cliffs, the stones are big and **jagged**, with sharp corners. Farther down the river, the stones are smaller and rounder. Near the mouth, many are smooth pebbles and sand. What happened to the corners along the way?

The big idea. Rushing water rolls stones along the bottom of a river. The stones **tumble**, knock and scrape against each other and against the sand. Each bump chips off a tiny bit. The pointy corners stick out the most, so they break off first. Little by little the river **wears away** the corners, and a jagged rock becomes a **rounded** one. The tiny bits that chip off become sand and mud, and the river carries them away. Fast, high water after a big rain moves the most stones. Waves on a beach roll stones back and forth and round them too.

Try it and see. You can make a river in a jar with sugar cubes. When you shake them hard, they knock together just like stones in a stream. Their sharp corners wear off, and sugar “sand” piles up at the bottom. The next time you hold a smooth river stone, you can say, “This stone has been on a bumpy trip!”



Stones bump and rub as they roll, so corners wear away.

As stones tumble downstream, they lose their corners. Sharp rocks become rounded stones, then pebbles, then sand.

PICTURE STUDY



John Ruskin, John Everett Millais, 1853–1854 · Oil on canvas · Ashmolean Museum, Oxford, England

John Everett Millais was an English painter. In the summer of 1853 he visited a rocky stream at Glenfinlas in Scotland with his friend John Ruskin, a writer who loved rocks, clouds and plants. Ruskin believed artists should paint nature just as it really is.

So Millais sat beside the stream day after day and painted every rock and ripple with tiny brushes. Look how carefully he showed the rocks the water had been rubbing.

Look closely

- Find John Ruskin. What is he standing on?
- Look at the rocks where the water runs. Do they look sharp or smooth?
- Find the white foam where the water rushes fast.
- Look for plants growing on the rocks and the banks.

Talk about it

1. Why do you think the rocks in the stream look smooth?
2. If you stood where Ruskin is standing, what would you hear?

Safety first. Use a plastic jar with a tight lid, not glass. Collect stones only with a grown-up: stay on the bank or in shallow, still water, and keep off slippery rocks. Many parks do not allow people to take stones, so ask first.

MAKE AND DO: SHAKE A RIVER IN A JAR

You will make sugar cubes tumble like stones in a rushing river. You will count their sharp corners before and after, and see the “sand” the river makes.

You will need

- A clean plastic jar with a tight lid (a peanut butter jar works well)
- 6 sugar cubes
- A sheet of dark paper
- A smooth pebble or river stone to compare
- Notebook and pencil
- A magnifying glass (if you have one)

Steps

1. Look at one sugar cube. Count its corners. Draw it in your notebook.
2. Put all 6 sugar cubes in the jar. Close the lid tightly.
3. Shake the jar hard while you count to 20.
4. Pour the cubes out onto the dark paper. What has changed? Look at the corners.
5. Put them back in the jar and shake for 20 more. Do this two more times.
6. Pour them out again. Pick one cube. Count how many sharp corners are left. Draw it next to your first drawing.
7. Look at the white powder on the paper. That is the “sand” your river wore off.
8. Hold your sugar cube next to a real river stone. How are they alike?

Tips

- Shaking harder is like a fast flood. Try one jar shaken gently and one shaken hard, the same number of times. Which wears off more corners?
- Keep the jar dry. Water would dissolve the sugar. River stones are much harder and stay whole as they tumble.

Check your work

- I can count the corners on a sugar cube before and after shaking.
- I can tell why the corners wore off.
- I can tell how a sharp rock becomes a round river stone.

FIELD NOTEBOOK

1. Draw a sharp, jagged rock and a smooth river stone side by side. Label them “jagged” and “rounded.”
2. Draw your sugar cube before shaking and after shaking.
3. Draw David’s five smooth stones. Count them as you draw.

From history. In many old towns in Europe and early America, people paved their streets with rounded stones gathered from riverbeds and beaches. These stones were about the size of a fist or a little bigger, and people called them cobblestones. You learned the word “cobble” in Unit 1. Some old cobblestone streets can still be seen today, and wagon wheels once rattled loudly over them.

WORKED EXAMPLES

Example 1. A sugar cube has 8 sharp corners. After shaking, Ben looked at one cube and found only 2 sharp corners left. How many corners wore off?

1. Start with 8 corners. Hold up 8 fingers.
2. 2 sharp corners are still left. Keep 2 fingers up.
3. Fold down the rest and count them: 1, 2, 3, 4, 5, 6.
4. So $8 - 2 = 6$.

Answer: 6 corners wore off.

PRACTICE

1. **EASY** Here are two rocks: one sharp and jagged, one smooth and round. Point to the one that most likely came from a river.
2. **EASY** What knocks the corners off river stones?
3. **MEDIUM** Mix a handful of stones together. Sort them into a “jagged” pile and a “rounded” pile. Count each pile. Which pile has more?
4. **MEDIUM** Look at the stones picture. Where do you find the smaller, rounder stones: near the mountains or far down the river?
(Use the map or drawing “From the mountains toward the sea.” shown earlier in this lesson.)
5. **HARD** What was the white powder at the bottom of your jar? In a real river, what does that powder become?

COMMON MISTAKES

- Thinking river stones were made round from the start. Most began as broken, sharp pieces of rock and were rounded as they tumbled.
- Thinking the water alone grinds the stones. The water rolls them, but it is mostly the stones and sand knocking and scraping each other that wear the corners away.
- Thinking every smooth stone came from a river. Waves on a beach roll and round stones too.

Make it a game • Rock Detective. A parent hides one rock at a time inside a sock. Reach in without looking and feel it. Say “jagged” or “rounded,” and then guess where it

came from: a broken cliff, a driveway, a river or a beach. Pull it out to check. Score one point for each right guess. Then trade places and let the parent be the detective.

Scripture. “And he took his staff in his hand, and chose him five smooth stones out of the brook, and put them in a shepherd’s bag which he had, even in a scrip; and his sling was in his hand: and he drew near to the Philistine.” (1 Samuel 17:40, KJV)

David knew where to find smooth stones: in the brook, where the water had rounded them. He used what God had made, and he trusted God to give him the victory.

Practice answers

1. The smooth, round one.
2. The rushing water rolls the stones, and they bump and rub against each other and the sand until the corners wear away.
3. Answers will vary. Check that the sharp, pointy stones are in the jagged pile, the smooth ones are in the rounded pile, and the counts are correct.
4. Far down the river, toward the sea.
5. It was the tiny bits of sugar that wore off the corners. In a real river, the tiny bits that wear off stones become sand and mud, and the water carries them downstream.

3.4 THE JORDAN RIVER (JOSHUA 3)

OBJECTIVES

- Retell how God stopped the flooding Jordan River so Israel crossed on dry ground (Joshua 3–4).
- Find the Jordan on a simple map and tell that it flows south, from the Sea of Galilee to the Dead Sea.
- Build a pile of twelve stones and tell why Joshua set up twelve stones to remember.

Warm-up. Lay a long blue towel or blanket on the floor for a river. Ask: “How could a whole family, with babies and pets and all their things, get across a deep, rushing river with no bridge and no boats?” Let the child share ideas. Then say, “Today we will hear how God brought a whole nation across a river.”

Video. Coming soon. The Jordan River and the crossing in Joshua 3–4 for young children: a Bible story retelling and real footage of the Jordan, the Sea of Galilee and the Dead Sea; search Bible lands nature footage, Holy Land travel films and children’s Bible story channels that read the text faithfully.

KEY TERMS

banks

The sides of a river, where the land meets the water.

ark of the covenant

The special chest covered with gold that held the tablets of God’s law. Priests carried it on poles.

memorial

Something set up to help people remember an important day.

CORE IDEAS

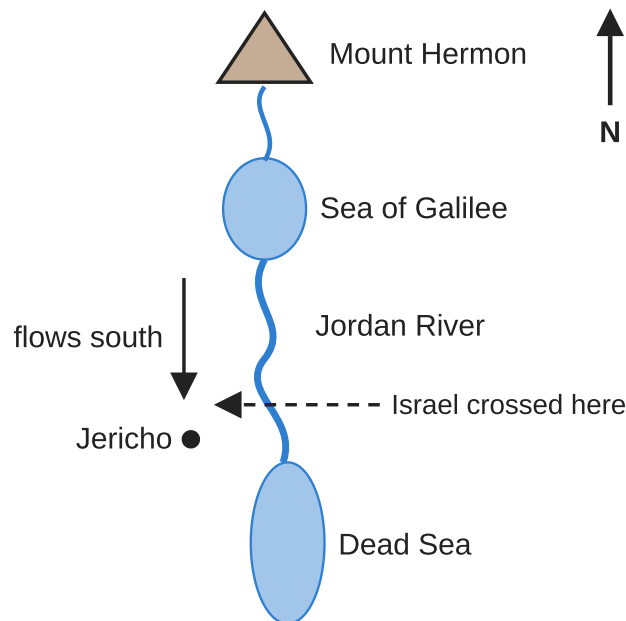
The story. The people of Israel camped beside the Jordan River. On the other side was the land God had promised them. But it was harvest time, and the Jordan was full and spilling over all its banks (Joshua 3:15). How could so many people, with children and animals, cross a flooding river? God told Joshua what to do. The priests carried the ark of the covenant into the river first. As soon as their feet dipped into the edge of the water, the river stopped! The water upstream stood up in a heap, far away near a town called Adam. The priests stood on dry ground in the middle of the riverbed, and all the people walked across on dry ground (Joshua 3:17).

How they remembered. God told Joshua to choose twelve men, one from each of the twelve tribes of Israel. Each man picked up a stone from the middle of the river, where the priests stood, and carried it on his shoulder. Joshua set up the twelve stones at their camp at Gilgal

as a **memorial**. One day children would ask, “What mean ye by these stones?” (Joshua 4:6). Then their parents would tell them how God stopped the Jordan.

The big idea. The Jordan is a real river you can visit today. Like the rivers in our first lesson, it starts high up. Springs and melting snow on Mount Hermon feed little streams in the north. The streams join and flow into the Sea of Galilee, which is a lake. Then the river runs out of the south end of the lake and winds downhill to the Dead Sea. The Dead Sea has no way out. Its water leaves only by drying up into the air, and the salt stays behind, so the Dead Sea is too salty for fish. In spring, when snow melts and rains fall, the Jordan rises over its **banks**, just as the Bible says.

God’s handiwork. God made the rivers, and they obey Him. Later, Jesus was baptized in this same river (Matthew 3:13). When you see a river, remember that the God who made it is strong enough to stop it, and kind enough to bring His people safely across.



The Jordan River flows south from the Sea of Galilee to the Dead Sea. Israel crossed near Jericho.

PICTURE STUDY



The Ark Passes Over the Jordan, James Tissot, about 1896-1902 · Gouache on board · The Jewish Museum, New York

James Tissot was a French painter who traveled to the Holy Land to see the real hills, rivers and towns of the Bible. Back home, he painted hundreds of pictures of Bible stories. Here he shows the priests carrying the ark of the covenant into the Jordan while the people of Israel follow.

Look closely

- Find the ark of the covenant. How are the priests carrying it?
- Look at the people. Are they near the ark or waiting behind it?
- Look at the ground near the priests' feet. What do you think it felt like to walk there?
- Find the land around the river. Is it flat, hilly or rocky?

Talk about it

1. How do you think the people felt as they walked into the riverbed?
2. Why did the priests carrying the ark go first?

Safety first. Lift stones with care and keep your fingers out from under them when you stack them. A grown-up should watch any water play. Do not take stones from parks or other people's land without asking.

MAKE AND DO: TWELVE STONES TO REMEMBER

You will act out the crossing of the Jordan with a little model river, and then build your own memorial of twelve stones, just as Joshua did.

You will need

- A long baking pan or shallow box
- Sand, dirt or play dough for the riverbanks
- A strip of blue paper or cloth for the river
- A small box with two pencils taped to its sides for the ark
- Clothespins or small toys for the people
- 12 stones, about the size of your fist or smaller (rounded river stones are best)
- A bucket of water and an old toothbrush
- Chalk, a paint pen or a washable marker

Steps

1. Make your model Jordan. Lay the blue strip down the middle of the pan. Build sandy banks on both sides.
2. Put the people on one bank. Read Joshua 3:14-17 aloud, or have a parent tell it.
3. Move the ark to the edge of the river. When the priests' feet touch the water, take away the blue strip to show the dry riverbed.
4. March the people across on dry ground. Then put the blue strip back after the priests come out (Joshua 4:18).
5. Now go outside and collect 12 stones, counting out loud as you find each one.
6. Wash your stones in the bucket with the toothbrush.
7. Mark each stone with a number from 1 to 12, or draw a small picture of something good God has done for your family.
8. Stack your stones in a pile by the door or in the garden. When someone asks, "What do these stones mean?", tell them the story.

Tips

- Look back at Lesson 3.3. Are your stones jagged or rounded? Where do you think they came from?
- If you cannot find twelve stones outside, use twelve small blocks or boxes for the model.

Check your work

- I can retell how Israel crossed the Jordan.
- I counted and built a pile of 12 stones.
- I can tell why Joshua set up the stones.

FIELD NOTEBOOK

1. Draw the priests carrying the ark into the Jordan, with the people waiting on the bank.
2. Draw your pile of twelve stones. Count the stones in your drawing to make sure there are 12.

3. Trace the map of the Jordan. Color the water blue and draw an arrow showing which way the river flows.

From history. In 1848 an American navy officer named William Lynch carried metal boats over land to the Sea of Galilee. Then he and his sailors rowed down the Jordan all the way to the Dead Sea. The river twisted and turned so much that their trip was much longer than a straight line on the map, and they had to drag their boats over rough, rocky rapids. Lynch wrote a book about what he saw so people at home could learn about the real river of the Bible.

WORKED EXAMPLES

Example 1. You are building a memorial of 12 stones. You have found 8 stones so far. How many more stones do you need?

1. Start at 8.
2. Count up to 12, holding up one finger for each number: 9, 10, 11, 12.
3. Count your fingers: 1, 2, 3, 4.

Answer: You need 4 more stones ($8 + 4 = 12$).

PRACTICE

1. **EASY** What did the priests carry into the river first?
2. **EASY** How many stones did Joshua set up? Why that number?
3. **MEDIUM** On the map, point to the Sea of Galilee and the Dead Sea. Which way does the Jordan flow?
(Use the map or drawing "Follow the river with your finger." shown earlier in this lesson.)
4. **MEDIUM** Why was the Jordan so full and over its banks at harvest time?
5. **HARD** Tell in your own words why God wanted the twelve stones set up.

COMMON MISTAKES

- Mixing up the Jordan with the Red Sea. Moses led Israel through the Red Sea when they left Egypt (Exodus 14). Joshua led them across the Jordan River into the promised land.
- Thinking the Jordan flows north. It flows south, downhill, from the Sea of Galilee to the Dead Sea.
- Thinking every sea is full of fish. The Dead Sea is so salty that fish cannot live in it.

Make it a game • Cross the Jordan. Lay a blue towel on the floor for the river. One player is the priest and carries a shoebox ark. The others wait on the bank. When the priest steps to the edge and says, "Feet in the water!", the parent pulls the towel away

and everyone crosses on “dry ground.” Each person carries one sock-ball stone across and adds it to a pile. Count the stones together. Keep crossing until the pile has 12.

Scripture. “And the priests that bare the ark of the covenant of the LORD stood firm on dry ground in the midst of Jordan, and all the Israelites passed over on dry ground, until all the people were passed clean over Jordan.” (Joshua 3:17, KJV)

The priests stood still in the middle of the riverbed until every single person had crossed. God did not leave anyone behind.

Practice answers

1. The ark of the covenant.
2. 12 stones, one for each of the twelve tribes of Israel.
3. It flows south (down on the map), from the Sea of Galilee to the Dead Sea.
4. In spring, snow melts on the mountains and rain falls, and all that water runs downhill into the river, so it rises over its banks.
5. So that when children asked what the stones meant, their parents would tell them how God stopped the Jordan and brought Israel across on dry ground. The stones helped people remember what God had done.

UNIT 3 REVIEW

This is an oral review. Ask each question aloud and let your child answer in their own words, point, or show you. Accept any answer that shows the main idea. The review is worth 20 points.

1. (3 pts) Tell me two places where a river can start.
2. (3 pts) Which way does water always flow? What happens when little streams join together?
3. (3 pts) After a rain, where does the water in the street run, and what can it carry?
4. (3 pts) Where does the gutter water go after it falls into the storm drain?
5. (3 pts) Show me a smooth river stone (or point to one in a picture). Why is it round and not sharp?
6. (3 pts) Tell me the story of how Israel crossed the Jordan River.
7. (2 pts) How many stones did Joshua set up, and why?

UNIT PROJECT: MY RIVER FROM SOURCE TO SEA

On a long strip of paper (or several sheets taped end to end), draw one river from its source to its mouth. At the top, draw a mountain with snow, rain and a spring. Draw little streams joining into the river as it runs downhill, a town with a gutter river and a storm drain, and the sea at the end. Glue on a few small rounded pebbles or sand near the mouth, and draw jagged rocks near the mountain.

Beside your river, add a drawing or photo of your pile of twelve stones. Then tell the whole story of your river aloud to your family, from the first drop of snowmelt to the sea, while a parent writes down a few of your words.

- **Source to sea:** The river has a clear source (snow, rain, spring or lake) and a clear mouth at the sea or a big lake.
- **Downhill and joining:** The river runs downhill, and at least two little streams are shown joining it.
- **Stones:** Jagged rocks are shown near the mountains and rounded pebbles or sand near the mouth, and the child can tell why.
- **Telling:** The child narrates the river's journey and the story of the twelve stones in their own words, clearly and in order.

Answer key

1. Any two: melting snow, rain running off the hills, a spring where water bubbles out of the ground, or a lake (like Lake Itasca).
2. Water flows downhill. When little streams join, they make a bigger stream, and streams join to make a river.
3. It runs downhill in the gutter, beside the curb. It can carry leaves, twigs, sand and small stones.

4. In many towns it goes through a pipe under the ground to a creek or river, and the river runs to the sea.
5. The rushing water rolled it, and it bumped and rubbed against other stones and sand until its sharp corners wore away.
6. The river was flooding at harvest time. The priests carried the ark of the covenant into the water. When their feet touched it, God stopped the river and the water stood up in a heap. The priests stood on dry ground in the middle, and all the people walked across on dry ground.
7. Twelve stones, one for each tribe, so that when children asked what they meant, parents would tell how God stopped the Jordan.

CLOUDS AND RAIN

Look up! Every day the sky above your house is painted with clouds, and no two days are ever quite the same. In this unit you will learn to see clouds the way a scientist does. You will meet Luke Howard, the man in London who sorted the clouds and gave them names in 1802, and you will learn his three main clouds: puffy **cumulus**, flat gray **stratus** and wispy **cirrus**.

Then you will make a real cloud in a jar and discover how clouds form: warm water **evaporates**, rises as invisible water vapor, cools and **condenses** into tiny drops. You will build your own **rain gauge** and measure the rain that falls in your yard. Last of all, you will stand with Elijah's servant on Mount Carmel and watch a little cloud, like a man's hand, rise out of the sea and grow into a great rain. All through the unit you will keep a cloud journal, and you will learn to thank God, who "covereth the heaven with clouds" and "prepareth rain for the earth" (Psalm 147:8).

BEFORE YOU BEGIN

- Can count objects to 20
- Can use a ruler to find a number with a parent's help
- Knows that water can be a liquid (water) or a solid (ice)
- Has heard that rivers and puddles fill up after rain (Unit 3)

MASTERY CHECKLIST

- I can tell who Luke Howard was and what he did.
- I can point to cumulus, stratus and cirrus clouds in the sky or in a picture.
- I can tell how a cloud forms: water evaporates, rises, cools and condenses into tiny drops.
- I can make and read a rain gauge and say which day had more rain.
- I can retell the story of Elijah's little cloud and tell how a little cloud can grow into a rain cloud.

OPTIONAL BOOKS AND RESOURCES

- **NOAA SciJinks** (<https://scijinks.gov/>): Free. Weather pages, pictures and games from NOAA and NASA, written for students. Parents can find simple explanations of clouds, rain and the water cycle to read aloud.
- **CoCoRaHS (Community Collaborative Rain, Hail and Snow Network)** (<https://www.cocorahs.org/>): Free. A network of volunteers, including many families, who measure rain in their own yards each day and share it with weather scientists. A parent can browse the maps of rain reports near your home and compare them with your own rain gauge.

4.1 LUKE HOWARD NAMES THE CLOUDS (1802) ★

OBJECTIVES

- Tell the story of Luke Howard, the man who gave the clouds their names.
- Name and point to three kinds of clouds: cumulus (puffy heaps), stratus (flat gray sheets) and cirrus (thin wisps).
- Explain that a cloud is made of tiny drops of water or tiny bits of ice.

Warm-up. Look out a window together (never look at the sun). Is the sky clear, or are there clouds? Use your hands to show the shape of the clouds you see: round and puffy, flat like a table, or thin like a feather. Then breathe on a cold window or mirror. Do you see the little foggy spot? That foggy spot is made of tiny drops of water, just like a cloud.

Video. Coming soon. Cloud types for young children (cumulus, stratus, cirrus): search NOAA SciJinks, NASA GLOBE Observer clouds, SciShow Kids, Homeschool Pop (Alternate) and calm sky time-lapse footage; for Luke Howard, search the UK Met Office and the Science Museum (London).

KEY TERMS

cloud

Many, many tiny drops of water (or tiny bits of ice) floating together high in the air.

cumulus

A puffy cloud that looks like a heap of cotton. The name means “heap.”

stratus

A flat, gray cloud that spreads across the sky like a blanket. The name means “spread out.”

cirrus

A thin, wispy cloud high in the sky, like a feather or a curl of hair. The name means “curl of hair.”

CORE IDEAS

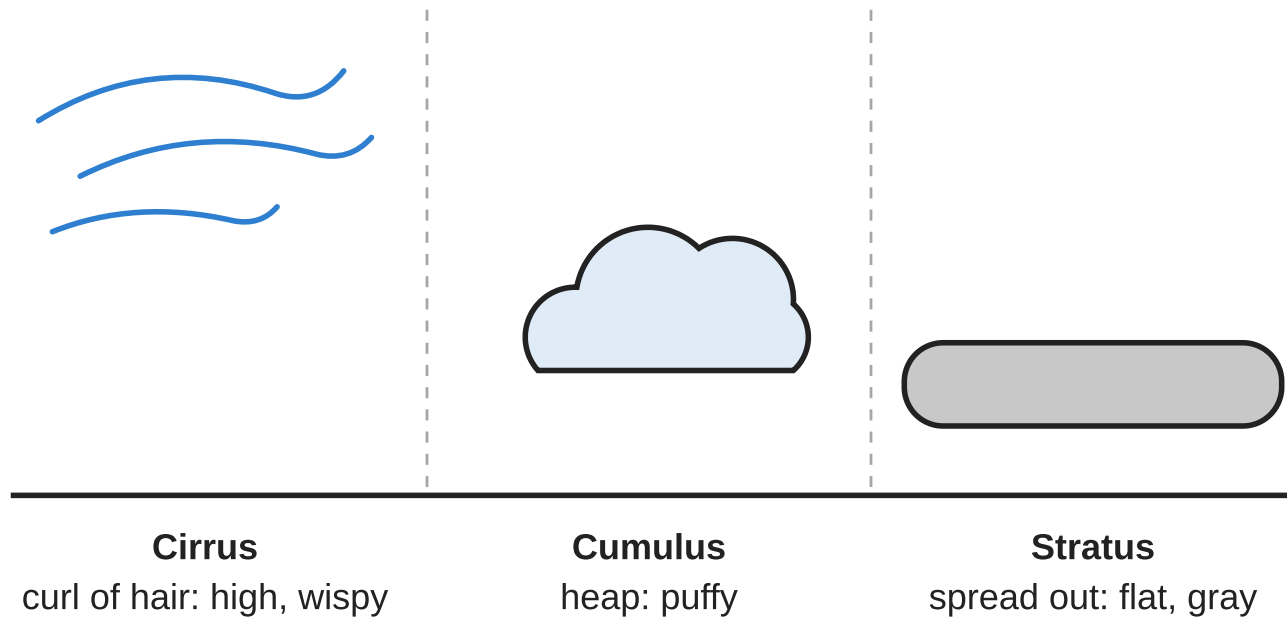
The story. Long ago in London, England, there lived a man named Luke Howard. His work was making medicines. But in his free time, he loved to look up. He watched the clouds again and again. He saw them puff up, spread out and drift away. Other people said clouds changed too fast to study. Luke Howard did not agree. In December of 1802, he gave a talk to a small club of science friends in London. He showed them his drawings of the sky, and he gave the clouds names.

How he figured it out. Luke Howard noticed that clouds keep changing, but they come back in a few main shapes, over and over. So he sorted them, the way you might sort rocks or leaves. He used Latin words, because scientists in many countries could read Latin.

Cumulus means “heap.” These are puffy clouds, like piles of cotton or popcorn. **Stratus** means “spread out.” These are flat, gray sheets, like a blanket over the sky. **Cirrus** means “curl of hair.” These are thin, wispy clouds, very high up, like feathers. He also named the rain cloud **nimbus**.

The big idea. A cloud is not cotton, and it is not smoke. A cloud is made of many, many tiny drops of water floating in the air. The drops are so small and light that they float. High cirrus clouds are up where it is very cold, so they are made of tiny bits of ice. Luke Howard’s names are still used today by weather watchers all over the world. The names can even be put together. A big, tall thundercloud is called a *cumulonimbus*: a heap rain cloud!

God’s handiwork. Luke Howard was a Christian who believed God made the world in good order. Even something as soft and changing as a cloud has an order we can learn. Long before Luke Howard, God asked Job, “Dost thou know the balancings of the clouds?” When you look up and say, “That is a cumulus,” you are doing what Luke Howard did. You are noticing the wondrous works of God.



Luke Howard’s three main clouds: cirrus (curl of hair), cumulus (heap) and stratus (spread out).

PICTURE STUDY



Cloud Study, John Constable, 1821 · Oil on paper laid on board · Yale Center for British Art, New Haven, Connecticut

John Constable was an English painter who loved the sky. In the summers of 1821 and 1822, he went up onto Hampstead Heath, a high, grassy hill near London, and painted the clouds again and again. He called this “skying.” He painted fast, because clouds do not hold still. On the back of many of his little paintings, he wrote the day, the time and which way the wind was blowing, just like a weather scientist. Some people think he may have read about Luke Howard’s cloud names, but no one knows for sure.

Look closely

- Is there any ground in this painting, or only sky? Why do you think the painter left the ground out?
- Find the puffiest cloud. Is it a cumulus, a stratus or a cirrus?
- Find the brightest white part and the darkest gray part of the clouds. Where is the sunlight hitting them?
- Look at the edges of the clouds. Are they sharp, or soft and fuzzy?

Talk about it

1. Why did Constable have to paint very quickly?
2. What did Constable write on the back of his cloud paintings? Why would that help him later?
3. If you painted the sky today, what colors would you need?

Safety first. When you look at clouds outdoors, never look straight at the sun, even on a cloudy day. Turn your back to the sun or look at the part of the sky away from it.

MAKE AND DO: COTTON-BALL CLOUD CHART

You will make your own cloud chart, just like a little Luke Howard. Then you will take it outside and match the real sky to your chart.

You will need

- A sheet of blue paper (or white paper colored blue with crayon)
- Cotton balls (about 8)
- Glue stick or white glue
- A gray crayon or pencil
- A marker for labels

Steps

1. Fold the blue paper into three parts, top to bottom. Open it up again.
2. In the top part, pull two cotton balls apart until they are thin and stringy. Glue them high up. Your parent writes **cirrus** (curl of hair) next to them.
3. In the middle part, fluff up three cotton balls into round, puffy heaps. Glue them down. Your parent writes **cumulus** (heap).
4. In the bottom part, stretch two or three cotton balls flat and side by side, so they make one long sheet. Rub them gently with a gray crayon. Glue them down. Your parent writes **stratus** (spread out).
5. Take your chart outside or to a window. Hold it up next to the sky. Which part of your chart matches the clouds you see today?
6. Put a sticker or a check mark by the cloud you saw. Do it again on a different day.

Tips

- If the sky is clear, that is a real observation too. Write “no clouds” and try again another day.
- Real skies often have two kinds of clouds at once. You may check more than one.

Check your work

- I can point to cirrus, cumulus and stratus on my chart.
- I can match my chart to the real sky.
- I can tell who gave the clouds their names.

FIELD NOTEBOOK

1. Draw the sky out your window today. Write the date at the top, the way John Constable did.
2. Draw Luke Howard’s three clouds in three boxes. Say each name out loud as you draw it.
3. Draw a puffy cumulus cloud and tell what animal or thing its shape reminds you of.

From history. Luke Howard's cloud names spread far beyond England. The great German poet Johann Wolfgang von Goethe read about them and liked them so much that he wrote a poem in Howard's honor. Today the official cloud book used by weather scientists around the world, the *International Cloud Atlas*, still uses Howard's Latin names.

WORKED EXAMPLES

Example 1. A girl watched the sky for one week and drew a cloud picture each day. Her chart shows: puffy cumulus on 4 days, flat stratus on 2 days and wispy cirrus on 1 day. Which cloud did she see the most? How many days did she watch?

1. Count the cumulus pictures: 1, 2, 3, 4. That is 4 days.
2. Count the stratus pictures: 1, 2. That is 2 days.
3. Count the cirrus pictures: 1. That is 1 day.
4. Compare: 4 is bigger than 2, and 2 is bigger than 1. So cumulus has the most.
5. Count all the pictures together: 4 and 2 make 6, and 1 more makes 7.

Answer: She saw cumulus clouds the most (4 days). She watched for 7 days, one whole week.

PRACTICE

1. **EASY** Which cloud name means "heap"? Show me a heap with your hands.
2. **EASY** Look at the cloud picture in this lesson. Point to the cloud that looks like a flat gray blanket. What is its name?
3. **MEDIUM** Match each cloud to its name: (a) puffy like popcorn, (b) thin and wispy like a feather, (c) a gray sheet over the whole sky.
4. **MEDIUM** On Monday you counted 3 puffy clouds. On Tuesday you counted 5. On which day did you see more? How many did you count in all?
5. **HARD** Tell back: Who was Luke Howard, and why was it helpful for him to give the clouds names?

COMMON MISTAKES

- Thinking clouds are made of cotton, smoke or steam from chimneys. Clouds are made of tiny drops of water or tiny bits of ice.
- Thinking every cloud brings rain. Many puffy cumulus clouds and wispy cirrus clouds never rain at all.
- Thinking clouds hold still. Clouds are always moving and changing, which is why Constable had to paint so fast.

Make it a game • Cloud Charades. One person acts out a cloud without words: stand tall and puff out your arms for cumulus, lie flat on the floor for stratus, or wiggle your

fingers high above your head for cirrus. Everyone else shouts the cloud name. Take turns. For a bonus, act out a cumulonimbus by puffing up big and then making a rain sound with your fingers.

Scripture. “Dost thou know the balancings of the clouds, the wondrous works of him which is perfect in knowledge?” (Job 37:16, KJV)

God made clouds that float and drift and change. Luke Howard learned to sort and name them, but only God fully knows how they work. Watching clouds is a way to wonder at His works.

Practice answers

1. Cumulus. (The child shows a round, piled-up shape.)
2. The flat gray sheet at the right is stratus.
3. (a) cumulus, (b) cirrus, (c) stratus.
4. Tuesday had more (5 is more than 3). In all: $3 + 5 = 8$ clouds.
5. Luke Howard was a man in London who loved to watch the sky. In 1802 he sorted clouds into kinds and gave them names like cumulus, stratus and cirrus. Names help people everywhere talk about the same clouds and learn about the weather.

4.2 CLOUD IN A JAR

OBJECTIVES

- Make a small cloud in a jar using warm water and ice.
- Explain in simple words how a cloud forms: warm water vapor rises, cools and turns into tiny drops.
- Use the words evaporate, water vapor and condense.

Warm-up. Hold a cold glass of ice water for a minute and set it on a towel. Watch the outside of the glass. Little drops of water appear! Where did they come from? (They came out of the air. There is invisible water in the air all around us, and the cold glass turned it back into drops.)

Video. Coming soon. Make a cloud in a jar with hot water, ice and hairspray: search NOAA SciJinks, NASA Climate Kids how clouds form, SciShow Kids, Science Max, Homeschool Pop (Alternate) and Moody Science classics on the water cycle.

KEY TERMS

evaporate

When liquid water slowly turns into water vapor and goes into the air, like a puddle drying up.

water vapor

Water that has turned into a gas. It is in the air all around us, but we cannot see it.

condense

When water vapor cools and turns back into tiny drops of liquid water. That is how clouds are made.

CORE IDEAS

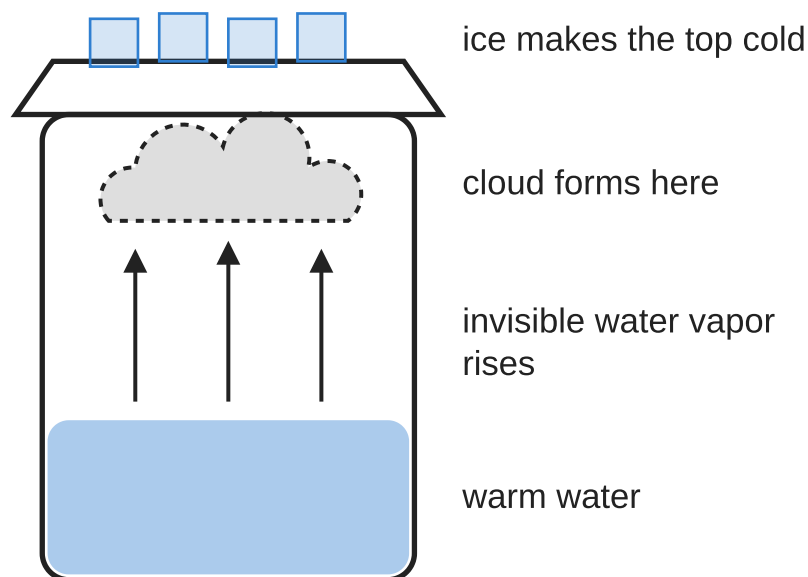
Try it and see. Today you will hold a real cloud in a jar! A parent pours some hot water into a big glass jar. A lid or small plate full of ice goes on top. Then a parent gives one tiny spray of hairspray into the jar and closes it quickly. Watch near the top. A soft, white, swirling mist appears. It is a little cloud! When you lift off the lid, the cloud floats out into the room.

How it works. The warm water in the jar **evaporates**. Some of it turns into **water vapor**, which is water as a gas. Water vapor is invisible, and warm water vapor rises. Up at the top of the jar, the ice makes the air cold. When water vapor gets cold, it **condenses**. It turns back into tiny drops of liquid water. Each tiny drop forms around a speck too small to see, like a bit of the hairspray. Millions of these tiny drops together make a cloud you can see.

The big idea. Real clouds in the sky are made the very same way. The sun warms the oceans, lakes and puddles, and water evaporates into the air. Warm air carries the water

vapor up, up, up. High in the sky, the air is cold. The water vapor cools and condenses on tiny specks of dust, sea salt or smoke. A cloud is born! When the tiny drops bump together and grow big and heavy, they fall as rain. Then the water runs back to the rivers and the sea, and it all starts again. This big circle is called the water cycle.

God's handiwork. The Bible says God "maketh small the drops of water." Long before anyone made a cloud in a jar, God was lifting water from the sea and sending it back as rain. He made the warm and the cold, the sea and the sky, to work together to water the whole earth.



Warm water vapor rises, the ice cools it at the top, and it condenses into a little cloud.

PICTURE STUDY



View of Haarlem with Bleaching Fields, Jacob van Ruisdael, about 1665 · Oil on canvas · Kunsthaus Zürich, Switzerland

Jacob van Ruisdael was a Dutch painter who loved big skies. The Netherlands is a very flat country, so when you look out, you see a lot of sky. In this painting, the sky takes up most of the picture. Below the clouds are the fields outside the city of Haarlem, where people spread long strips of linen cloth on the grass so the sun would bleach them white. On the far edge stands the city's great church.

Look closely

- Use your finger to show where the land stops and the sky starts. Which part is bigger, the land or the sky?
- Find the big puffy clouds. Are they cumulus, stratus or cirrus?
- Look at the fields. Some parts are bright and some are dark. What do you think is making the dark patches? (The shadows of clouds!)
- Find the long white strips of cloth in the fields and the tall church on the horizon.

Talk about it

1. Why do you think the painter made the sky so big?
2. The people needed sunshine to bleach their cloth. Would a sky full of gray stratus clouds help them or not?
3. Have you ever seen a cloud's shadow move across the ground?

Safety first. A parent handles the hot water. Use hot tap water or water that is warm, not boiling, and keep the jar on a towel on the table. A parent does the hairspray, sprays only

once, away from faces, and keeps it away from any flame. Wipe up spills right away so no one slips.

MAKE AND DO: A CLOUD IN A JAR

You will make a real cloud in a jar and then let it go free. Then you will try it again without the warm water, to see what changes.

You will need

- A large clear glass jar (a quart canning jar works well)
- A metal jar lid or small plate that fits on top, turned upside down
- Hot tap water (a parent pours)
- A handful of ice cubes
- Hairspray in a spray can (a parent uses it)
- A piece of black or dark paper to hold behind the jar
- A second jar and cold tap water, for the test

Steps

1. A parent pours hot tap water into the jar until it is about as deep as your hand is wide.
2. A parent swirls the jar gently to warm the sides.
3. Turn the lid upside down and put it on top of the jar like a little dish. Fill it with ice cubes.
4. A parent lifts one edge of the lid, gives one quick spray of hairspray into the jar, and puts the lid back.
5. Hold the dark paper behind the jar. Watch the top of the jar for about a minute. What do you see?
6. Lift the lid off. Watch your cloud float out and fade away into the room.
7. Now try the test: do the same thing with cold tap water in the second jar. Does a cloud form? Which jar made the better cloud?

Tips

- The dark paper behind the jar makes the white cloud much easier to see.
- If you have no hairspray, try it anyway. You may get a thinner cloud, because there are fewer specks for the drops to form on.

Check your work

- I made a cloud in a jar.
- I can tell what the warm water and the ice each did.
- I can say the three words: evaporate, water vapor, condense.

FIELD NOTEBOOK

1. Draw your cloud jar. Label the warm water, the ice and the cloud.
2. Draw two jars side by side: warm water and cold water. Draw what happened in each.
3. Draw a picture of the water cycle: the sea, an arrow going up, a cloud, and rain falling down.

From history. A Scottish scientist named Charles Thomson Rees Wilson once spent time at the top of Ben Nevis, the highest mountain in Britain, where he watched clouds and colored rings of light form around the mountaintop. He went back to his laboratory and tried to make clouds inside a glass box. His cloud box, called a *cloud chamber*, became so useful to scientists that he won a Nobel Prize for it in 1927.

WORKED EXAMPLES

Example 1. Two jars are set up the same way, with ice on top and one spray of hairspray. Jar A has warm water. Jar B has cold water. In Jar A, a thick white cloud forms. In Jar B, almost nothing forms. Which jar made the better cloud, and why?

1. Look at what was the same: both jars had ice on top and one spray of hairspray.
2. Look at what was different: Jar A had warm water, and Jar B had cold water.
3. Compare the clouds: Jar A made a thick cloud. Jar B made almost none.
4. Think: warm water makes much more water vapor than cold water. More water vapor rising to the cold top means more tiny drops.

Answer: Jar A, with warm water, made the better cloud, because warm water sends up much more water vapor for the ice to cool into tiny drops.

PRACTICE

1. **EASY** What did we put on top of the jar? What did it do to the air at the top?
2. **EASY** Look at the jar picture in this lesson. Point to where the cloud formed: near the warm water or near the ice?
3. **MEDIUM** Can you see water vapor? What happens when it gets cold?
4. **MEDIUM** You made a cloud in a jar 3 times. Your brother made one 2 times. How many clouds did you make together?
5. **HARD** On a cold winter day, your breath makes a little white cloud. Use today's words to tell why.

COMMON MISTAKES

- Thinking we can see water vapor. Water vapor is an invisible gas. The white mist we see is made of tiny drops of liquid water that have already condensed.

- Thinking water is gone forever when a puddle dries up. It evaporated into the air and will come back down someday as rain or snow.
- Thinking clouds are made of a gas. A cloud is made of tiny drops of liquid water (or tiny bits of ice) floating in the air.

Make it a game · Water Cycle Freeze. Everyone is a drop of water. When the parent says “Sun!”, wiggle and float up onto your tiptoes: you are evaporating. When the parent says “Cold!”, huddle close together in a bunch: you have condensed into a cloud. When the parent says “Rain!”, crouch down low and patter your fingers on the floor. When the parent says “River!”, walk slowly back to the starting spot, the sea. Anyone who does the wrong move sits out one turn.

Scripture. “For he maketh small the drops of water: they pour down rain according to the vapour thereof: Which the clouds do drop and distil upon man abundantly.” (Job 36:27-28, KJV)

This verse talks about small drops, vapor and rain, the very things we saw in our jar. God made the water cycle that carries water up into the clouds and pours it down again.

Practice answers

1. Ice. It made the air at the top cold.
2. Near the top, by the ice, where the air is cold.
3. No, water vapor is invisible. When it gets cold, it condenses into tiny drops of water, which we can see as a cloud or mist.
4. $3 + 2 = 5$ clouds.
5. Your breath is warm and has water vapor in it. When it goes out into the cold air, the water vapor cools and condenses into tiny drops, which make a little cloud.

4.3 A RAIN GAUGE

OBJECTIVES

- Make a simple rain gauge from a straight-sided jar and a ruler.
- Read a rain gauge by looking at the water line at eye level and saying the number.
- Compare rain on two days and tell which day had more.

Warm-up. Fill a clear cup partway with water. Stand a ruler up beside it. Bend down so your eyes are level with the top of the water. Which number on the ruler does the water reach? Now look at the cup from high above. Is it harder to tell? This is the secret of reading a rain gauge: get your eyes down level with the water.

Video. Coming soon. How to make and read a homemade rain gauge for kids: search NOAA SciJinks, National Weather Service, CoCoRaHS (volunteer rain watchers), SciShow Kids, Homeschool Pop (Alternate) and Science Max; for history, search King Sejong’s rain gauge (cheugugi) from Korean museums.

KEY TERMS

rain gauge

A cup or tube with a ruler on it that catches rain and shows how much fell.

measure

To find out how big, how long or how much something is, using a tool like a ruler.

centimeter

A small step on a ruler, about as wide as your little finger. We can measure rain in centimeters.

CORE IDEAS

The story. Long ago in Korea, a wise king named Sejong cared about his farmers. Farmers need to know how much rain has fallen. Too little, and the rice dries up. Too much, and the fields flood. In 1441, the king’s son and his helpers made a **rain gauge**: a straight metal cup set on a stone stand. Soon rain gauges were sent to towns all across the land. After every rain, workers put a measuring stick into the cup and wrote down how deep the water was. Now the king could know how much rain fell everywhere.

How it works. A rain gauge is simple. It is a cup with straight sides, set out in the open. Rain falls into it. Then you **measure** how deep the water is with a ruler. If the water reaches the 2 on the ruler, then 2 centimeters of rain fell. That is how deep the rain would be if it stayed on flat ground and did not soak in or run away. The sides must be straight up and down, so every part of the cup fills the same.

Try it and see. To read your gauge, bend down so your eyes are level with the top of the water. Read the number. Write it down. Then empty the gauge so it is ready for the next rain. Check it at the same time every day. Put your gauge in an open place, away from roofs and trees, so they do not drip extra water in or block the rain.

God's handiwork. Today, many families, even children, measure rain in their backyards and send their numbers to weather scientists. Their careful records help farmers, towns and forecasters. When you read your rain gauge, you are counting a gift. The Bible says God "prepareth rain for the earth" and "maketh grass to grow upon the mountains." Every centimeter in your jar is water God sent to make things grow.

PICTURE STUDY



Driving Rain at Shōno, Utagawa Hiroshige, about 1833–1834 · Woodblock print, ink and color on paper, from the series *The Fifty-three Stations of the Tōkaidō* · Metropolitan Museum of Art, New York (this print; other copies are in many museums)

Utagawa Hiroshige was a Japanese artist. He drew pictures that were carved into wooden blocks and printed with ink and color, so many copies could be made. He made a famous set of prints of the towns along the Tōkaidō, a great road in Japan. In this one, a sudden hard rain has caught travelers on a hill near the town of Shōno. Hiroshige drew the rain as many thin, straight, slanting lines, and everyone is hurrying to get out of it.

Look closely

- Find the lines of rain. Which way do they slant? What does that tell you about the wind?
- Count the people you can find. What is each one doing?
- Find the bamboo trees behind the people. Are they standing straight or bending?
- Find the two men carrying a covered chair on a pole. Is someone riding inside?

Talk about it

1. Where do you think all this rain will go after it lands on the road?
2. If a traveler had set out a rain gauge here, would it fill up fast or slowly? Why?
3. What do you do when a sudden rain catches you outside?

Safety first. A parent does any cutting. Choose a jar that will not break easily, or set a glass jar inside a box or ring of rocks so it does not tip over. Never go outside to check the gauge during thunder or lightning; wait until the storm has passed. Do not drink the rainwater.

MAKE AND DO: MAKE YOUR OWN RAIN GAUGE

You will make a real rain gauge, set it outside and read it after the next rain. This is the gauge you will use again in the Field Lab's Rain Gauge Week.

You will need

- A clear jar or plastic container with straight sides and a flat bottom (an olive jar or tall plastic food container works well)
- A ruler with centimeters
- A strip of masking tape or clear packing tape
- A marker
- A few rocks or a small box, to keep the gauge from tipping
- Your nature notebook

Steps

1. Check the jar. Are the sides straight up and down? Is the bottom flat inside? If so, it will make a good gauge.
2. Stick a strip of masking tape up the side of the jar, from the bottom to the top.
3. Hold the ruler against the tape with the 0 at the bottom of the inside of the jar. A parent helps you mark lines at 1, 2, 3, 4 and 5 centimeters and write the numbers. (Or tape a short plastic ruler right onto the jar.)
4. Cover the tape with clear tape so the rain will not smear the numbers.
5. Pick a spot in the open, away from roofs, trees and fences. Set the jar there and put rocks around it so it will not blow over.
6. After it rains, go out (when it is safe). Bend down so your eyes are level with the water. Read the number and write it in your notebook with the date.
7. Empty the gauge and set it back in its place, ready for the next rain.

Tips

- If the water is between two lines, say "a little more than 1" or "almost 2." That is a good scientist's answer.
- Try to check your gauge at the same time each day, like right after breakfast.

Check your work

- My gauge has straight sides and numbers that start at 0 at the bottom.
- I put it in an open place.
- I can read the water line with my eyes level, write the number down, and empty the gauge.

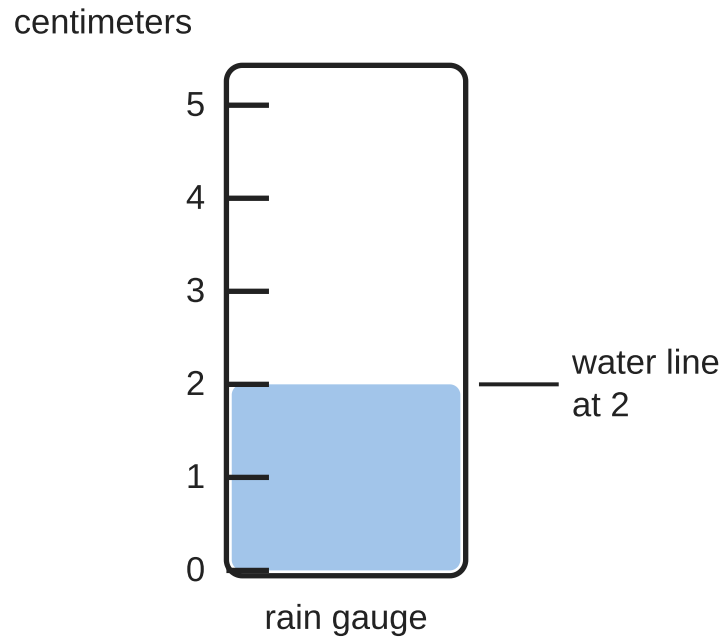
FIELD NOTEBOOK

1. Draw your rain gauge in its spot outside. Draw the things around it.
2. After a rain, draw your gauge with the water in it. Color the water blue and write the number it reached.
3. Make a rain page: write the days of the week down the side and leave space to write how much rain fell each day.

From history. In the United States, ordinary people have helped the weather service measure rain since 1890. They are called cooperative observers. Many of them use a standard metal rain gauge with an opening 8 inches across, and some families have kept their weather records on the same farm for many years, passing the job from parents to children.

WORKED EXAMPLES

Example 1. Look at the rain gauge picture. How much rain fell?



The water reaches the 2 line: 2 centimeters of rain.

1. Find the 0 at the bottom of the ruler. That is where we start counting.
2. Bend down so your eyes are level with the top of the blue water.
3. Follow the top of the water across to the ruler. It lines up with the mark labeled 2.
4. Say the number and the unit: 2 centimeters.

Answer: 2 centimeters of rain fell.

PRACTICE

1. **EASY** Where is a good place to put a rain gauge: under a tree, next to the house under the roof, or out in the open yard?
2. **EASY** Why do we empty the rain gauge after we read it?
3. **MEDIUM** On Monday the gauge showed 1 centimeter. On Tuesday it showed 3 centimeters. Which day had more rain? How much more?
4. **MEDIUM** This week it rained 2 centimeters on Sunday, 0 on Monday and 4 on Tuesday. Count up all the rain. How much fell in all?
5. **CHALLENGE** Your parent says to read the gauge with your eyes level with the water, not from up high. Show how you would do it, and tell why.

COMMON MISTAKES

- Putting the gauge under a tree or near a roof. Drips from leaves or a roof add extra water, and branches can block rain from falling in.
- Forgetting to empty the gauge. Then today's rain gets added to yesterday's, and the number is too big.
- Thinking a wide bowl will show more rain than a narrow jar. If both have straight sides, the water in each will be the same depth, because the same rain falls on every spot.

Make it a game · Guess the Rain. A parent secretly pours some water into the rain gauge while you hide your eyes. Then you guess how much “rain” fell before you look closely. Now crouch down, read the gauge at eye level and say the real number. If your guess was within 1 of the real number, you score a point. Take turns being the rain maker. Play until someone has 5 points.

Scripture. “Who covereth the heaven with clouds, who prepareth rain for the earth, who maketh grass to grow upon the mountains.” (Psalm 147:8, KJV)

God covers the sky with clouds and prepares the rain. When we measure rain, we see how God waters the earth so grass and gardens can grow.

Practice answers

1. Out in the open yard, away from trees and roofs, so only rain from the sky falls in.
2. So it starts at 0 again and the next reading shows only the new rain.
3. Tuesday had more rain. 3 is 2 more than 1, so Tuesday had 2 centimeters more.
4. $2 + 0 + 4 = 6$ centimeters in all.
5. The child crouches down so their eyes are even with the top of the water. Looking from up high makes it hard to see which line the water really reaches, so you might read the wrong number.

4.4 ELIJAH’S LITTLE CLOUD (1 KINGS 18:44)

OBJECTIVES

- Retell the story of Elijah praying for rain and his servant seeing a little cloud rise out of the sea.
- Explain that clouds often come from water evaporating from the sea, and that a small cloud can grow into a big rain cloud.
- Say that God sends the rain and uses the water cycle He made.

Warm-up. Hold up your hand and look at it. Imagine a cloud far away over the sea that looks only as big as your hand. Could a cloud that small make it rain on a whole country? Today we will hear about a cloud just like that.

Video. Coming soon. Elijah prays for rain on Mount Carmel (1 Kings 18) for children, plus how a small cumulus cloud grows into a rain cloud: search for Bible story readings from trusted Christian children’s channels, Moody Science classics, NOAA SciJinks, and sea-cloud time-lapse nature footage.

KEY TERMS

drought

A long time with little or no rain, when the ground gets dry and plants cannot grow.

prophet

A person God chose to speak His words to the people.

rain cloud

A cloud that has grown so full of water drops that the drops fall as rain.

CORE IDEAS

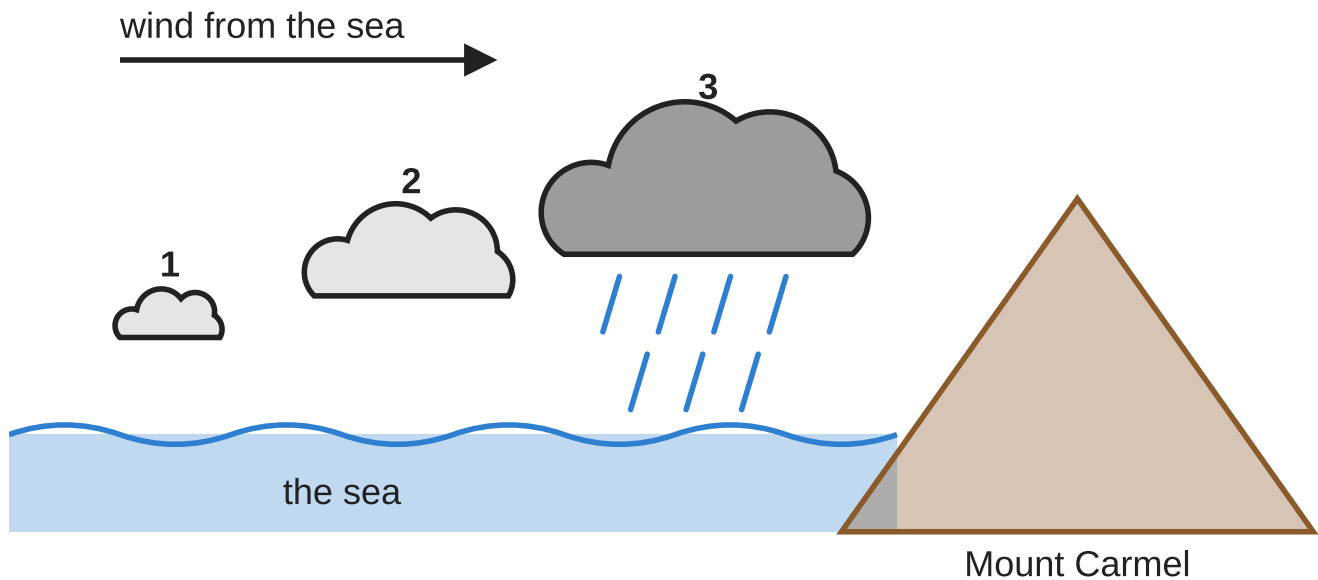
The story. In the days of King Ahab, God’s prophet Elijah told the king that it would not rain. And it did not rain for more than three years. The land was dry and dusty. The grass turned brown, and the streams dried up. This is called a **drought**. Then God showed all the people on Mount Carmel that He is the true God. After that, Elijah climbed to the top of the mountain to pray for rain. He bowed down low, with his face between his knees.

What the servant saw. Elijah told his servant, “Go up now, look toward the sea.” The servant looked. “There is nothing,” he said. Elijah sent him to look again, and again, and again. At the seventh time, the servant came back and said, “Behold, there ariseth a little cloud out of the sea, like a man’s hand.” Elijah knew the rain was coming! Soon the sky was black with clouds and wind, and there was a great rain.

The big idea. Mount Carmel stands right beside the big sea. Remember our cloud in a jar? The sun warms the sea, and water evaporates into the air as water vapor. Warm air carries it

up, where it cools and condenses into a cloud. Wind from the sea pushes the clouds toward the land. A little cloud can grow and grow as more and more water vapor rises into it. When its drops grow big and heavy, they fall as rain. A cloud as small as a hand can grow into a sky full of rain clouds.

God's handiwork. We can learn how rain forms, and that is a good thing to know. But knowing how it works does not mean God is not in it. God made the sea, the sun, the wind and the clouds, and He sends the rain. Elijah did not tell the clouds what to do. He prayed to the God who made them, and he kept watching, even when the answer was "nothing" again and again.



A little cloud rises out of the sea (1), grows bigger (2), and becomes a rain cloud (3) as the wind carries it toward the land.

PICTURE STUDY



Elijah in the Desert, Washington Allston, 1818 · Oil on canvas · Museum of Fine Arts, Boston

Washington Allston was an American painter who loved big, dramatic skies and wild places. He painted this picture while he was living in England. It shows the prophet Elijah alone in a dry, empty land during the drought, before the little cloud came. The Bible tells us that during this time God sent ravens to bring Elijah bread and meat (1 Kings 17:6).

Look closely

- Find Elijah. Is he big or small in the picture? Why do you think the painter made him that size?
- Look at the big tree. Does it have green leaves? What does that tell you about the weather?
- Find the birds in the sky. What did God send the ravens to do?
- Look at the sky. Do you see any clouds that might bring rain someday?

Talk about it

1. How do you think Elijah felt, waiting in the dry land?
2. How would this picture look different after the great rain came?
3. What would you want to see after a long time with no rain?

Safety first. Do the sponge-cloud activity over a big bowl or in the sink, and wipe up any spills right away so no one slips.

MAKE AND DO: A SPONGE CLOUD THAT GROWS AND RAINS

You will act out how Elijah's little cloud grew into a rain cloud. A clean kitchen sponge will be your cloud. Little by little, you will add water drops, just as water vapor rises into a cloud from the sea, until your cloud is so full it rains.

You will need

- A clean, dry kitchen sponge
- A big bowl (this is the sea)
- A cup of water and a spoon or eyedropper
- A towel
- Cotton balls, blue paper and glue, for the picture

Steps

1. Put some water in the bowl. This is the sea beside Mount Carmel.
2. Hold the dry sponge over the bowl. This is the little cloud, like a man's hand. Is it raining yet?
3. Use the spoon to add water to the sponge, one spoonful at a time. Count each spoonful out loud. Each spoonful is like more water vapor rising up from the sea into the cloud.
4. Watch the bottom of the sponge. When does the first drop fall? Keep adding water until it rains steadily into the bowl.
5. Squeeze the sponge gently. A great rain!
6. Now make a story picture: glue one tiny cotton-ball cloud low over a blue sea, then a bigger one, then a big gray one with rain lines drawn under it. Draw Elijah praying on the mountaintop.

Tips

- Real clouds are not sponges. A sponge holds water in tiny holes, but a cloud is made of tiny drops floating in the air. The sponge only helps us see that a cloud must gather a lot of water before it rains.
- Write down how many spoonfuls it took before the first drop fell.

Check your work

- I can tell the story of Elijah's little cloud.
- I can show how a little cloud grows into a rain cloud.
- I can tell where the water in the cloud came from.

FIELD NOTEBOOK

1. Draw your hand by tracing around it. Turn it into a little cloud over the sea, the way the servant saw it.
2. Draw two pictures: the dry land before the rain, and the same land after the great rain.
3. Draw Elijah praying on the top of Mount Carmel, with the sea in the background.

From history. Mount Carmel is a real mountain ridge in northern Israel. It runs right down to the shore of the Mediterranean Sea, which the Bible calls the great sea. The city of Haifa is built on its slopes today. In that land, most of the rain still comes in the cooler months, when winds blow clouds in from the sea, just as the servant saw.

WORKED EXAMPLES

Example 1. Elijah sent his servant to look toward the sea again and again. The little cloud came at the seventh time. Make one tally mark for each time, up to the seventh. How many marks did you make?

1. Make one mark for the first time the servant looked: |
2. Keep going, one mark for each time: | | | |
3. When you get to 5, draw a line across the first four marks to make a bundle of five.
4. Make two more marks: 6, 7.
5. Count: a bundle of 5 and 2 more makes 7.

Answer: 7 tally marks: a bundle of 5 and 2 more. The little cloud came at the seventh time.

PRACTICE

1. **EASY** How big did the little cloud look to the servant? Show me with your body.
2. **EASY** Where did the little cloud come from? Point to it in the picture.
3. **MEDIUM** Put these in story order: (a) the sky is black with clouds and there is a great rain, (b) the land is dry and brown, (c) a little cloud like a man's hand rises from the sea, (d) Elijah prays on the mountain.
4. **MEDIUM** Hold up all the fingers on one hand. Count them. Now keep counting on your other hand until you reach 7. How many fingers on your second hand are up?
5. **HARD** Tell how a little cloud can grow into a big rain cloud.

COMMON MISTAKES

- Thinking a small cloud always stays small. Clouds can grow quickly when lots of warm, wet air keeps rising into them.
- Thinking rain is brand-new water. Rain is water that evaporated from seas, lakes and land and is coming back down again.
- Thinking that if we know how rain forms, God has nothing to do with it. God made the water cycle, and He uses it to send the rain.

Make it a game • Go Look Toward the Sea. One child is Elijah and one is the servant. The parent hides a small paper cloud somewhere in the room (or out in the yard). Elijah says, "Go up now, look toward the sea." The servant looks for a short count of ten. If they do not find it, they come back and say, "There is nothing," and Elijah sends them again.

Keep count of the trips. When the servant finds the cloud, they shout, "I see a little cloud like a man's hand!" and everyone patters fingers on the table to make the sound of a great rain. Then switch places.

Scripture. "And it came to pass at the seventh time, that he said, Behold, there ariseth a little cloud out of the sea, like a man's hand. And he said, Go up, say unto Ahab, Prepare thy chariot, and get thee down, that the rain stop thee not." (1 Kings 18:44, KJV)

Elijah prayed and kept watching, even when the answer was "nothing." When the little cloud came, he trusted that God was sending a great rain. We can be patient and watchful too.

Practice answers

1. Like a man's hand. (The child holds up a hand.)
2. Out of the sea. (The child points to the small cloud over the sea, marked 1.)
3. (b) dry land, (d) Elijah prays, (c) the little cloud, (a) the great rain.
4. One hand has 5 fingers. To reach 7, you need 2 more, so 2 fingers are up on the second hand.
5. The sun warms the sea and water evaporates. The water vapor rises, cools and condenses into the cloud, so the cloud grows bigger. When its tiny drops join into big, heavy drops, they fall as rain.

UNIT 4 REVIEW

This is an oral review. A parent reads each question aloud, and the child answers by telling, pointing or showing. Accept answers in the child's own words. The review is worth 20 points.

1. (3 pts) Who was Luke Howard, and what did he do?
2. (3 pts) Name these clouds: a puffy heap like cotton, a flat gray sheet like a blanket, and a thin wisp high up like a feather.
3. (3 pts) Tell how we made a cloud in a jar. What did the warm water do, and what did the ice do?
4. (3 pts) What is a cloud made of?
5. (3 pts) Show me how to read a rain gauge. Where should we put it, and what do we do after we read it?
6. (2 pts) The rain gauge showed 2 centimeters on Monday and 1 centimeter on Tuesday. Which day had more rain? How much rain fell on both days together?
7. (3 pts) Tell the story of Elijah's little cloud. Where did the cloud come from, and what happened next?

UNIT PROJECT: MY CLOUD JOURNAL

For two weeks, keep a cloud journal. Each day, look at the sky (never at the sun), write the date, draw the clouds you see and name them: cumulus, stratus, cirrus, or "no clouds." On rainy days, read your rain gauge and write how many centimeters fell. At the end, count how many days you saw each kind of cloud and how many days it rained, add your cotton-ball cloud chart and your cloud-in-a-jar drawing, and tell your family what you learned, including the story of Elijah's little cloud.

- **Daily watching:** The journal has a dated page for most days, with a drawing of the sky each day.
- **Cloud names:** Clouds are named correctly as cumulus, stratus or cirrus, and the drawings match the names.
- **Rain records:** Rain gauge readings are written with the date and the number of centimeters, and the child can tell which day had the most rain.
- **Telling back:** The child explains how a cloud forms and retells Elijah's little cloud in their own words.

Answer key

1. He was a man in London who loved to watch the sky. In 1802 he sorted the clouds into kinds and gave them names (cumulus, stratus, cirrus and nimbus).
2. Cumulus (puffy heap), stratus (flat gray sheet), cirrus (thin, high wisp). One point for each.
3. We put hot water in a jar, put ice on top, and added one spray of hairspray. The warm water made water vapor that rose up. The ice made the top cold, so the water vapor condensed into tiny drops: a cloud.

4. Many, many tiny drops of water (or tiny bits of ice, in high clouds) floating in the air. Not cotton, smoke or gas.
5. Bend down so your eyes are level with the water and read the number on the ruler. Put it in an open place away from roofs and trees. Empty it after reading.
6. Monday had more. Together: $2 + 1 = 3$ centimeters.
7. After a long drought, Elijah prayed for rain on Mount Carmel and sent his servant to look toward the sea again and again. At the seventh time, the servant saw a little cloud like a man's hand rising out of the sea. Soon the sky was black with clouds and wind, and there was a great rain. The cloud grew because water from the sea evaporated, rose and condensed into it.

WIND

Nobody has ever seen the wind. Yet we feel it on our faces, hear it in the trees and watch it lift kites and push sailboats. In this unit, children learn that **wind is moving air**, sent across the land when the sun warms some places more than others. Like real weather watchers, they will make instruments and use them: a **windsock** to tell whether the wind is calm, gentle or strong, and a **wind vane** to find which way it is blowing.

Along the way, children will visit a small airport's windsock, George Washington's dove of peace weather vane at Mount Vernon and the row of old windmills at Kinderdijk in the Netherlands, where people used the wind to pump water and grind grain. They will make a pinwheel and see that stronger wind makes it spin faster. The unit ends on a fishing boat on the Sea of Galilee, where the wind and the waves obeyed the voice of Jesus: "Peace, be still" (Mark 4:39).

BEFORE YOU BEGIN

- Can count objects to 12 and compare two small numbers
- Knows left and right and can point in a named direction
- Can listen to a short story and tell it back in order
- Can use glue, tape and crayons with a little help

MASTERY CHECKLIST

- I can say what wind is: moving air.
- I can use a windsock to tell if the wind is calm, gentle or strong.
- I can name north, east, south and west and use a wind vane to tell where the wind is coming from.
- I can tell how a windmill uses the wind to grind grain or pump water.
- I can retell how Jesus calmed the wind and the sea, and why the disciples were amazed.

OPTIONAL BOOKS AND RESOURCES

- **NOAA SciJinks** (<https://scijinks.gov/>): Free. The weather website of NOAA and NASA for students, with simple explanations, pictures and games about wind and weather. Best browsed by a parent with the child.
- **George Washington's Mount Vernon** (<https://www.mountvernon.org/>): Free. Search the site for "weathervane" to see pictures of the dove of peace weather vane Washington ordered for his home (Lesson 5.2).
- **National Weather Service JetStream** (<https://www.weather.gov/jetstream/>): Free. The National Weather Service's online weather school. Written for older students, but a parent will find clear background on wind, wind direction and the Beaufort scale.

5.1 A WINDSOCK ★

OBJECTIVES

- Explain that wind is moving air, which we cannot see but can feel and watch at work.
- Make a windsock and use it to tell whether the wind is calm, gentle or strong.

Warm-up. Hold a small plastic bag open, swoop it through the air and twist the top shut. Squeeze it. What is inside pushing back? Air! Now wave a sheet of paper fast in front of your face. Do you feel a breeze? You cannot see air, but you can feel it push. Wind is air on the move.

Video. Coming soon. What is wind and how a windsock works, for young children: search NOAA SciJinks, the National Weather Service, SciShow Kids, Homeschool Pop (Alternate), Science Max, and airport windsock footage in light and strong wind.

KEY TERMS

air

The invisible stuff all around us that we breathe. We cannot see it, but it is real and it can push.

wind

Air that is moving from one place to another.

windsock

A cloth tube on a pole that fills with wind and shows which way the wind is blowing and how strong it is.

calm

No wind at all. Smoke goes straight up and a windsock hangs down.

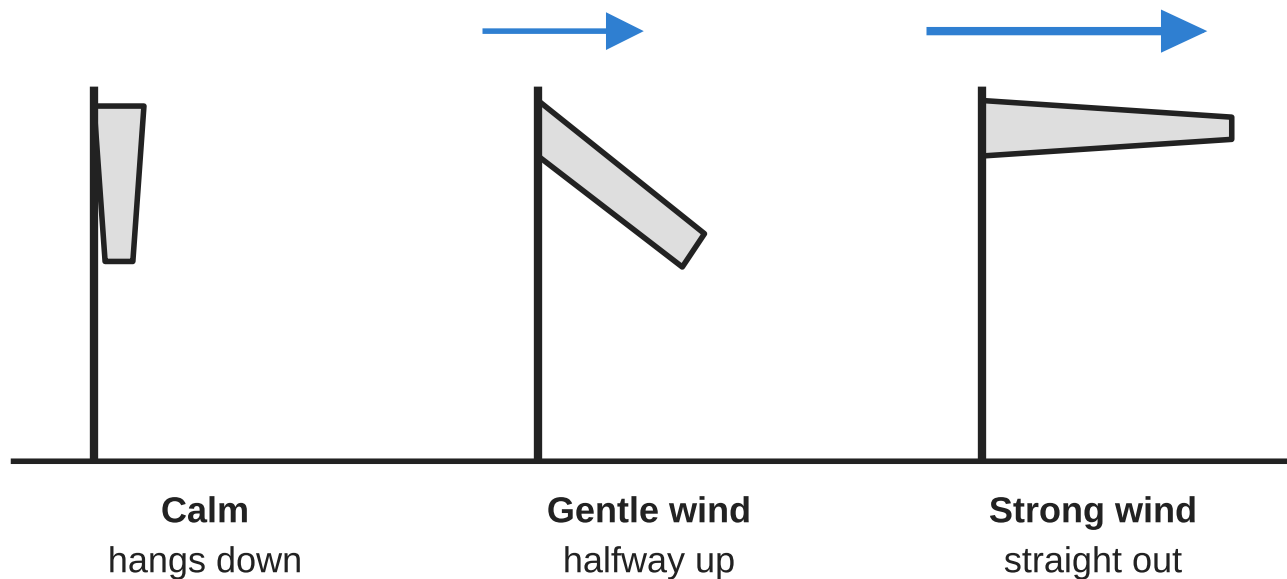
CORE IDEAS

The story. If you ever visit a small airport, look along the side of the runway. You may see a tall pole with a big striped tube flapping at the top. It is often orange and white, so pilots can see it from far up in the sky. It is called a **windsock**. Before landing an airplane, a pilot looks for the windsock. It tells the pilot which way the wind is blowing and how hard. Pilots try to take off and land facing into the wind, because the moving air helps lift their wings.

How they figured it out. Nobody has ever seen the wind. But people have always watched what the wind *does*. A poet named Christina Rossetti wrote: “Who has seen the wind? Neither I nor you: But when the leaves hang trembling, The wind is passing through.” A windsock works the same way. The wind blows into the big open end and fills the tube, and the thin tail streams out the way the wind is going. When the sock hangs down limp, the air is **calm**. When it lifts halfway, there is a gentle wind. When it sticks straight out, the wind is strong.

The big idea. **Air** is real, even though we cannot see it. **Wind** is air that is moving. Why does air move? The sun warms some places more than others. Warm air rises up, and cooler air rushes in to take its place. That rushing air is wind. Wind pushes sailboats, dries wet laundry, carries seeds and lifts kites. Scientists watch the wind because it brings changes in the weather.

God's handiwork. Jesus once talked about the wind. He said that we hear its sound, but we cannot tell where it comes from or where it goes. The wind is a little like God's work in a person's heart. We cannot see it, but we can see what it does. When you watch your windsock flap, you are seeing an invisible thing God made, hard at work.



A windsock shows how strong the wind is: hanging down (calm), halfway up (gentle wind) or straight out (strong wind).

PICTURE STUDY



Woman with a Parasol: Madame Monet and Her Son, Claude Monet, 1875 · Oil on canvas · National Gallery of Art, Washington, D.C.

Claude Monet was a French painter who loved to paint outdoors, right where he could see the light and feel the weather. One summer day he painted his wife, Camille, and their little boy, Jean, on a hill near their home. He painted quickly with short, fast brushstrokes. You can almost feel the breeze in this painting. Look for the wind at work, just as you would look at a windsock.

Look closely

- Find Camille's veil and the bottom of her skirt. Which way are they blowing?
- Look at the grass and the flowers at her feet. Are they standing still, or bending?
- Look at the clouds behind her. Do they look calm or windy to you?
- Find the little boy. What is he doing?

Talk about it

1. We cannot see wind. How did Monet show us the wind in this painting?
2. If Camille had a windsock, which way would its tail point?
3. Do you think this was a calm day, a gentle wind day or a strong wind day? Why?

Safety first. A parent should do any cutting with sharp scissors and any poking with a hole punch or pin. Hang the windsock where no one can trip on a string or bump into a stick.

MAKE AND DO: MAKE A PAPER WINDSOCK

You will make your own little windsock, hang it outside and watch what the wind does to it. Then you will tell whether the wind is calm, gentle or strong.

You will need

- One sheet of construction paper
- Crayons, markers or stickers
- Tape or a stapler
- Five to eight strips of crepe paper or tissue paper, each about as long as your arm
- A piece of string or yarn
- A hole punch
- A stick, a porch rail or a tree branch to hang it from

Steps

1. Lay the paper flat and decorate it with bright stripes or pictures. Bright colors are easy to see from far away, just like an airport windsock.
2. Roll the paper into a tube, colored side out. Your parent tapes or staples it shut.
3. Tape the crepe paper streamers all around one end of the tube. Count them as you go.
4. Your parent punches two holes on opposite sides of the other end. Tie the string through both holes to make a handle.
5. Hang your windsock outside from a stick, a porch rail or a low branch where you can see it from a window.
6. Watch it three times today. Each time, say whether it is hanging down (calm), lifting halfway (gentle) or blowing straight out (strong). Make a mark on a chart for each one.

Tips

- Crepe paper tears in rain. Bring your windsock inside if it starts to rain.
- If your windsock just spins, hang it by one string tied to the middle of the handle so it can turn to face the wind.

Check your work

- I made a windsock and hung it outside.
- I can tell if the wind is calm, gentle or strong by looking at it.
- I can say what wind is: moving air.

FIELD NOTEBOOK

1. Draw your windsock on a calm day and again on a windy day, side by side.
2. Go outside and find three things the wind is moving, such as leaves, a flag or grass. Draw them.

3. Draw an airport windsock on its tall pole, like the ones in this lesson's drawing. Color it with orange and white stripes.

From history. In 1805, a British navy officer named Francis Beaufort made a way to tell how strong the wind was just by looking. At first it described what the wind did to a ship's sails. Later it was changed for people on land. It goes from 0, when smoke rises straight up, to 12, a terrible storm. In between, leaves rustle, small trees sway and big branches move. Weather watchers still use the Beaufort scale today, and so can you.

WORKED EXAMPLES

Example 1. A boy looked at his windsock once a day for one week. He made a picture chart: straight out (strong) on 2 days, halfway up (gentle) on 4 days, hanging down (calm) on 1 day. Which kind of day did he see the most? How many days did he look?

1. Count the strong days: 1, 2. That is 2 days.
2. Count the gentle days: 1, 2, 3, 4. That is 4 days.
3. Count the calm days: 1. That is 1 day.
4. Compare: 4 is bigger than 2, and 2 is bigger than 1. Gentle has the most.
5. Count them all together: 2 and 4 make 6, and 1 more makes 7.

Answer: He saw gentle wind the most (4 days). He looked on 7 days, one whole week.

PRACTICE

1. **EASY** What is wind?
2. **EASY** Look at the windsock picture in this lesson. Point to the windsock that shows a strong wind.
3. **MEDIUM** Sort these into two piles, things the wind can move and things the wind cannot move: a leaf, a big rock, a kite, a house, a dandelion seed.
4. **MEDIUM** Your windsock has 6 streamers. You tape on 3 more. How many streamers does it have now?
5. **HARD** Tell back: We cannot see the wind. How can we tell it is there?

COMMON MISTAKES

- Thinking air is “nothing.” Air is real stuff. It fills a bag, pushes on a kite and holds up an airplane.
- Thinking trees make the wind by waving their branches. The wind moves the trees, not the other way around.
- Thinking a windsock that hangs down is broken. A limp windsock is telling you something true: the air is calm.

Make it a game • Be the Windsock. Hold a scarf or a long ribbon by one end. Your parent calls out “calm,” “gentle wind” or “strong wind.” For calm, let the scarf hang straight down and stand still. For gentle wind, walk slowly so it lifts halfway. For strong wind, run so it streams straight out behind you. Then switch: you call it out and your parent is the windsock.

Scripture. “The wind bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh, and whither it goeth: so is every one that is born of the Spirit.” (John 3:8, KJV)

“Listeth” means “wants to.” We cannot see the wind, but we can hear it and see what it does. Jesus used the wind to teach that God works in people’s hearts in a way we cannot see, but we can see the good change it makes.

Practice answers

1. Wind is moving air.
2. The one on the right, which sticks straight out from its pole.
3. The wind can move: a leaf, a kite, a dandelion seed. The wind cannot move: a big rock, a house.
4. 9 streamers (6 and 3 more make 9).
5. We can feel it on our skin and hear it, and we can see what it does: leaves move, flags wave, kites fly and a windsock fills up and lifts.

5.2 WHICH WAY? WIND VANES AND WIND DIRECTION ★

OBJECTIVES

- Name the four directions (north, east, south and west) and find east by where the sun comes up.
- Explain that a wind is named for the direction it comes from, and that a wind vane points into the wind.
- Make a wind vane and use it to tell which way the wind is blowing.

Warm-up. Lick one finger and hold it up high outside, or just turn your face slowly in a circle. Which side of your finger or face feels coolest? That is the side the wind is coming from. Point to it. Then ask your parent which way the sun comes up in the morning at your house, and point there too. That way is east.

Video. Coming soon. Wind direction and how a weather vane works, for young children: search NOAA SciJinks, the National Weather Service, SciShow Kids, Homeschool Pop (Alternate), Science Max, and George Washington’s Mount Vernon for the dove of peace weather vane.

KEY TERMS

direction

The way something points or moves. The four main directions are north, east, south and west.

wind vane

A pointer that turns on a pole. Its point turns to face where the wind is coming from. It is also called a weather vane.

north wind

A wind that comes from the north and blows toward the south. Winds are named for where they come from.

compass rose

A drawing that shows the four directions: N for north, E for east, S for south and W for west.

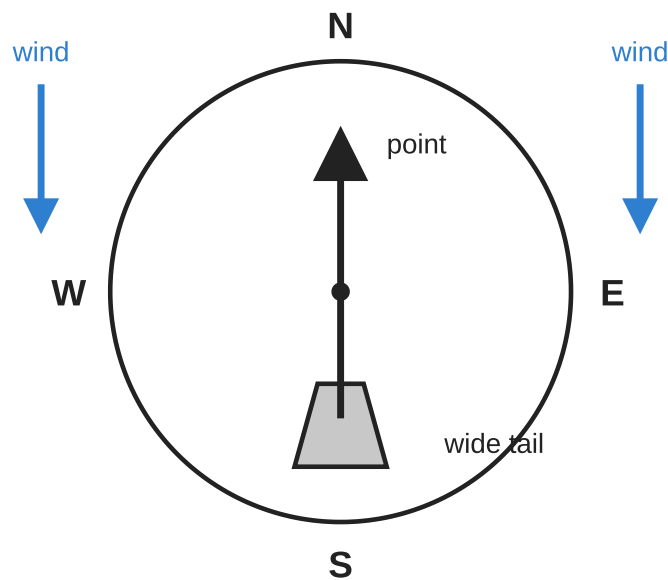
CORE IDEAS

The story. In 1787, George Washington was in Philadelphia helping to write the Constitution. But he was also thinking about his home, Mount Vernon in Virginia. He wanted a weather vane for the little tower on top of his roof. He asked a metalworker to make a dove of peace with an olive branch in its beak. The dove would turn in the wind high on the roof. Washington was a farmer, and farmers always want to know which way the wind is blowing. You can still see a dove weather vane on top of Mount Vernon today.

How they figured it out. A **wind vane** has a pointed front and a wide tail. The wind pushes hard on the wide tail and shoves it away. So the point always swings around to face *into* the wind, toward where the wind is coming from. Long ago, people put wind vanes on barns, houses and church steeples, where the wind could reach them. Many old churches have a rooster on top. People say the rooster reminds them of the rooster that crowed when Peter said he did not know Jesus.

The big idea. There are four main **directions**: north, east, south and west. The sun comes up in the east and goes down in the west. Winds are named for the direction they come *from*. A **north wind** comes from the north and blows toward the south. A north wind is often cold. A south wind is often warm. A wind vane points to where the wind is coming from. A windsock's tail streams the other way, toward where the wind is going.

God's handiwork. The wind is always moving and changing. Yet God made it to follow a pattern. King Solomon noticed this long ago. He wrote that the wind goes toward the south and turns about to the north, round and round in its circuits. Weather watchers today still watch the wind's direction, because a change in the wind often means a change in the weather is coming.



A north wind blows from the north. The wind pushes the vane's wide tail away, so the arrow points into the wind, toward N.

PICTURE STUDY



The Fog Warning, Winslow Homer, 1885 · Oil on canvas · Museum of Fine Arts, Boston

Winslow Homer was an American painter who lived by the sea in Maine. He watched fishermen work in all kinds of weather. In this painting, a fisherman has caught two big halibut and is rowing his small boat, called a dory, back to his big ship. But a fog bank is coming, and the waves are rough. He must watch the sky, the waves and the wind to find his way home safely.

Look closely

- Find the fisherman's face. Where is he looking?
- Find the dark fog along the edge of the sky. Find the big ship far away.
- Look at the waves. Are they flat and calm, or tall and rough?
- Find the two big fish in the boat.

Talk about it

1. Why does a fisherman need to know which way the wind is blowing?
2. What do you think the fisherman will do next?
3. What would be scary about the fog for someone in a small boat at sea?

Safety first. A parent should push the pin through the straw and into the pencil eraser. Keep pins away from small children, and set up the wind vane where no one will poke an eye on it.

MAKE AND DO: MAKE A WIND VANE

You will make a wind vane like the ones on old barns and church steeples. Then you will take it outside and find out which way the wind is blowing.

You will need

- A paper plate
- A marker
- A drinking straw
- A small piece of card stock or a cereal box
- Scissors (for the parent)
- Tape
- A straight pin
- A new pencil with an eraser
- A lump of play dough or modeling clay, or a paper cup turned upside down
- A phone compass, or knowing which way the sun comes up

Steps

1. Turn the paper plate upside down. Write N, E, S and W around the edge, like the compass rose in this lesson. N goes at the top, E on the right, S at the bottom and W on the left.
2. Your parent cuts a small triangle and a bigger tail shape from the card stock. Make the tail wider than the point.
3. Tape the triangle to one end of the straw for the point. Tape the tail to the other end.
4. Find the spot where the straw balances on your finger. Your parent pushes the pin through the straw at that spot and into the pencil eraser.
5. Push the pencil through the middle of the plate and stand it in the play dough, or poke it into the bottom of an upside-down cup.
6. Take it outside to an open spot. Turn the plate so N faces north. (East is where the sun comes up.)
7. Blow on the tail to make sure the straw spins freely. Then wait for the wind. Which letter does the point face? That is where the wind is coming from. Say, "The wind is from the ____."

Tips

- If the straw will not turn, wiggle the pin to make the hole a little bigger.
- Stand away from walls and buildings. They bend the wind and can fool your wind vane.

Check your work

- I can point to north, east, south and west.
- I can tell which way the wind is coming from with my wind vane.
- I can name a wind by where it comes from.

FIELD NOTEBOOK

1. Draw a compass rose and label N, E, S and W.
2. Draw your wind vane outside. Draw an arrow to show which way the wind was blowing, and write the day on top.
3. Draw a weather vane shaped like your favorite animal, the way Washington chose a dove.

From history. On December 17, 1903, Orville and Wilbur Wright made the first airplane flights on a sandy beach near Kitty Hawk, North Carolina. They had chosen that place after asking the United States Weather Bureau where they could find steady winds. On the morning of the flight, a cold, strong wind was blowing. The brothers laid their wooden launching rail facing straight into the wind, because flying into the wind helped lift their airplane into the air.

WORKED EXAMPLES

Example 1. A girl checked her wind vane every morning for one week. Her chart shows: wind from the north on 3 days, from the west on 2 days, from the south on 1 day and from the east on 1 day. Which way did the wind come from most often? How many days did she check?

1. Count the north days: 1, 2, 3. That is 3 days.
2. Count the west days: 1, 2. That is 2 days.
3. South has 1 day, and east has 1 day.
4. Compare: 3 is the biggest number. North wins.
5. Count them all: 3 and 2 make 5. 5 and 1 make 6. 6 and 1 make 7.

Answer: The wind came from the north most often (3 days). She checked on 7 days, one whole week.

PRACTICE

1. **EASY** Name the four directions. Point to where the sun comes up. Which direction is that?
2. **EASY** Look at the wind vane picture in this lesson. Which letter is the arrow pointing to? Where is the wind coming from?
3. **MEDIUM** A wind is blowing from the west toward the east. What do we call this wind? Which way does the wind vane point?
4. **MEDIUM** On one street, 4 houses have a rooster weather vane and 3 houses have an arrow weather vane. How many weather vanes is that in all?
5. **HARD** Tell back: Why does the point of a wind vane always turn to face into the wind?

COMMON MISTAKES

- Thinking a north wind blows toward the north. Winds are named for where they come from, so a north wind blows from the north toward the south.
- Mixing up a wind vane and a windsock. The vane's point faces where the wind comes from. The windsock's tail streams toward where the wind is going.
- Thinking the wind always blows the same way. The wind changes direction, sometimes many times in one day.

Make it a game · Weather Vane, Turn!. Mark north, east, south and west on the walls of a room with paper signs. The child is the weather vane and stands in the middle with arms out like an arrow. The parent calls out a wind, such as "North wind!" The weather vane turns to point into the wind, toward the north sign. Then try "From the east!" and "South wind!" Switch places and let the child call the winds.

Scripture. "The wind goeth toward the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits." (Ecclesiastes 1:6, KJV)

King Solomon watched the wind change direction, north and south and round again. God made the wind to move in patterns, and we can watch and learn them with a simple wind vane.

Practice answers

1. North, east, south and west. The sun comes up in the east.
2. The arrow points to N. The wind is coming from the north. It is a north wind.
3. A west wind. The wind vane points west, into the wind.
4. 7 weather vanes (4 and 3 more make 7).
5. The tail is wide, so the wind pushes on it hard and shoves it away. That swings the point around to face where the wind is coming from.

5.3 WINDMILLS

OBJECTIVES

- Explain that a windmill uses the push of the wind to do work, such as grinding grain or pumping water.
- Name the main parts of a windmill: sails, cap and tower.
- Make a pinwheel and show that a stronger wind makes it spin faster.

Warm-up. Hold a sheet of paper by one edge and blow on it. Watch it move. Now blow softly, then hard. Which push moved it more? Wind can push things. Think of something that needs a push to do its job, like a swing or a sailboat.

Video. Coming soon. How old windmills work, for young children: search the windmills of Kinderdijk in the Netherlands, Dutch working windmill footage (sails turning, millstones grinding), American farm windmills pumping water, SciShow Kids, Homeschool Pop (Alternate) and Science Max.

KEY TERMS

windmill

A machine with big sails that the wind turns. The turning does work, like grinding grain into flour or pumping water.

sails

The long arms of a windmill. The wind pushes on them and makes them turn.

grind

To crush something into tiny bits, the way a mill crushes grain into flour.

miller

The person who runs a mill and grinds grain into flour.

CORE IDEAS

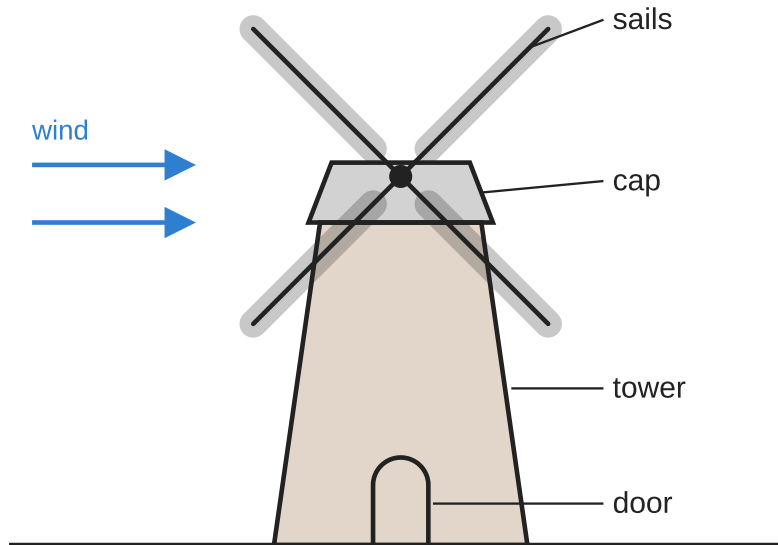
The story. In the Netherlands, a country in Europe, much of the land is lower than the sea and the rivers around it. Long ago, water kept flooding the fields. So the Dutch people built strong walls of earth called dikes. Then they built windmills to pump the extra water out of the fields and over the dikes into the river. At a place called Kinderdijk, 19 old windmills still stand in a long row beside the water. Their big sails turn in the wind, just as they did long ago.

How they figured it out. People noticed that the wind can push. It pushes sailboats across the water. So they put big **sails** on a tall tower, where the wind is strong. When the wind pushes the sails, they turn. The turning sails spin a big wooden shaft inside the mill. In a grain mill, the shaft turns a heavy round stone that **grinds** wheat into flour. In a pumping mill like the ones at Kinderdijk, it turns a big wheel that scoops water up and out of the

fields. The **mill** turns the top of the windmill, called the cap, so the sails face into the wind.

The big idea. A **windmill** uses the push of moving air to do work that people or animals would have to do by hand. The stronger the wind, the faster the sails turn. If the wind is too strong, the miller must stop the sails so they do not break. On the wide prairies of America, farmers put up small metal windmills with many blades. They pumped water up from deep wells for families and their cattle.

In the world today. You may see tall white wind turbines on hills or farms. They are a kind of windmill too. Instead of grinding flour, their turning blades spin a machine that makes electricity. God gave people minds to make good tools. Windmills are one of the ways people have used the gifts God put in creation, like the wind, to feed families and care for the land.



The parts of a windmill. The wind pushes the sails. The cap turns so the sails face the wind. The tower holds everything up high where the wind is strong.

PICTURE STUDY



The Windmill at Wijk bij Duurstede, Jacob van Ruisdael, about 1668–1670 · Oil on canvas · Rijksmuseum, Amsterdam

Jacob van Ruisdael was a Dutch painter who loved to paint his country's land, water and big, cloudy skies. Here he painted a windmill beside a wide river in the town of Wijk bij Duurstede. He painted it from low down, so the windmill looks very tall and strong against the sky. This painting hangs in the Rijksmuseum, the great art museum of the Netherlands.

Look closely

- Find the windmill. How many sails can you count?
- Look at the sky. Is it calm and blue, or full of clouds? Is it a windy day?
- Find the sailboat on the river. What else is the wind pushing in this painting?
- Find the tiny people. How big are they next to the windmill?

Talk about it

1. Why do you think windmills were built tall?
2. What work might this windmill be doing?
3. If you lived near this windmill, what sounds do you think you would hear?

Safety first. A parent should cut the paper and push the pushpin or straight pin through the pinwheel into the pencil eraser. Keep pins away from small children. Do not blow until you feel dizzy; take a rest.

MAKE AND DO: MAKE A PINWHEEL WINDMILL

You will make a pinwheel, which is a little windmill you can hold. Then you will test it: does a strong wind make it spin faster than a gentle wind?

You will need

- A square of paper, about the size of your two hands (card stock or construction paper works best)
- Crayons or markers
- A ruler and a pencil
- Scissors (for the parent)
- A pushpin or a straight pin
- A new pencil with an eraser, or a straw
- A small bead (optional)

Steps

1. Color both sides of the square paper.
2. With a ruler, draw a line from one corner to the opposite corner. Draw another line between the other two corners. You have made an X.
3. Your parent cuts along each line from the corner toward the middle, stopping a little way before the center.
4. Bend every other point into the middle, so four points meet at the center. Do not crease them flat.
5. Your parent pushes the pin through all four points and the center, then into the side of the pencil eraser. (A bead between the paper and the eraser helps it spin.)
6. Test it: blow very gently on your pinwheel. Then blow hard. Which way spins faster?
7. Take it outside. Hold it facing different ways. Find the way it spins best. That is the way the wind is coming from.

Tips

- If the pinwheel will not spin, loosen the pin a little so it is not pressed too tight against the eraser.
- Run with your pinwheel on a calm day. Running makes your own wind!

Check your work

- I made a pinwheel that spins in the wind.
- I found out that a stronger wind makes it spin faster.
- I can tell what work a windmill does.

FIELD NOTEBOOK

1. Draw a windmill. Label the sails, the cap and the tower.

2. Draw a sack of flour and a loaf of bread. Draw arrows to show how wheat goes to the mill and becomes bread.
3. Draw your pinwheel spinning in the wind. Add wind lines to show where the wind came from.

From history. One of the most famous stories ever written has windmills in it. In *Don Quixote*, a Spanish book by Miguel de Cervantes, a silly old knight rides across the plains of Spain. He sees a row of windmills and thinks their turning arms belong to giants. He charges at one with his long lance, and the windmill's sail catches him and tosses him and his horse to the ground. Today, when people fight a pretend enemy, we say they are "tilting at windmills."

WORKED EXAMPLES

Example 1. A picture shows 3 old windmills in a row. Each windmill has 4 sails. How many sails are there in all?

1. Look at the first windmill and count its sails: 1, 2, 3, 4.
2. Keep counting on with the second windmill: 5, 6, 7, 8.
3. Keep counting on with the third windmill: 9, 10, 11, 12.

Answer: There are 12 sails in all.

PRACTICE

1. **EASY** What makes a windmill's sails turn?
2. **EASY** Look at the windmill picture in this lesson. Point to the sails, the cap and the tower.
3. **MEDIUM** Match each windmill to its job: (a) a Dutch windmill at Kinderdijk, (b) a windmill with a millstone, (c) a metal windmill on an American farm. Jobs: grinds grain into flour, pumps water out of low fields, pumps water up from a deep well.
4. **MEDIUM** You blow gently and your pinwheel turns 5 times. You blow hard and it turns 9 times. Which blow made it turn more? How many more?
5. **HARD** Tell back: Why did the people of the Netherlands need windmills?

COMMON MISTAKES

- Thinking windmills make the wind. The wind turns the windmill. A windmill can only turn when the wind blows.
- Thinking a windmill works best facing any way at all. The sails must face into the wind, which is why the miller turns the cap.
- Thinking all windmills grind flour. Some grind grain, some pump water, and some saw wood or make electricity.

Make it a game · Windmill, Windmill, Stop!. The child holds both arms out straight and turns them in big circles like windmill sails. The parent calls “gentle wind” (turn slowly), “strong wind” (turn fast) or “calm” (stop and hold still, like a miller stopping the sails). Then the parent calls “Turn the cap!” and points to a wall. The windmill must turn to face that way. Take turns being the miller.

Scripture. “He causeth the vapours to ascend from the ends of the earth; he maketh lightnings for the rain; he bringeth the wind out of his treasures.” (Psalm 135:7, KJV)

The Bible says God brings the wind out of His treasures, like a rich king bringing out his treasure. The wind is one of God’s gifts. A windmill is a way of using that gift to grind bread and pump water for people.

Practice answers

1. The wind pushes on the sails and makes them turn.
2. The sails are the four long arms in an X. The cap is the top part just under the sails. The tower is the wide part that stands on the ground.
3. (a) pumps water out of low fields, (b) grinds grain into flour, (c) pumps water up from a deep well.
4. The hard blow made it turn more. 9 is 4 more than 5.
5. Much of their land is lower than the sea and rivers, so water kept flooding the fields. Windmills used the wind to pump the water out of the fields and over the dikes. Windmills also ground grain into flour.

5.4 JESUS CALMS THE WIND (MARK 4:39)

OBJECTIVES

- Retell the story of Jesus calming the wind and the waves on the Sea of Galilee.
- Explain that wind makes waves, and that waves usually keep rolling for a while even after the wind stops.
- Tell why the disciples were amazed: even the wind and the sea obey Jesus.

Warm-up. Fill a bowl with water. Blow across the top through a straw. What happens to the water? Now stop blowing. Watch closely. Does the water go flat right away, or does it keep wiggling for a little while? Count slowly until it is still.

Video. Coming soon. Jesus calms the storm (Mark 4:35–41) told for young children, plus how wind makes waves: search Bible storytelling channels for children, Moody Science classics, SciShow Kids, NOAA SciJinks and footage of the Sea of Galilee and its surrounding hills.

KEY TERMS

Sea of Galilee

A big lake in Israel with hills all around it. Jesus and His disciples sailed on it in fishing boats.

storm

Very strong wind, often with rain, that can make big waves on the water.

wave

A hump of water that moves across a lake or the sea. Wind pushing on the water makes waves.

miracle

A wonderful thing that only God can do, beyond the usual way things work.

CORE IDEAS

The story. One evening, Jesus said to His disciples, “Let us pass over unto the other side.” They got into a fishing boat and sailed out onto the Sea of Galilee. Jesus was tired. He lay down in the back of the boat and fell asleep on a pillow. Then a great storm of wind came. The waves crashed into the boat, and it began to fill with water. The disciples were afraid. They woke Jesus and cried, “Master, carest thou not that we perish?”

What happened next. Jesus got up. He spoke to the wind, and He said to the sea, “Peace, be still.” And the wind stopped. The Bible says, “there was a great calm.” The disciples were amazed. They said to one another, “What manner of man is this, that even the wind and the sea obey him?” (Mark 4:35–41).

The big idea. The Sea of Galilee really does have sudden storms. It is a lake sitting low in a bowl of hills. Cool air can rush down through the hills and stir up the water very fast. **Waves** are made by the wind pushing on the water. The harder the wind blows, the bigger the waves. Here is something scientists notice: when the wind stops, the waves do not stop right away. They keep rolling for a while, just like the water in your bowl. But when Jesus spoke, the wind stopped *and* the sea went calm at once. That is a **miracle**.

God's handiwork. All through this unit, you have watched the wind with a windsock, a wind vane and a pinwheel. You learned that the wind is strong and that nobody can see it or hold it. But Jesus, the Son of God, made the wind. The wind and the waves listen to Him. When you feel afraid, you can remember the disciples in the boat. Jesus was with them, and He is with His people still.

PICTURE STUDY



The Storm on the Sea of Galilee, Rembrandt van Rijn, 1633 · Oil on canvas · Isabella Stewart Gardner Museum, Boston (stolen in 1990 and still missing)

Rembrandt was a Dutch painter who painted many Bible stories. This is the only painting of the sea he ever made. It shows the moment in Mark 4 when the storm is at its worst, just before Jesus calms it. The front of the boat is in bright light, with crashing waves and a torn sail. The back of the boat is in shadow, where Jesus sits with His frightened disciples.

Sadly, in 1990 thieves stole this painting from a museum in Boston. No one has found it yet. The museum still keeps its empty frame on the wall, waiting for the painting to come home.

Look closely

- Find the big wave. Which way is the boat tipping?
- Find the sail. What has the wind done to it?

- Find Jesus in the back of the boat. Is He frightened like the others, or calm?
- Find the bright patch of sky. Where else do you see light and where do you see dark?

Talk about it

1. How do you think the disciples felt? How can you tell from the painting?
2. Why do you think Rembrandt painted the front of the boat bright and the back dark?
3. What happened right after the moment in this painting?

Safety first. Do this activity with a grown-up close by. Use only a shallow pan of water, wipe up spills right away so no one slips, and never drink the pan water.

MAKE AND DO: A STORM IN A PAN

You will make a little boat and a little storm. You will see how wind makes waves, and how long the waves keep going after the wind stops.

You will need

- A baking pan or a large shallow dish
- Water
- A square of aluminum foil about the size of your hand, or a cork or a bottle cap
- A drinking straw
- A towel for spills

Steps

1. Set the pan on a towel on a table. Pour in water until it is about as deep as your thumb is long.
2. Fold the foil into a little boat by pinching up the edges all around. Set it on the water. This is the disciples' boat.
3. Blow gently across the water through the straw. Watch the little waves. Does the boat move?
4. Now blow hard. This is the storm! What happens to the waves and the boat?
5. Stop blowing. Your parent counts slowly out loud. How many counts does it take until the water is flat and still?
6. Talk about it: The water in the pan kept moving after the wind stopped. What did the sea do when Jesus said, "Peace, be still"?

Tips

- If your boat tips over, make its sides taller and its bottom wider.
- Put a few pennies or pebbles in the boat to see if a heavier boat stays steadier in the storm.

Check your work

- I saw that wind makes waves.
- I counted how long the water kept moving after the wind stopped.
- I can retell the story of Jesus calming the wind and the sea.

FIELD NOTEBOOK

1. Draw two pictures of the boat on the Sea of Galilee: one in the storm and one in the great calm after Jesus spoke.
2. Draw your storm in a pan. Draw wavy lines for the waves and an arrow for your wind.
3. Copy the words “Peace, be still” in your best writing and decorate them with a calm blue sea.

From history. In 1986 the Sea of Galilee was lower than usual because there had been very little rain. Two brothers who were fishermen walked along the muddy shore and found the outline of an old wooden boat sunk in the mud. Scientists carefully dug it out and found it was a fishing boat from about the time of Jesus. It was big enough to hold more than a dozen people. Today it is kept in a museum beside the Sea of Galilee, so visitors can see what kind of boat Jesus and His disciples may have sailed in.

WORKED EXAMPLES

Example 1. A boy blew a gentle wind across his pan, then stopped. The water was still after he counted to 4. Then he blew a strong wind and stopped. The water was still after he counted to 9. Which wind made waves that lasted longer? How many more counts?

1. The gentle wind waves lasted 4 counts.
2. The strong wind waves lasted 9 counts.
3. Compare: 9 is bigger than 4. The strong wind waves lasted longer.
4. Count up from 4 to 9: 5, 6, 7, 8, 9. That is 5 more counts.

Answer: The strong wind made waves that lasted longer, 5 more counts. Bigger winds make bigger waves, and bigger waves take longer to settle down.

PRACTICE

1. **EASY** Where was Jesus when the storm began, and what was He doing?
2. **EASY** What three words did Jesus say to the sea?
3. **MEDIUM** Put these in order: (a) the disciples wake Jesus, (b) there is a great calm, (c) a great storm of wind comes, (d) Jesus falls asleep in the boat, (e) Jesus says, “Peace, be still.”
4. **MEDIUM** Jesus had 12 disciples. Peter, Andrew, James and John were 4 of them, and they were fishermen. How many other disciples were there? Use your fingers to count.
5. **HARD** Tell back: Why were the disciples so amazed when the sea went calm?

COMMON MISTAKES

- Thinking waves come from fish or from the bottom of the lake. Waves on a lake are made by the wind pushing on the water.
- Thinking the water goes flat the moment the wind stops. Usually the waves keep rolling for a while. That is why the great calm was a miracle.
- Thinking Jesus was asleep because He did not care. He was tired from a long day of teaching, and He was never in danger of losing control of the storm.

Make it a game • Peace, Be Still! Everyone in the family is the stormy sea. Wave your arms, sway, and make whooshing wind sounds, getting louder and wilder. One person is chosen to stand up and say, “Peace, be still!” Everyone must freeze at once and be perfectly quiet. Anyone who wiggles or giggles becomes the next one to say the words. Talk afterward about how hard it is to stop all at once, and how the real sea obeyed Jesus right away.

Scripture. “And he arose, and rebuked the wind, and said unto the sea, Peace, be still. And the wind ceased, and there was a great calm.” (Mark 4:39, KJV)

“Rebuked” means He told the wind to stop. “Ceased” means stopped. The wind that we can measure but never hold obeyed the voice of Jesus, because He made it.

Practice answers

1. He was in the back of the boat, asleep on a pillow.
2. “Peace, be still.”
3. (d), (c), (a), (e), (b).
4. 8 other disciples (12 take away 4 is 8).
5. Waves usually keep rolling for a while after the wind stops, but when Jesus spoke, the wind stopped and the sea went calm right away. Only God can command the wind and the sea, so they asked, “What manner of man is this, that even the wind and the sea obey him?”

UNIT 5 REVIEW

This is an oral review. The parent reads each question aloud and the child answers out loud, points or shows. Give full points for a clear answer in the child's own words. The review is worth 20 points.

1. (2 pts) What is wind? We cannot see it, so how do we know it is there?
2. (3 pts) Show me with your arm what a windsock does when the wind is calm, when it is gentle and when it is strong.
3. (3 pts) Name the four directions. Which way does the sun come up?
4. (3 pts) A north wind is blowing. Where is it coming from? Which way does the wind vane point?
5. (3 pts) What makes a windmill turn? Tell me one job a windmill can do.
6. (2 pts) Two windmills each have 4 sails. How many sails is that in all?
7. (4 pts) Tell me the story of Jesus calming the storm. What did Jesus say, and what did the disciples ask afterward?

UNIT PROJECT: MY WIND WATCH BOOK

Make a small book that shows everything you learned about the wind. Fold and staple a few sheets of paper together. Include a drawing of your windsock and a chart of what it showed (calm, gentle or strong) on at least three days, a compass rose and a chart of where your wind vane said the wind came from, a labeled drawing of a windmill with your pinwheel taped inside, and a picture of Jesus calming the storm with the words "Peace, be still." Tell your book to your family, page by page.

- **Observations:** The windsock and wind vane charts show at least three real days of watching, with a mark for each day.
- **Labels:** The compass rose shows N, E, S and W in the right places, and the windmill drawing labels the sails, cap and tower.
- **Telling back:** The child explains each page in their own words, including what wind is and how Jesus calmed the storm.
- **Care:** The book is neat and colorful, with a cover and a title.

Answer key

1. Wind is moving air. We can feel it and hear it, and we can see what it does: leaves move, flags wave and kites fly.
2. Calm: the arm hangs straight down. Gentle: the arm lifts halfway. Strong: the arm sticks straight out.
3. North, east, south and west. The sun comes up in the east.
4. It is coming from the north. The wind vane points north, into the wind.
5. The wind pushes on the sails and turns them. A windmill can grind grain into flour or pump water (out of low fields, or up from a well).
6. 8 sails (4 and 4 make 8).

7. Jesus and His disciples were in a boat on the Sea of Galilee. Jesus fell asleep, and a great storm of wind filled the boat with waves. The frightened disciples woke Him. He said to the sea, "Peace, be still," and the wind stopped and there was a great calm. The disciples asked, "What manner of man is this, that even the wind and the sea obey him?"

THE MOON

In the last units you watched rocks, rivers, clouds and wind down here on the earth. Now we look up! God made “the lesser light to rule the night” (Genesis 1:16), and every child can see it from the back porch. In this unit you will become a moon watcher like Galileo. You will keep a moon calendar for a whole month, make the moon’s phases out of sandwich cookies, and use a lamp and a ball to find out why the moon seems to grow and shrink.

Then you will travel to the moon with the astronauts of Apollo 11, who landed the *Eagle* there on July 20, 1969, and left bootprints that are still there today. Last of all, you will bomb a pan of flour with pebbles to see how the moon got its craters. All through the unit you will remember that the moon shines with the sun’s light and keeps its steady path, just as God set it, as a calendar in the sky.

BEFORE YOU BEGIN

- Can count objects to 20 and add and take away small numbers
- Knows the days of the week and can find today’s date on a calendar with help
- Can use a ruler to measure in inches with help
- Knows that the sun gives us light and warmth (and that we never look straight at it)

MASTERY CHECKLIST

- I can say that the moon does not make its own light: it reflects light from the sun.
- I can name and draw the new moon, a crescent, a half moon and the full moon.
- I can tell a growing (waxing) moon from a shrinking (waning) moon.
- I can tell the story of Apollo 11 and name the three astronauts.
- I can make a crater and point to its rim and rays, and I can say that most moon craters were made by rocks from space.

OPTIONAL BOOKS AND RESOURCES

- **NASA Moon (moon.nasa.gov)** (<https://moon.nasa.gov/>): Free. NASA’s own moon site, with real photographs, a moon phase guide and pictures of craters and the Apollo landing sites. A parent can pick pictures to show alongside Lessons 6.1, 6.3 and 6.4.
- **NASA Space Place** (<https://spaceplace.nasa.gov/>): Free. NASA’s site for children, with simple pages, games and crafts about the moon and its phases.
- **Smithsonian National Air and Space Museum** (<https://airandspace.si.edu/>): Free. The museum in Washington, D.C., that keeps the real Apollo 11 spaceship *Columbia*. Its website has photographs of *Columbia* and of Apollo spacesuits (Lesson 6.3).

6.1 MOON PHASES CALENDAR ★

OBJECTIVES

- Look at the moon on many nights and draw its shape on a calendar.
- Explain that the moon does not make its own light: it shines because the sun lights it up.
- Name four moon phases: new moon, crescent, half moon and full moon.

Warm-up. Close your eyes and think: what shape was the moon the last time you saw it? Was it round like a ball, thin like a fingernail, or something in between? Draw that shape in the air with your finger. Now look at a wall calendar together. Count the boxes in one week. Tonight we start a calendar just for the moon!

Video. Coming soon. Moon phases for children, why the moon changes shape and how to keep a moon journal: search NASA Space Place, NASA Moon (moon.nasa.gov), SciShow Kids, Homeschool Pop (Alternate), Science Max and Moody Science classics, plus time-lapse footage of the moon through one month.

KEY TERMS

moon phase

The shape of the lit-up part of the moon that we see on one night.

full moon

When we see the whole round face of the moon lit up, like a bright plate.

new moon

When the lit-up side of the moon faces away from us, so we cannot see the moon at all.

crescent

A thin, curved moon shape, like a fingernail clipping or a banana.

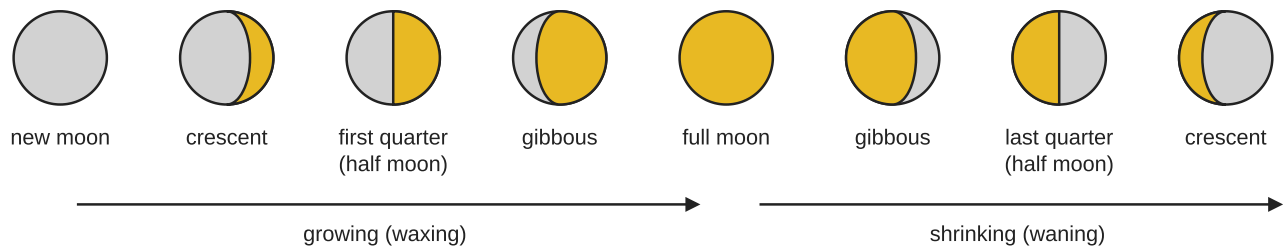
CORE IDEAS

The story. In the late fall of 1609, a teacher named Galileo Galilei lived in the city of Padua, in Italy. He had made a new telescope, a tube with glass lenses that made faraway things look bigger. One night he pointed it at the moon. He saw mountains and round holes! He took out his paper and brushes and painted what he saw. Night after night he looked again. Each night the moon had a different shape, so he painted it again.

Try it and see. You can be a moon watcher like Galileo. You do not even need a telescope. On each clear night this month, go outside with a parent and find the moon. Then draw its shape in one box of your moon calendar. If clouds hide the moon, draw a cloud. If you cannot find it at all, leave the box dark. Sometimes you will even see the moon in the daytime sky!

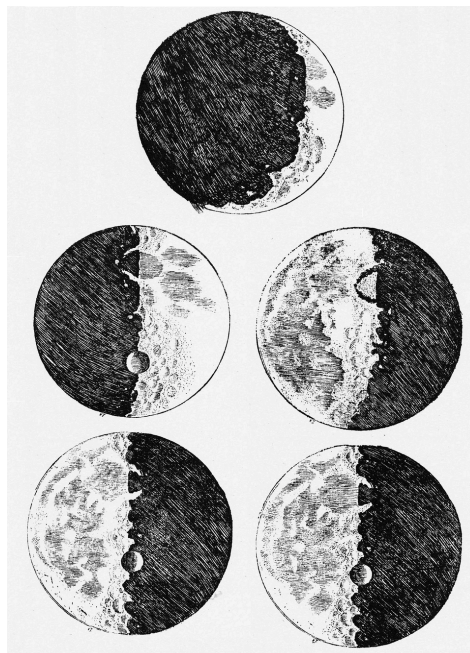
The big idea. The moon does not make its own light. The sun shines on it, and the moon reflects the light back to us, like a mirror or a white wall. One half of the moon is always lit by the sun. The moon travels all the way around the earth about once a month. As it moves, we see more or less of its sunny half. These shapes are called **moon phases**. At the **new moon** we see none of the sunny side. Then a thin **crescent** grows into a half moon, and the half moon grows into a bright, round **full moon**. Then the moon shrinks back again, night by night. In about a month it starts all over.

God's handiwork. On the fourth day of creation, God made the sun and the moon. He said they would be "for signs, and for seasons, and for days, and years" (Genesis 1:14). Long before there were paper calendars, people counted their months by the moon. Our English word *month* even comes from the word *moon*. God hung a calendar in the sky for everyone on earth to read.



The moon phases in order, as we see them from North America. The lit part grows, then shrinks.

PICTURE STUDY



Galileo's Moon Pictures from The Starry Messenger, Galileo Galilei, 1610 · Pictures printed from Galileo's drawings in his book Sidereus Nuncius (The Starry Messenger) · Museo Galileo, Florence, Italy (this copy)

These are some of the very first pictures of the moon made by a person looking through a telescope. Galileo looked through his telescope, then down at his paper, then up again, over and over, and painted the moon on many nights. In 1610 he put pictures made from his drawings into a small book called *The Starry Messenger*, so people all over Europe could see what he had found: the moon has mountains and round hollows, just like the earth has hills and valleys.

Look closely

- Count the moons. Are they all the same shape?
- Find the line where the light part meets the dark part. Is it smooth or bumpy?
- Look for tiny light spots sitting in the dark part. Galileo thought these were mountaintops catching the sunlight first, like hilltops at sunrise.
- Find a round hollow on the lit part of the moon.

Talk about it

1. Why do you think Galileo drew the moon on many different nights?
2. How is your moon calendar like Galileo's pictures?
3. What would you like to see if you could look at the moon through a telescope?

Safety first. Go outside at night only with a grown-up, and bring a flashlight so you do not trip. Sometimes the moon is up in the daytime. Look only at the moon, and never look at the sun, even for a moment.

MAKE AND DO: MY MOON PHASES CALENDAR

You will make a calendar just for the moon and fill it in for one whole month. By the end, your calendar will show the moon growing and shrinking, just like Galileo's paintings.

You will need

- A large sheet of dark blue or black paper (or a printed blank calendar page for this month)
- A ruler and a white or yellow crayon, colored pencil or gel pen
- A pencil to write the dates
- A flashlight for going outside at night

Steps

1. With a parent, use the ruler to draw a grid on the dark paper: 7 boxes across for the days of the week, and 5 rows down.
2. Write the name of the month at the top and a small number for each date in the corner of each box.
3. Each evening, go outside with a parent and look for the moon. Look east, south and west. Some nights it rises late, so it may not be up at bedtime.

4. Draw the moon's shape in that day's box with your white or yellow crayon. Color only the bright part.
5. If clouds hide the moon, draw a little cloud. If the moon is not up, leave the box dark.
6. Once a week, look at your calendar together. Is the moon getting bigger or smaller?
7. At the end of the month, find your full moon and your thinnest crescent. Circle them.

Tips

- A full moon rises in the evening, about when the sun sets. A growing moon is easy to see in the early evening. A shrinking moon rises late at night and can often be seen in the morning sky, so look out the window at breakfast too.
- Here in America, a growing moon is lit on the right side. A shrinking moon is lit on the left side.
- It is fine to miss some nights. Real scientists have cloudy nights too!

Check your work

- I drew the moon on many nights this month.
- I can point to a crescent, a half moon and a full moon on my calendar.
- I can say where the moon's light comes from.

FIELD NOTEBOOK

1. Draw the moon tonight, and draw your house or a tree under it so you remember where it was in the sky.
2. Draw the sun shining on the moon, with arrows showing the light going to the moon and bouncing to the earth.
3. Draw your favorite moon phase and write its name under it with a parent's help.

From history. Galileo was not the only one looking. In the summer of 1609, a few months before Galileo, an English scientist named Thomas Harriot pointed a telescope at the moon and made a simple drawing of a crescent moon. Harriot did not publish his drawings, so few people knew about them for a long time. Galileo printed his moon pictures in his little book *The Starry Messenger* in 1610, and it amazed readers all over Europe.

WORKED EXAMPLES

Example 1. Sam kept a moon chart for one week. Sunday: thin crescent. Monday: a little fatter crescent. Tuesday: cloud. Wednesday: half moon. Thursday: cloud. Friday: more than half. Saturday: even more. On how many nights did Sam see the moon? Was the moon growing or shrinking?

1. Point to each box with a moon in it and count: Sunday 1, Monday 2, Wednesday 3, Friday 4, Saturday 5.
2. Count the cloud boxes: Tuesday and Thursday. That is 2.
3. Check: 5 moon nights + 2 cloudy nights = 7 nights, one whole week.
4. Look at the shapes in order: crescent, fatter crescent, half, more than half, even more. The bright part got bigger each time.

Answer: Sam saw the moon on 5 nights. The moon was growing.

PRACTICE

1. **EASY** Look at the moon phases picture in this lesson. Point to the full moon. Now point to the new moon.
2. **EASY** Does the moon make its own light? Where does moonlight come from?
3. **MEDIUM** Count the moons in the moon phases picture. How many are there?
4. **MEDIUM** You watched for the moon on 7 nights. On 3 nights it was cloudy. On how many nights did you see the moon?
5. **HARD** Tell in your own words why the moon looks like it changes shape.

COMMON MISTAKES

- Thinking the moon makes its own light. The moon is a big ball of rock that reflects light from the sun.
- Thinking the moon only comes out at night. The moon is often in the sky during the day too. We just notice it more at night.
- Thinking the moon really changes shape. The moon is always a round ball. Only the part we see lit up changes.

Make it a game · Show Me the Moon. A parent calls out a moon phase: “New moon!”, “Crescent!”, “Half moon!” or “Full moon!” Make that shape with your arms. For a full moon, make a big circle over your head. For a half moon, make a half circle with one arm. For a crescent, curve one arm like a banana. For a new moon, crouch down and hide your face, because you cannot see it! Then switch and let the child call the phases.

Scripture. “He appointed the moon for seasons: the sun knoweth his going down.” (Psalm 104:19, KJV)

God set the moon in the sky to mark time for us. When you fill in your moon calendar, you are reading the calendar God made.

Practice answers

1. The full moon is the round moon that is all lit up, the fifth one in the row. The new moon is the first one, which is all dark.
2. No. Moonlight is sunlight that bounces off the moon to us.
3. 8 moons.
4. $7 - 3 = 4$ nights.
5. The sun always lights half of the moon. As the moon goes around the earth, we see more or less of that lit half, so it looks like it grows and shrinks. The moon itself is always round.

6.2 OREO MOON PHASES

OBJECTIVES

- Make the eight moon phases in order out of sandwich cookies.
- Use a lamp and a ball to show that the sun always lights half of the moon.
- Tell a growing (waxing) moon from a shrinking (waning) moon.

Warm-up. Turn on a lamp with no lampshade in a dim room. Hold an orange or a ball near it. Which side is bright? Walk all the way around the lamp, holding the ball out toward it. Does the bright side always face the lamp? (Yes! The side facing the light is always lit, just like the moon and the sun.)

Video. Coming soon. Oreo cookie moon phases activity and the lamp-and-ball model of moon phases: search NASA Space Place, NASA Moon (moon.nasa.gov), SciShow Kids, Homeschool Pop (Alternate), Science Max and Moody Science classics.

KEY TERMS

waxing

Growing. A waxing moon shows a little more light each night.

waning

Shrinking. A waning moon shows a little less light each night.

quarter moon

Another name for a half moon, when we see half of the moon's face lit up.

gibbous

A fat moon that is more than half lit but not yet full. Say it "GIB-us."

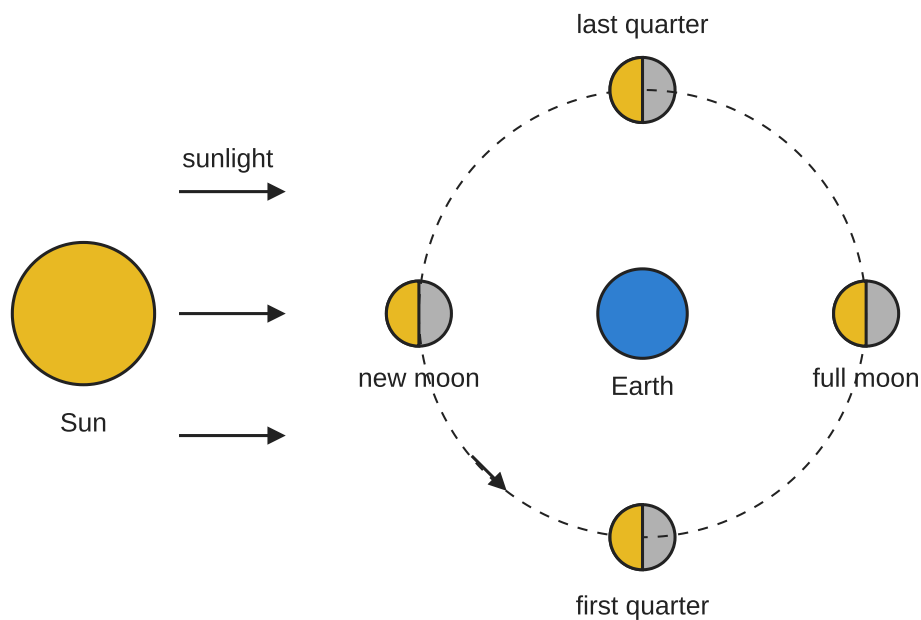
CORE IDEAS

Try it and see. Twist open a chocolate sandwich cookie. One side has the white cream and one side is bare. The white cream will be the sunny, lit-up part of the moon. The dark cookie will be the part in shadow. With a spoon or a craft stick, you can scrape away some of the cream to make any moon shape you want. Leave all the cream, and you have a full moon. Scrape it all off, and you have a new moon.

How it works. The sun is always shining on the moon, so one half of the moon is always lit. The moon goes around the earth about once a month. When the moon is between the earth and the sun, its sunny side faces away from us. That is the **new moon**. A few days later we can see a thin edge of the sunny side, a crescent. When the moon has gone a quarter of the way around, we see half of its face lit. That is why a half moon is also called a **quarter moon**. When the moon is on the far side of the earth from the sun, we see its whole sunny face. That is the full moon.

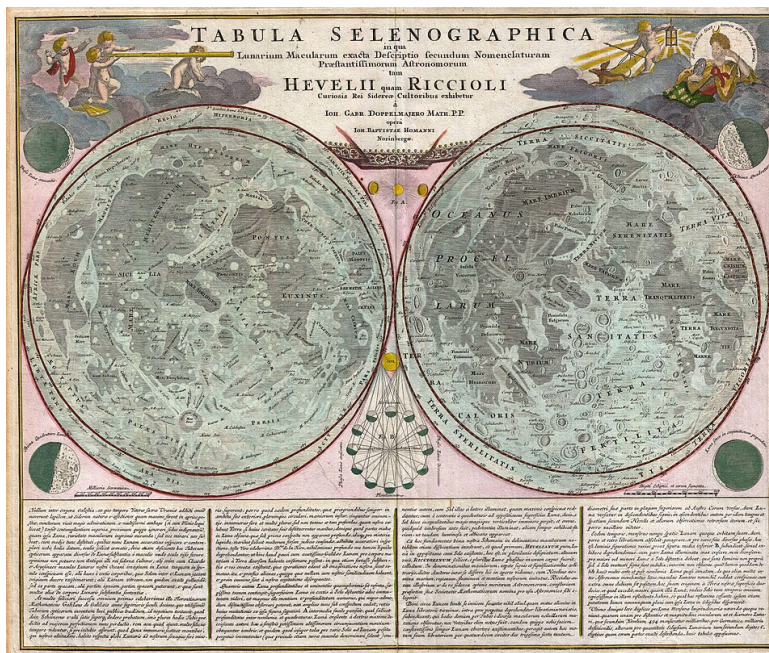
The big idea. From new moon to full moon, the moon is **waxing**, or growing. From full moon back to new moon, it is **waning**, or shrinking. Here in America, a waxing moon is lit on the right side and a waning moon is lit on the left. A fat moon that is more than half lit is called **gibbous**. Here is a trick: a moon shaped like the letter D is growing, and a moon shaped like the letter C is shrinking.

God's handiwork. The Bible calls the moon "the lesser light to rule the night" (Genesis 1:16). The moon has no light of its own, yet it brightens the night by reflecting the light of the sun. In the same way, God's people do not shine by their own light. They show the light of the Lord to others.



Looking down from far above: the sun always lights the half of the moon that faces it. Where the moon is in its path decides how much of the lit half we see from the earth.

PICTURE STUDY



Map of the Moon (Tabula Selenographica), Johann Baptist Homann and Johann Gabriel Doppelmayr, about 1707 · Hand-colored engraved map · Printed in Nuremberg, Germany, in Homann's atlas; copies are kept in many libraries and map collections

Johann Baptist Homann was a German mapmaker in the city of Nuremberg. Most of his maps showed countries and seas, but this one shows the moon! It puts two famous moon maps side by side, one made by Johannes Hevelius and one made by Giovanni Riccioli. Around the big maps, small pictures show the moon in its different phases, the same shapes you are making with your cookies.

Look closely

- Find the two big round maps of the moon. How are they alike? How are they different?
- Find the small moon pictures. Can you find a crescent, a half moon and a full moon?
- Find a small moon that is lit on the right side. Is it growing or shrinking?
- Find the dark patches on the big maps. Long ago people called them seas.

Talk about it

1. Why do you think the mapmaker put the moon phases around the maps?
2. How is this map like your cookie moons?
3. If you made a map of the moon, what would you put on it?

Safety first. Check the cookie package for allergies (these cookies have wheat and soy) and use another treat if needed. Use a spoon or craft stick to scrape, not a sharp knife. Wash hands before handling food. A bare light bulb gets hot, so do not touch it, and keep the lamp cord out of the way.

MAKE AND DO: COOKIE MOON PHASES

You will make all eight moon phases out of chocolate sandwich cookies, put them in order, and label them. Then you will use a lamp and a ball to see why the moon's shape changes. And yes, you may eat your moons at the end!

You will need

- 8 chocolate sandwich cookies with white cream (Oreos or any store brand)
- A spoon, popsicle stick or plastic spoon handle for scraping
- A paper plate or a long strip of dark paper
- A marker and 8 small sticky notes or slips of paper for labels
- A lamp with the shade taken off, and a ball, orange or styrofoam ball on a pencil

Steps

1. Twist each cookie apart. Keep the half that has the cream. (You may eat the bare halves!)
2. Full moon: leave all the cream on.
3. New moon: scrape off all the cream.
4. First quarter: scrape the cream off the left half. Leave the right half white.
5. Last quarter: scrape the cream off the right half. Leave the left half white.
6. Crescents: on one cookie, leave only a thin curved edge of cream on the right side. On another, leave a thin edge on the left side.
7. Gibbous moons: on one cookie, scrape away only a thin curved edge on the left side. On another, scrape a thin edge on the right side.
8. Lay the cookies in a row or around the plate in this order: new moon, crescent (right), first quarter, gibbous, full moon, gibbous, last quarter, crescent (left). Label each one.
9. Second session: in a dark room, a parent turns on the bare lamp. Stand a few steps away and hold the ball out at arm's length, a little above your head. You are the earth, the ball is the moon, and the lamp is the sun.
10. Start with the ball pointing toward the lamp. Turn slowly in place to your left, keeping your arm out and your eyes on the ball. Watch the lit part grow from a thin crescent, to half, to full, and back again.

Tips

- Scraping is easier if the cookies sit in the refrigerator for a few minutes first.
- Use the D and C trick: a D-shaped moon is growing, and a C-shaped moon is shrinking.
- In the lamp-and-ball game, hold the ball a little above your head so your own head does not block the light.

Check your work

- I made eight cookie moons and put them in order.
- I can point to a waxing moon and a waning moon.

- I used a lamp and a ball to show that half of the moon is always lit.

FIELD NOTEBOOK

1. Draw your eight cookie moons in a row and write the names of the phases under them with a parent's help.
2. Draw the lamp, the ball and yourself, and color the half of the ball that the lamp lights up.
3. Draw a big letter D and a big letter C. Under the D write "growing." Under the C write "shrinking."

From history. In Bible times, the people of Israel began each month with the new moon. Psalm 81:3 says, "Blow up the trumpet in the new moon." Later Jewish writings tell how watchers looked for the first thin crescent in the evening sky after the new moon and came to tell the leaders in Jerusalem, so that the new month could begin. Our English word *month* comes from the old English word for moon.

WORKED EXAMPLES

Example 1. Look at your row of eight cookie moons. How many are growing moons, lit on the right? How many are shrinking moons, lit on the left? How many are all cream or no cream? Do they add up to 8?

1. Count the growing moons, with the bright cream on the right and any bare edge on the left: the right crescent, the first quarter and the first gibbous. That is 3.
2. Count the shrinking moons, with the bright cream on the left and any bare edge on the right: the second gibbous, the last quarter and the left crescent. That is 3.
3. Count the cookies that are all cream or no cream: the full moon and the new moon. That is 2.
4. Add: $3 + 3 + 2 = 8$.

Answer: 3 growing moons lit on the right, 3 shrinking moons lit on the left, and 2 that are full or new. $3 + 3 + 2 = 8$ cookies.

PRACTICE

1. **EASY** Which cookie kept all of its white cream? Which cookie had none?
2. **EASY** Point to the sun in the sun, earth and moon picture. Now point to the full moon.
3. **MEDIUM** A pack has 12 cookies. You use 8 to make moon phases. How many cookies are left?
4. **MEDIUM** A parent shows you a cookie moon lit on the right side, then one lit on the left side. Say "growing" or "shrinking" for each.
5. **HARD** Use the lamp and the ball to show a parent a full moon. Then tell why it looked full.

COMMON MISTAKES

- Thinking the earth's shadow makes the moon phases. The phases come from how much of the moon's sunny half we can see. The earth's shadow falls on the moon only during a lunar eclipse, which happens only now and then.
- Thinking the dark part of the moon is gone. The whole round moon is still there. The dark part is just not facing the sun.
- Thinking a new moon means God makes a brand-new moon each month. It is the same moon. "New moon" is just the name for the start of the moon's monthly trip.

Make it a game · Grow or Shrink?. A parent holds up one cookie moon (or draws a moon shape on paper). If the moon is growing, stand up tall and stretch your arms wide. If it is shrinking, crouch down small. If it is full, jump and make a big circle with your arms. If it is new, close your eyes and freeze. Every right answer earns a point. At 8 points, you may eat a cookie moon!

Scripture. "And God made two great lights; the greater light to rule the day, and the lesser light to rule the night: he made the stars also." (Genesis 1:16, KJV)

The moon is the "lesser light." It shines by bouncing back the sun's light, which is why we see it in phases.

Practice answers

1. The full moon kept all its cream. The new moon had none.
2. The sun is on the left. The full moon is on the far right side of the circle, on the other side of the earth from the sun.
3. $12 - 8 = 4$ cookies.
4. Lit on the right: growing (waxing). Lit on the left: shrinking (waning).
5. Turn so your back is toward the lamp and the ball is on the far side of you from the lamp (held a little high). The whole side of the ball facing you is lit, because you are looking at the same side the lamp is shining on.

6.3 APOLLO 11 (JULY 20, 1969)

OBJECTIVES

- Retell the story of Apollo 11, when people first walked on the moon.
- Name the three astronauts and tell who stayed in the spaceship and who walked on the moon.
- Tell two ways the moon is different from the earth: it has no air to breathe, and things weigh much less there.

Warm-up. Stand up and jump as high as you can. Now pretend you are on the moon, where you would feel much lighter. Take slow, floaty bunny hops across the room, the way astronauts did. Which way of moving is easier? Which is more fun?

Video. Coming soon. Apollo 11 moon landing for children, with real NASA footage of the launch, the landing and the first steps on the moon: search NASA, the Smithsonian National Air and Space Museum, NASA Space Place, SciShow Kids, Homeschool Pop (Alternate) and historic archive footage.

KEY TERMS

astronaut

A person who is trained to travel into space.

rocket

A tall machine that pushes out hot gas very fast to blast up into space.

lunar module

The small spaceship that carried two astronauts down to the moon and back up again. Apollo 11's was named *Eagle*. *Lunar* means "of the moon."

gravity

The pull that holds us down to the ground. The moon's pull is much weaker than the earth's, so things feel much lighter there.

CORE IDEAS

The story. On July 16, 1969, a giant rocket roared up into the sky from Florida. At the top sat three American **astronauts**: Neil Armstrong, Buzz Aldrin and Michael Collins. After about three days they reached the moon. On July 20, Armstrong and Aldrin climbed into a small lander called the *Eagle*. Collins stayed behind in the main spaceship, *Columbia*, and circled the moon. The *Eagle* flew down and landed on a flat, dusty plain called the Sea of Tranquility. Armstrong radioed home: "Houston, Tranquility Base here. The Eagle has landed."

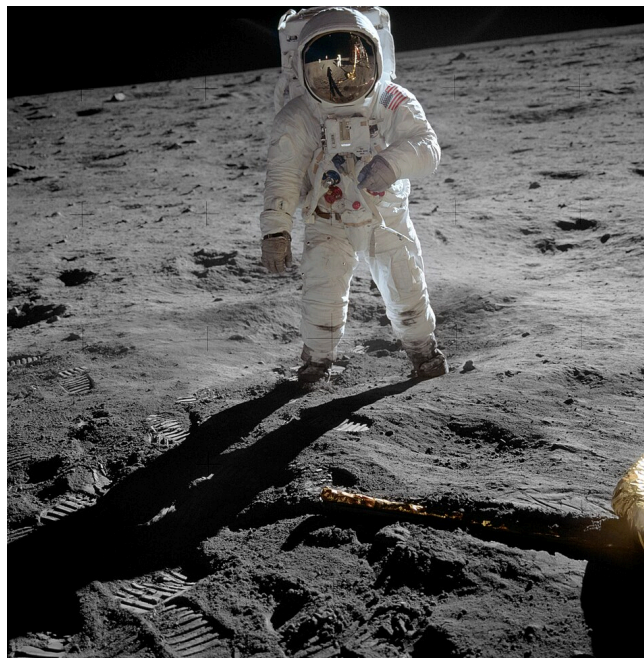
The first steps. A few hours later, Armstrong climbed down the ladder. Millions of people on earth watched on television. As he stepped onto the moon, he said, "That's one small step for

man, one giant leap for mankind.” Soon Aldrin joined him. The moon has no air, so they wore big white spacesuits with air packs on their backs. The moon’s **gravity** is weak, so they bounced and hopped like kangaroos. They picked up moon rocks and dust, set up science tools and planted an American flag. They left a sign that says, “We came in peace for all mankind.”

The big idea. On the moon there is no wind and no rain. So the astronauts’ bootprints are still there today, pressed into the gray dust. After about two and a half hours outside, Armstrong and Aldrin flew the *Eagle* back up to Collins. The three men flew home and splashed down in the Pacific Ocean on July 24. The moon rocks they brought back are still studied by scientists today.

God’s handiwork. Buzz Aldrin was a Christian. After the *Eagle* landed, before the moonwalk, he quietly took communion with bread and wine from his church. He also read words of Jesus: “I am the vine, ye are the branches” (John 15:5). Even far from home, he remembered the God who made the moon.

PICTURE STUDY



Buzz Aldrin on the Moon, Neil Armstrong (NASA photograph), July 20, 1969 · Color photograph taken with a Hasselblad camera · NASA (public domain); the original film is kept by NASA

Neil Armstrong carried the camera for most of the moonwalk, so most of the famous pictures from Apollo 11 show Buzz Aldrin. In this photograph Aldrin is standing on the Sea of Tranquility. Look closely at his shiny gold visor. It works like a mirror, and in it you can see Neil Armstrong taking the picture and the *Eagle* lander behind him.

Look closely

- Look at the sky. What color is it? (On the moon there is no air to scatter sunlight, so the sky looks black even in the daytime.)
- Find the backpack on Aldrin's back. What do you think is inside it?
- Look closely at the visor. Can you find Neil Armstrong and the lander reflected there?
- Look at the ground. Can you find any footprints in the dust?

Talk about it

1. How is the moon in this picture different from a park or a beach on earth?
2. Why did the astronauts need such big suits?
3. If you could take one picture on the moon, what would it be?

Safety first. Use child-safe scissors. A parent cuts any foil or cardboard that is hard to cut. Do the moon hops on a soft rug or grass, away from table corners.

MAKE AND DO: BUILD AN EAGLE AND LAND IT

You will build your own little *Eagle* lander and fly a pretend Apollo 11 mission, from blast-off to splashdown. Then you will be the storyteller and tell the whole trip in order.

You will need

- A paper cup or small yogurt cup
- Aluminum foil
- 4 bendy straws or pipe cleaners for legs
- Tape and child-safe scissors
- 4 small bottle caps or cardboard circles for footpads
- A gray blanket or pillow for the moon, and a blue towel for the ocean
- Play dough and a toy boot or your thumb, for footprints

Steps

1. Turn the cup upside down. Wrap it in foil. This is the body of the *Eagle*.
2. Tape 4 legs around the sides so they spread out like a spider. Tape a bottle cap to the bottom of each leg for a footpad.
3. Spread the gray blanket on the floor. This is the Sea of Tranquility.
4. Count down together from 10 to 1, and "blast off" by lifting your lander high over your head.
5. Fly it slowly around the room for three "days." Then fly it down gently to the blanket and say, "The Eagle has landed!"
6. Flatten a piece of play dough into a little moon patch. Press a footprint into it. Set it where no one will touch it, and check it tomorrow. It stays, just like the real footprints on the moon.
7. Fly the *Eagle* back up, and "splash down" on the blue towel ocean.

8. Now tell a parent the whole story in order: blast-off, the trip, the landing, the moonwalk, the trip home and the splashdown.

Tips

- If your lander tips over, spread the legs wider. A wide stance is more steady. The real *Eagle* had wide legs too.
- Let a younger brother or sister be Michael Collins, circling the room in *Columbia* while you land.

Check your work

- I built a lander with four legs.
- I can name the three astronauts.
- I can tell the story of Apollo 11 in order.

FIELD NOTEBOOK

1. Draw the *Eagle* standing on the moon, with two astronauts and the black sky above.
2. Draw your footprint, or trace your shoe, and write “Bootprints stay on the moon” under it with a parent’s help.
3. Draw the earth as the astronauts saw it from the moon: a round blue and white ball in a black sky.

From history. Seven months before Apollo 11, on Christmas Eve 1968, the astronauts of Apollo 8, Frank Borman, Jim Lovell and Bill Anders, became the first people ever to circle the moon. That night they spoke to people on earth by television from their spaceship and took turns reading the first verses of the Bible: “In the beginning God created the heaven and the earth.” Many people around the world heard them.

WORKED EXAMPLES

Example 1. Three astronauts flew to the moon on Apollo 11. Two of them walked on the moon. How many stayed in *Columbia*, circling the moon?

1. Hold up 3 fingers, one for each astronaut: Armstrong, Aldrin and Collins.
2. Fold down 2 fingers for the two who walked on the moon: Armstrong and Aldrin.
3. Count the fingers still up: 1.
4. Check: $3 - 2 = 1$. That one was Michael Collins.

Answer: 1 astronaut, Michael Collins, stayed in *Columbia*.

PRACTICE

1. **EASY** What was the name of the little lander that set down on the moon?

2. **EASY** Who was the first person to step onto the moon?
3. **MEDIUM** The *Eagle* had 4 legs. If you build 2 landers, how many legs will you need?
4. **MEDIUM** Why are the astronauts' bootprints still on the moon?
5. **HARD** A parent lays out picture cards (or says the parts out of order): splashdown, blast-off, landing, moonwalk, flying home. Put them in the right order and tell the story.

COMMON MISTAKES

- Thinking all three astronauts walked on the moon. Only Armstrong and Aldrin did. Michael Collins circled the moon in *Columbia* and waited for them.
- Thinking the moon is close, like an airplane trip. It took the astronauts about three days to fly there.
- Thinking the flag waved in a moon wind. There is no air or wind on the moon. The flag had a rod across the top to hold it out.

Make it a game • Mission Control Says. A parent is Mission Control. Mission Control calls out commands: "Blast off!" (jump up with arms high), "Moon hop!" (slow bunny hops), "Pick up a moon rock!" (squat and scoop), "Plant the flag!" (stand tall and salute), "Splashdown!" (sit down fast). Only obey if Mission Control says "Houston says" first. If you move without "Houston says," you are back on earth for one turn.

Scripture. "When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained; What is man, that thou art mindful of him? and the son of man, that thou visitest him?" (Psalm 8:3-4, KJV)

King David looked up at the moon and felt very small. God made the great moon, and yet He cares for each one of us. He even let people visit the moon He made.

Practice answers

1. The *Eagle*.
2. Neil Armstrong.
3. $4 + 4 = 8$ legs.
4. The moon has no wind and no rain to blow or wash them away.
5. Blast-off, landing, moonwalk, flying home, splashdown.

6.4 CRATERS WITH FLOUR AND PEBBLES

OBJECTIVES

- Make craters by dropping pebbles into a pan of flour, and find the crater, the rim and the rays.
- Explain that most moon craters were made when rocks from space hit the moon.
- Compare craters and tell which is bigger, using a ruler.

Warm-up. Press your fist gently into a soft pillow or a ball of play dough, then lift it away. What is left behind? A dent, or hollow! Now look at a picture of the full moon. Can you find round dents on the moon too?

Video. Coming soon. How craters form on the moon, with a flour-and-cocoa crater experiment and close-up telescope views of moon craters: search NASA, NASA Space Place, NASA Moon (moon.nasa.gov), SciShow Kids, Science Max and Homeschool Pop (Alternate).

KEY TERMS

crater

A round, bowl-shaped hole in the ground, made when something hits hard.

impact

When one thing crashes into another thing hard and fast.

rim

The raised edge around a crater, like the edge of a bowl.

rays

Bright streaks that spread out from some craters, made of dust and rock thrown out by the crash.

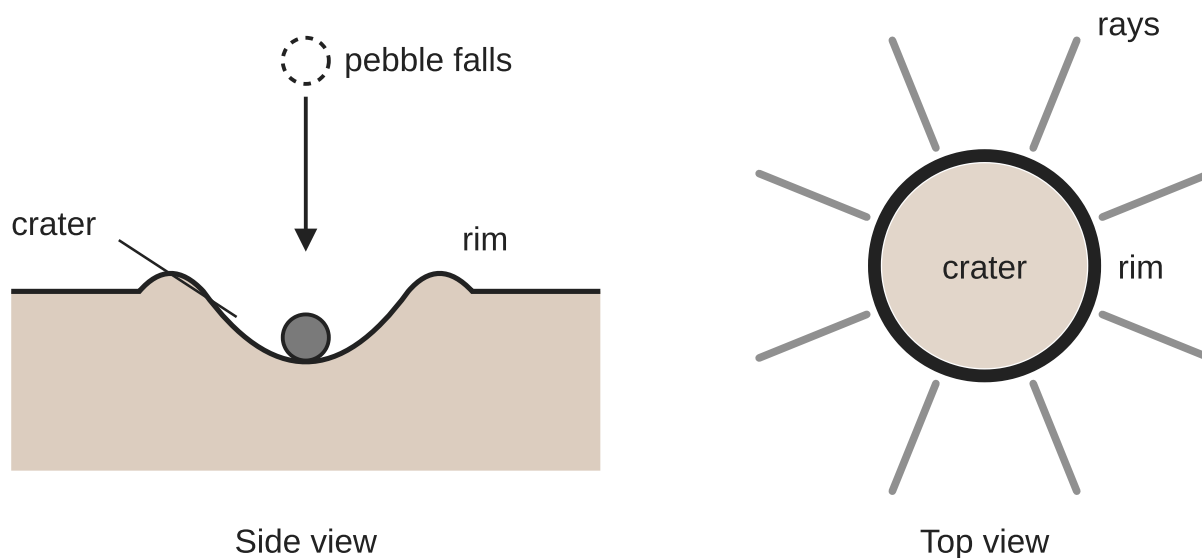
CORE IDEAS

The story. When Galileo looked at the moon with his telescope in 1609, he saw that it was not smooth. It was covered with round holes, big and small. Today we call them **craters**. With a pair of binoculars you can see some of them yourself. Near the full moon, look near the bottom of the moon's face for a bright crater called Tycho, with long white streaks shooting out from it like the spokes of a wheel.

How they figured it out. For a long time people wondered how the craters were made. Now most scientists agree that most of them were made by **impacts**. Rocks from space crashed into the moon. Each crash blasted out a round hole, pushed up a **rim** around the edge, and threw out dust and rock that sometimes made long bright **rays**. Bigger rocks and faster rocks make bigger craters.

Try it and see. You can make craters at home! Fill a pan with flour and sprinkle a thin layer of cocoa powder on top, like the moon's gray dust. Drop pebbles straight down into it. Each pebble makes a crater with a rim. White flour from underneath splashes out over the brown cocoa and makes rays, just like Tycho. Try a small pebble and a big one. Try dropping one from low and from high. Which makes the biggest crater?

God's handiwork. On the earth, rain, wind, rivers and plants slowly wear down and fill in holes in the ground. The moon has no air, no rain and no plants, so its craters stay sharp. The earth also has a blanket of air. Most small space rocks burn up in the air before they reach the ground. We see them at night as shooting stars. God wrapped our home in a blanket of air that protects us.



Side view and top view of a crater. The crash makes a bowl, pushes up a rim and throws out rays.

Thinking About Time

What the sign says. Many science books say the moon's craters were made a very, very long time ago.

What we observe. We can see many craters on the moon. We can see that the moon has no wind or rain to wear them away.

How Christians read it. Many Christians believe God made the moon on Day Four, not so very long ago. They think many craters could have been made quickly, when lots of space rocks fell in a short time.

Try it. Make five craters in your pan in one minute. Lots of craters can be made very fast!

Genesis 1:16

PICTURE STUDY



A Normal Lunar Crater (Nasmyth's Plaster Moon Model), James Nasmyth (with James Carpenter), 1874 · Woodburytype photograph of a plaster model, Plate XXI in the book *The Moon: Considered as a Planet, a World, and a Satellite* · Library of Congress, Washington, D.C. (this copy); the book was published in London in 1874

James Nasmyth was a Scottish engineer who invented a great steam hammer for factories. He also loved the moon. For many years he studied it through telescopes he built himself and drew what he saw. Then he did something clever. He made models of the moon's craters out of plaster, set them in bright, slanting sunlight, and photographed them. The pictures look so real that it is easy to mistake them for photographs of the moon itself!

Look closely

- Find the big crater. Trace its round rim with your finger.
- Find the dark shadows. Which side of the crater is in shadow? Where do you think the light is coming from?
- Look for the little mountain in the middle of the crater.
- Look at the ground around the crater. Is it smooth or rough?

Talk about it

1. How is Nasmyth's plaster model like your flour craters?
2. Why do you think he put his models in slanting light instead of light from straight above?
3. If you made a model of the moon, what would you use?

Safety first. Drop the pebbles straight down. Never throw them. Everyone else stands back from the pan. Keep small pebbles and marbles away from babies and toddlers, who

could choke on them. Do not blow on the flour or breathe in the dust. Work outside or on newspaper, and wash your hands when you are done.

MAKE AND DO: FLOUR MOON CRATERS

You will make a little moon surface in a pan and bomb it with pebbles. You will find the crater, the rim and the rays, and you will measure which pebbles make the biggest craters.

You will need

- A baking pan or a shallow box lid
- Flour, enough to fill the pan about as deep as your finger is long
- Cocoa powder (or powdered drink mix, or dry tempera paint) and a small sieve or tea strainer
- Pebbles or marbles of different sizes: one small and one big
- A ruler
- A spoon, and newspaper or an old sheet to work on

Steps

1. Lay down newspaper, or take everything outside on a calm day.
2. Pour flour into the pan and smooth the top gently with the ruler.
3. Shake a thin layer of cocoa powder through the sieve over the flour so the top is evenly brown.
4. Hold the small pebble at the height of your knees and let it drop straight down. Look at the crater. Find the rim and any white rays.
5. Hold the big pebble at the same height and drop it in a new spot. Which crater is bigger?
6. Now drop the small pebble again, but this time from as high as you can reach while standing on the floor. Is this crater bigger than the first small one?
7. Lift each pebble out gently with a spoon. Lay the ruler across each crater and measure how wide it is, rim to rim. A parent writes the numbers down.
8. Look down on your pan from above. It looks like the moon!

Tips

- Use a flashlight in a dim room and shine it from the side, low over the pan. The craters will throw shadows, just like Nasmyth's plaster models.
- If the cocoa gets too messy, scrape off the top, smooth the flour and sprinkle new cocoa. Then you can start over.

Check your work

- I made craters and can point to a crater, a rim and rays.
- I compared a big pebble and a small pebble dropped from the same height.
- I measured my craters with a ruler.

FIELD NOTEBOOK

1. Draw your crater pan from above. Label one crater, one rim and one ray.
2. Draw a side view of a crater: the ground, the bowl, the rim and the pebble in the bottom.
3. Look at the moon with binoculars (or at a moon picture) and draw three craters you can see.

From history. Many moon craters are named after scientists. In 1651 an Italian priest and astronomer named Giovanni Battista Riccioli and his friend Francesco Grimaldi made a map of the moon, and Riccioli gave names to its craters and plains. He named craters after great thinkers such as Copernicus, Tycho and Kepler. He also named the dark plains “seas,” including the Sea of Tranquility, the very place where the *Eagle* landed in 1969. Many of his names are still used today.

WORKED EXAMPLES

Example 1. Both pebbles were dropped from knee height. The small pebble made a crater 2 inches wide. The big pebble made a crater 4 inches wide. Which crater is bigger, and by how many inches?

1. Lay the ruler across the small pebble’s crater, rim to rim. It reaches the 2.
2. Lay the ruler across the big pebble’s crater, rim to rim. It reaches the 4.
3. Compare: 4 is more than 2, so the big pebble’s crater is bigger.
4. Find how much bigger: count up from 2 to 4. That is 2 more. So $4 - 2 = 2$.

Answer: The big pebble’s crater is bigger, by 2 inches. A bigger rock makes a bigger crater.

PRACTICE

1. **EASY** Look at the crater picture in this lesson. Point to the rim. Now point to the rays.
2. **EASY** What made most of the craters on the moon?
3. **MEDIUM** You dropped 3 small pebbles and 2 big pebbles into your pan, each in a new spot. How many craters did you make?
4. **MEDIUM** You dropped the same pebble twice. From your knees, it made a crater 3 inches wide. From high over your head, it made a crater 5 inches wide. Which drop made the bigger crater? How many inches bigger?
5. **HARD** If you dig a hole in your yard, rain and wind will slowly fill it in. Why do craters on the moon stay sharp?

COMMON MISTAKES

- Thinking a crater is the rock that hit. The crater is the hole. The rock that made it usually breaks apart or is blasted away in the crash.
- Thinking only a bigger rock makes a bigger crater. Speed matters too. A small rock going very fast can make a big crater.
- Thinking the dark patches on the moon are seas of water. Long ago people called them “seas,” but they are flat plains of dark rock. There is no water sloshing on the moon.

Make it a game · Big Rock, Little Rock. A parent calls out a space rock: “Little rock, falling slow!” or “Big rock, falling fast!” and so on. You crash down onto a soft pillow and then make a crater with your arms: a small circle for a little, slow rock and a giant circle for a big or fast rock. Then wiggle your fingers out from your circle to make rays. If the parent calls “Shooting star!”, the rock burns up in the air, so twinkle your fingers and do not crash at all!

Scripture. “It shall be established for ever as the moon, and as a faithful witness in heaven. Selah.” (Psalm 89:37, KJV)

The moon is steady and faithful. It keeps its craters and keeps its path around the earth, night after night, just as God set it. God’s promises are even more steady than the moon.

Practice answers

1. The rim is the raised edge around the crater. The rays are the long streaks spreading out in the top view.
2. Rocks from space crashing into the moon (impacts).
3. $3 + 2 = 5$ craters.
4. The high drop made the bigger crater, by 2 inches ($5 - 3 = 2$). A faster rock makes a bigger crater.
5. The moon has no air, no wind, no rain and no plants, so nothing wears down or fills in its craters.

UNIT 6 REVIEW

This is an oral review. A parent reads each question aloud, and the child answers in his or her own words, points, or draws. Give points for the main idea, not for exact words. The review is worth 20 points.

1. (3 pts) Does the moon make its own light? Where does moonlight come from?
2. (3 pts) Draw a full moon, a half moon and a crescent moon. Say the name of each.
3. (3 pts) In our cookie moons, what did the white cream stand for? What did the dark cookie stand for?
4. (3 pts) A parent draws a moon lit on the right side, then a moon lit on the left side. Which one is growing and which one is shrinking? Why does the moon look like it changes shape at all?
5. (3 pts) Tell the story of Apollo 11. Who were the three astronauts, and who walked on the moon?
6. (2 pts) Why are the astronauts' bootprints still on the moon today?
7. (3 pts) What made most of the craters on the moon? Point to the rim on a crater picture. Which makes a bigger crater, a small pebble or a big pebble dropped from the same height?

UNIT PROJECT: MY MOON BOOK

Make a little book about the moon. Staple or tie together a few sheets of paper, and make a cover with your best moon drawing. Inside, put your finished moon phases calendar (or a copy of it), a drawing of your eight cookie moons in order with their names, a picture of the *Eagle* on the moon with the three astronauts' names, and a drawing of your flour crater with the crater, rim and rays labeled. On the last page, a parent writes down the child's own words telling why the moon seems to change shape.

- **Observation:** The moon calendar shows the moon drawn on many nights, with clouds or dark boxes marked honestly.
- **Accuracy:** The moon phases are drawn in the right order, and the crater, rim and rays are labeled correctly.
- **Retelling:** The child can tell the Apollo 11 story in order and explain in his or her own words that the moon shines with the sun's light.
- **Care:** The book is neat and colorful, with each page clearly titled.

Answer key

1. No. Moonlight is sunlight that bounces off the moon to us.
2. Full moon: a whole round circle lit up. Half moon: half a circle lit. Crescent: a thin curved sliver, like a fingernail or banana.
3. The white cream was the sunny, lit-up part of the moon. The dark cookie was the part in shadow.

4. Lit on the right: growing (waxing). Lit on the left: shrinking (waning). The sun always lights half of the moon, and as the moon goes around the earth we see more or less of that lit half.
5. Neil Armstrong, Buzz Aldrin and Michael Collins flew a rocket to the moon. Armstrong and Aldrin landed in the *Eagle* and walked on the moon. Armstrong stepped out first. Collins stayed in *Columbia*, circling the moon. Then they all flew home and splashed down in the ocean.
6. The moon has no wind and no rain to blow or wash them away.
7. Rocks from space crashing into the moon. The rim is the raised edge around the crater. The big pebble makes the bigger crater.

FOSSIL HUNTERS

A fossil is part of a living thing, or a mark it made, kept in rock. Bones, teeth, shells, eggs and even footprints can become fossils. In this unit your child becomes a fossil hunter. They will dig slowly with a brush, press prints into clay, watch shells get buried in a jar, and hatch a pretend dinosaur egg.

Along the way they will meet real fossil hunters. Mary Anning and her brother Joseph dug a whole ichthyosaur out of the cliffs at Lyme Regis. Pliny Moody plowed up a stone with three-toed tracks, and Edward Hitchcock studied thousands more. Nicolas Steno held a “tongue stone” next to a shark’s tooth and saw that they matched. Roy Chapman Andrews drove cars across the Gobi Desert, and his team found nests of dinosaur eggs.

In every lesson we ask the fossil hunter’s question: **what does this clue tell us?** We also remember that God made the great creatures of the sea and the land “after their kind” (Genesis 1:21, 25), and that the Bible tells of a great Flood that buried many creatures in mud. When museum signs use words like “Jurassic,” the 🕒 Thinking About Time boxes help your child understand what the sign says and how Christians read the same rocks.

BEFORE YOU BEGIN

- Can count to 20 and count by twos to 12
- Has started a rock collection (Unit 1) and knows that clay is soft and can be shaped (Unit 2)
- Can sort things into two groups and tell why
- Can listen to a short story and tell it back

MASTERY CHECKLIST

- I can tell how Mary Anning and Joseph found the ichthyosaur, and why it was a sea reptile, not a fish or a dinosaur.
- I can explain that a fossil can be a bone, a shell, an egg or a print, and I can make a fossil print in clay.
- I can tell how Steno showed that tongue stones were shark teeth, and what sea shells on a mountain tell us.
- I can tell what Roy Chapman Andrews’s team found in the Gobi Desert, and why the “egg thief” was not a thief.
- I can dig, sort, count and draw fossils like a real fossil hunter.

OPTIONAL BOOKS AND RESOURCES

- **Smithsonian National Museum of Natural History** (<https://naturalhistory.si.edu/>): Free. Browse pictures of real fossils, and take a virtual tour of the fossil halls with your child. Parents may wish to preview, since signs use long ages.

- **American Museum of Natural History** (<https://www.amnh.org/>): Free to browse. The museum that sent Roy Chapman Andrews to the Gobi. Search the site for “Roy Chapman Andrews” and “dinosaur eggs” to find old photographs of the expeditions.

7.1 MARY ANNING'S ICHTHYOSAUR ★

OBJECTIVES

- Tell how Mary Anning and her brother Joseph found a whole ichthyosaur in the cliffs at Lyme Regis.
- Point to the eye, snout, paddles and tail fin of an ichthyosaur and explain that it was a sea reptile that breathed air, not a fish and not a dinosaur.
- Dig out a pretend skeleton slowly and carefully, the way a real fossil hunter does.

Warm-up. Hide a spoon, a button and a toy car in a bowl of dry rice or beans. Ask your child to find all three using only a paintbrush or two fingers, gently, without dumping the bowl. Talk about it: why would a fossil hunter need to dig slowly and gently?

Video. Coming soon. Mary Anning and the ichthyosaur for young children: search Natural History Museum (London), Lyme Regis Museum, Smithsonian, SciShow Kids, Homeschool Pop (Alternate); look for footage of ichthyosaur skeletons and the Lyme Regis cliffs.

KEY TERMS

fossil

Part of a living thing, or a mark it made, that has been kept in rock. Bones, shells, teeth and footprints can all become fossils.

ichthyosaur

A big sea reptile shaped a bit like a dolphin. Its name means “fish lizard,” but it was not a fish and not a lizard.

skeleton

All the bones of a body fitted together.

reptile

An animal with a backbone and dry scaly skin that breathes air, like a turtle, lizard or crocodile.

CORE IDEAS

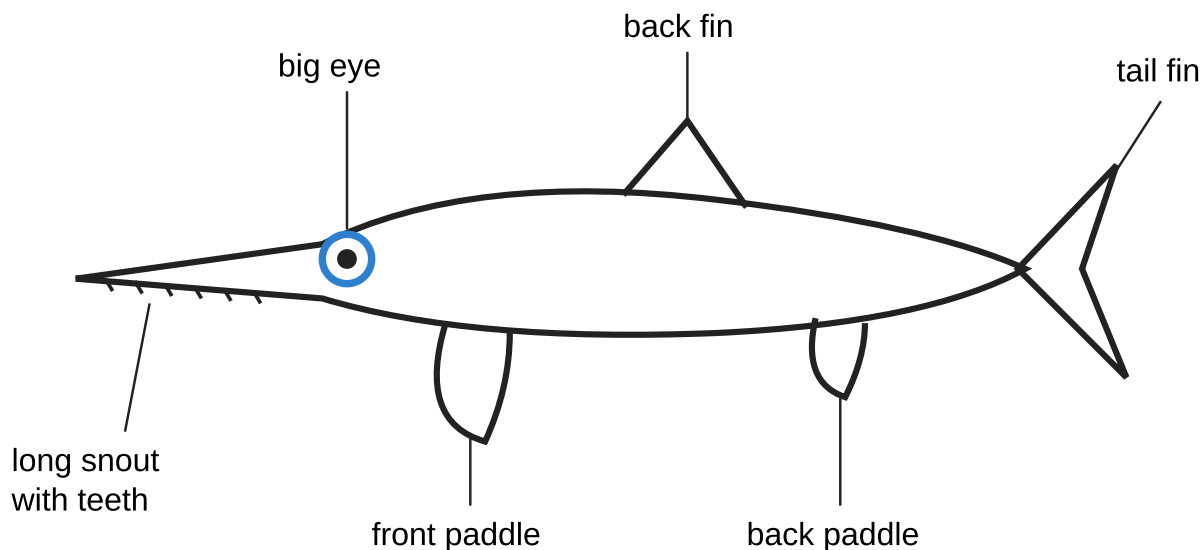
The story. Mary Anning lived in Lyme Regis, a little town by the sea in England. The cliffs there are made of soft gray rock, and storms often knock pieces onto the beach. In 1811 Mary's brother Joseph found a strange skull sticking out of the rock. It had a long, thin snout full of sharp teeth and a giant hole for an eye. Was it a crocodile? Mary kept looking. About a year later, after storms had worn away more of the cliff, she found the rest of the body. Men from the town helped her dig out the long skeleton.

How they figured it out. No one in town had ever seen an animal like it. Scientists in London studied the bones. The backbone and teeth looked like a reptile's. But it had paddles

instead of legs, and a body shaped for swimming, like a dolphin. They named it **ichthyosaur**, which means “fish lizard.” Later fossils showed that ichthyosaurs breathed air and had live babies instead of laying eggs, just as dolphins do.

The big idea. A **fossil** is part of a living thing kept in rock. The ichthyosaur died, and mud covered it before its bones could fall apart. The mud became rock, and the bones became hard as stone. Fossil hunters read these bones like clues. Big eyes tell us it could see well in the dark sea. Sharp teeth tell us it ate fish. The ichthyosaur was a sea reptile. It was not a dinosaur, because dinosaurs lived on land.

God’s handiwork. On the fifth day God made the creatures of the sea “after their kind” (Genesis 1:21). Mary Anning loved God and read her Bible. Each fossil she found showed her more of the wonderful animals He had made. When you look at an ichthyosaur, you are looking at one of God’s great sea creatures.



An ichthyosaur had a long snout, a huge eye, paddles for steering and a tail fin for speed.

Thinking About Time

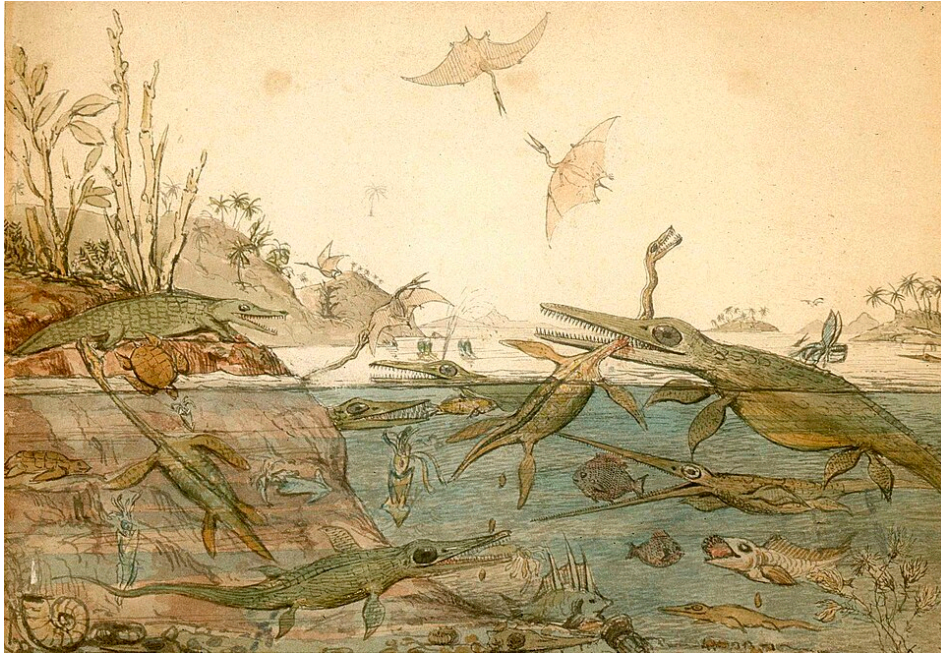
What the sign says. Museum signs say ichthyosaurs lived in the “Jurassic,” a very, very long time ago, before there were any people.

What we observe. We can see ichthyosaur bones in layers of gray rock in the cliffs. The rock was once soft mud that covered the animal quickly.

How Christians read it. Many Christians believe God made the sea creatures on the fifth day, and that many of them were buried in mud during Noah’s Flood.

Try it. Feel a piece of mud or wet clay, then a stone. Which one could cover an animal fast?

PICTURE STUDY



Duria Antiquior (A More Ancient Dorset), Henry De la Beche, 1830 · Watercolor, later printed as a lithograph
· National Museum Wales, Cardiff

Henry De la Beche was a geologist who grew up near Lyme Regis and went fossil hunting there. He knew Mary Anning well. He painted this picture to show what the sea creatures from Mary's fossils may have looked like when they were alive.

When Mary was having a hard year, he had copies of the picture printed and sold, and he gave the money to help her. It is one of the very first pictures ever made of these sea animals.

Look closely

- Find an ichthyosaur. Look for the big eye and the long, toothy snout.
- Find an animal with a very long neck. That is a plesiosaur, another sea reptile Mary found.
- Look up at the sky. What creatures are flying?
- Find the line where the water meets the air. Which animals are under the water, and which are above it?

Talk about it

1. How did the painter know what these animals looked like?
2. Which animal in the picture would you most like to find as a fossil? Why?
3. Is this a photograph or a painting? How can you tell?

Safety first. Small pasta or bones can be a choking danger, so an adult should watch young children. If you visit a beach with cliffs, stay away from the bottom of the cliffs (rocks can fall), watch the tide, and never climb.

MAKE AND DO: DIG OUT A SEA MONSTER

You will dig a buried “skeleton” out of sand, slowly and gently, just as Mary did. Then you will put the bones together on paper.

You will need

- A plastic tub or baking pan filled with sand, dry rice or cornmeal
- Dry pasta in different shapes (macaroni for backbones, penne for leg bones, a big shell for a skull), or clean dried chicken bones
- A spoon, a soft paintbrush and an old toothbrush
- A sheet of dark paper and glue
- A crayon or white chalk

Steps

1. A parent lays the pasta “bones” in the tub in the shape of an ichthyosaur: a big shell for the head, a long line of macaroni for the backbone, and small pieces for four paddles. Then the parent covers them with sand.
2. Look at the top of the sand. Do you see any bone peeking out, like Joseph’s skull in the cliff?
3. Dig with the spoon only near the top. When you touch a bone, switch to the paintbrush and brush the sand away gently.
4. Do not pull bones out right away. First uncover them all and look at how they lie.
5. Lift each bone out and lay it on the dark paper in the same place it lay in the sand.
6. Glue the bones down. Draw a big eye, a tail fin and a back fin with chalk or crayon.
7. Count the paddles and the bones in the backbone. Tell your family the story of Mary and Joseph’s find.

Tips

- Fossil hunters go slowly. A broken bone is a lost clue.
- Take turns: one person digs while the other is the “museum scientist” who lays out the bones.

Check your work

- I dug slowly with a brush.
- My skeleton has a head, a backbone, four paddles and a tail.
- I can tell who found the ichthyosaur and where.

FIELD NOTEBOOK

1. Draw an ichthyosaur. Label the big eye, the snout, the paddles and the tail fin.
2. Draw Mary Anning on the beach below the cliffs with her basket and hammer.
3. Draw a dolphin next to your ichthyosaur. Circle one way they look alike.

From history. Mary Anning kept hunting fossils all her life. She later found the first nearly whole plesiosaur, a long-necked sea reptile, and the first flying reptile found in Britain. Scientists came from far away to visit her little shop in Lyme Regis. Her ichthyosaur can still be seen today in the Natural History Museum in London.

WORKED EXAMPLES

Example 1. Look at the ichthyosaur picture. How many paddles can you see? How many paddles did a whole ichthyosaur have?

(Use the map or drawing “Count the paddles you can see, then think about the side you cannot see.” shown earlier in this lesson.)

1. Point to each paddle in the picture and count: a front paddle and a back paddle. That is 2.
2. The picture shows only one side of the animal. The other side has the same paddles: 2 more.
3. Put them together: $2 + 2 = 4$.

Answer: We can see 2 paddles. A whole ichthyosaur had 4 paddles, 2 on each side.

PRACTICE

1. **EASY** Who found the ichthyosaur skull first, and who found the rest of the body?
2. **EASY** Point to the ichthyosaur’s eye in the picture. Was it small or very big?
3. **MEDIUM** Sort these into two piles, “lived in the sea” and “lived on land”: ichthyosaur, dolphin, horse, fish, cow.
4. **MEDIUM** Draw an ichthyosaur’s teeth. What do sharp, pointy teeth tell us it ate?
5. **HARD** Tell in your own words: why was the ichthyosaur not a fish?

COMMON MISTAKES

- Thinking the ichthyosaur was a dinosaur. It was a sea reptile. Dinosaurs lived on land.
- Thinking the ichthyosaur was a fish because of its name and shape. It breathed air, like a dolphin or a whale.
- Thinking a fossil bone is soft like a fresh bone. Fossil bones are hard and heavy like stone.

Make it a game · Sea or Land? A parent names an animal: ichthyosaur, whale, dog, shark, dinosaur, octopus, cat. If it lives in the sea, the child swims with arms like paddles. If it lives on land, the child stomps like a dinosaur. Each right move earns a point. Play to ten points.

Scripture. “And God created great whales, and every living creature that moveth, which the waters brought forth abundantly, after their kind, and every winged fowl after his kind: and God saw that it was good.” (Genesis 1:21, KJV)

God filled the seas with living creatures, great and small. The ichthyosaur was one of them, and God saw that it was good.

Practice answers

1. Mary’s brother Joseph found the skull. Mary found the rest of the body.
2. Very big.
3. Sea: ichthyosaur, dolphin, fish. Land: horse, cow.
4. Sharp, pointy teeth tell us it caught and ate other animals, such as fish.
5. It breathed air and was a reptile. Fish breathe water through gills. (It also had live babies, like a dolphin.)

7.2 MAKE A FOSSIL PRINT IN CLAY

OBJECTIVES

- Explain that a fossil print forms when something presses into soft mud, the mud is covered, and it hardens into rock.
- Make clay prints of shells, leaves and toy feet, and match each print to the thing that made it.

Warm-up. Press your thumb into a ball of play dough or a lump of bread dough. Take your thumb away. What is left behind? Now press a fork, a coin and a button. Can someone else guess which print came from which thing?

Video. Coming soon. How fossil prints, molds and dinosaur tracks form, for young children: search Smithsonian, USGS, Dinosaur State Park (Connecticut), SciShow Kids, Homeschool Pop (Alternate); look for footage of real dinosaur trackways and kids making clay or plaster fossils.

KEY TERMS

print

The shape left behind when something presses into something soft, like a boot print in mud.

track

A footprint left by an animal. A row of tracks is called a trackway.

mold

A hollow shape in rock or clay left by a shell, leaf or bone.

cast

A copy made when something fills up a mold and hardens.

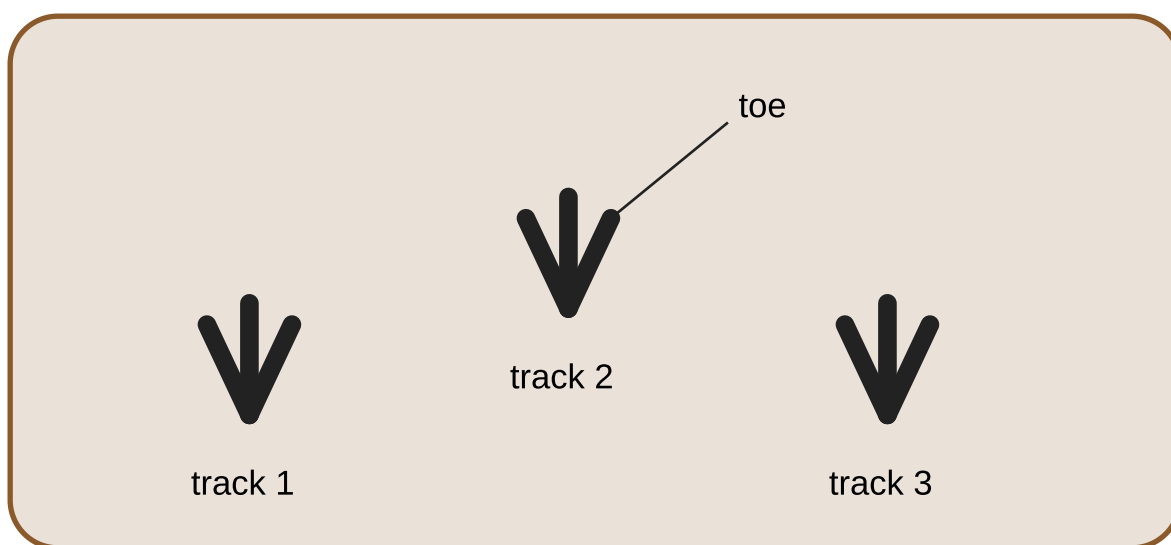
CORE IDEAS

The story. In 1802, in South Hadley, Massachusetts, a young farmer named Pliny Moody was plowing his family's field. His plow turned up a flat stone. On it were footprints with three long toes, like a giant bird's. People in town joked that they were the tracks of Noah's raven! For a while the stone was even used as a doorstep, and people walked right over it.

How they figured it out. Later a preacher and scientist named Edward Hitchcock began to collect stones like this one from along the Connecticut River. He gathered thousands of tracks. He measured them, drew them and lined them up in rows. He thought giant birds had made them. Today most scientists think three-toed dinosaurs made many of them. A footprint is a clue: the number of toes, the size and the space between steps tell us about the animal that walked there.

The big idea. Not every fossil is a bone. Some fossils are **prints**. A foot, a shell or a leaf presses into soft mud and leaves its shape. If the mud dries in the sun, or gets covered quickly by more mud or sand, the print can last. The mud slowly hardens into rock, and the print hardens with it. The hollow shape is called a **mold**. If sand or minerals fill the mold and harden, they make a **cast**, a copy of the thing itself.

Try it and see. Clay is a lot like soft mud. When you press a shell into clay and let it dry, you are making a fossil print the same way. Then you can be a fossil hunter: look at a print and guess what made it. God made a world where even a footprint can tell a story. “Speak to the earth, and it shall teach thee” (Job 12:8).



stone slab (once soft mud)

A trackway: three-toed footprints pressed into mud that hardened into stone.

Thinking About Time

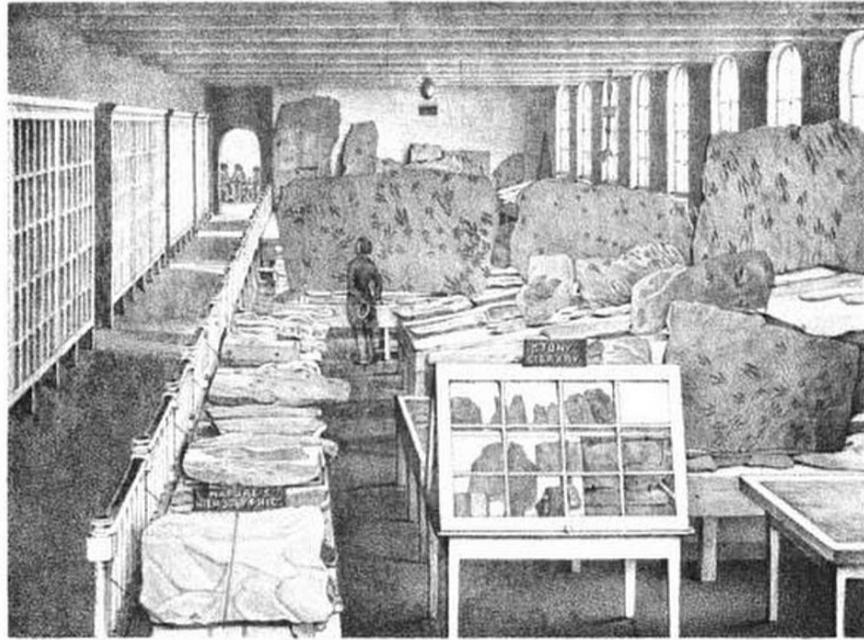
What the sign says. Some books say fossil prints were made very, very slowly, long before people lived.

What we observe. A print in wet mud washes away fast unless it dries or gets covered quickly. We find many tracks kept sharp and clear in rock.

How Christians read it. Many Christians think lots of tracks were made as animals walked on fresh mud during the time of Noah’s Flood and were covered quickly.

Try it. Make a print in wet sand at the beach or sandbox. Pour a cup of water over it. What happens?

PICTURE STUDY



Hitchcock's Ichnological Cabinet (from Ichnology of New England), Edward Hitchcock (lithograph plate in his book), 1858 · Lithograph plate in a printed book (Plate 4, Figure 1) · Published in Boston; many of Hitchcock's track stones are still at Amherst College's Beneski Museum of Natural History

Edward Hitchcock spent many years collecting stones with footprints from the Connecticut River valley. He brought them to Amherst College and set them up in a long room so that students and visitors could walk among them and study them.

This picture of the room was printed in his big book about tracks. Look how many stones there are! Hitchcock called his collection a “stony library,” because each slab was like a page that told a story.

Look closely

- Find the big stone slabs standing up. Can you see the little three-toed footprints on them?
- Find the person standing in the room. Is the person bigger or smaller than the biggest slab?
- Find the sign on the glass case. What do you think “Stony Library” means?
- Count the arched windows you can see.

Talk about it

1. Why do you think Hitchcock thought birds made these tracks?
2. What can a footprint tell us about an animal? What can it not tell us?
3. If you had a room full of fossil prints, how would you set them out so people could study them?

Safety first. If a parent makes a plaster cast, the parent mixes the plaster: do not breathe the dust, and keep hands out of plaster while it sets, because it gets warm. Wash hands after handling clay.

MAKE AND DO: MY CLAY FOSSIL PRINTS

You will make fossil prints in clay, let them harden, and then play “fossil detective” to match each print to what made it.

You will need

- Air-dry clay, salt dough or modeling clay
- A rolling pin or a smooth jar
- Things to press: seashells, a leaf with strong veins, a pine cone, a small bone, toy dinosaur feet
- A plastic knife and a paper plate for each print
- Optional, for a parent: plaster of Paris and a strip of cardboard to make a cast

Steps

1. Make a ball of clay about the size of your fist. Flatten it with the rolling pin until it is as thick as your finger.
2. Choose one thing and press it firmly into the clay. Lift it straight up so the print stays sharp.
3. Make four or five prints, each on its own piece of clay.
4. Set them on paper plates to dry. Air-dry clay takes a day or two. Salt dough can be baked by a parent in a low oven.
5. Hide the things you pressed in a bag. Mix up the prints. Can your family match each print to the thing that made it?
6. Optional: a parent wraps a cardboard strip around one print to make a wall, pours in plaster, and lets it set. Peel off the clay. Now you have a cast: a copy of the shell!
7. Line up your prints and give each one a label card.

Tips

- Things with bumps and lines, like ridged shells and leaves, make the best prints.
- Press straight down and lift straight up, so the print does not smear.

Check your work

- I made at least four clear prints.
- I can match each print to what made it.
- I can tell how a print in mud becomes a fossil.

FIELD NOTEBOOK

1. Trace around your hand. Next to it, draw a three-toed dinosaur footprint. Which has more toes?
2. Draw your best clay print and label it with what made it.
3. Draw three steps: a shell pressed in mud, mud covering it, and a hard rock with the print inside.

From history. Edward Hitchcock was a pastor before he became a professor and president of Amherst College. He also wrote a book about how the study of rocks and the Bible fit together. His huge collection of fossil tracks is still kept at Amherst College in Massachusetts, where visitors can walk past walls of stone footprints.

WORKED EXAMPLES

Example 1. Look at the trackway picture. How many footprints are there? How many toes does each footprint have?

(Use the map or drawing “Count the footprints, then count the toes on one footprint.” shown earlier in this lesson.)

1. Touch each footprint and count: 1, 2, 3. There are 3 footprints.
2. Look at one footprint. Touch each toe: 1, 2, 3. It has 3 toes.
3. Check the other footprints. Each one also has 3 toes.

Answer: There are 3 footprints, and each footprint has 3 toes.

PRACTICE

1. **EASY** Is every fossil a bone? Name one fossil that is not a bone.
2. **EASY** What did Pliny Moody find while plowing his field?
3. **MEDIUM** Count the toes on your own foot. Then count the toes on the three-toed track. Which has more? How many more?
4. **MEDIUM** Match: a hollow shape left by a shell is a _____. A copy made by filling that shape is a _____.
5. **HARD** Tell why a footprint in mud needs to be covered or dried quickly to become a fossil.

COMMON MISTAKES

- Thinking only bones can be fossils. Prints, tracks, shells and leaves can be fossils too.
- Thinking a footprint shows what the whole animal looked like. A track tells us about its feet and steps, not its color or shape.
- Thinking any print in mud will last. Most are washed away unless they dry or are covered quickly.

Make it a game · Whose Track Is It?. Press a few things into play dough while your child hides their eyes: a fork, a toy car wheel, a finger, a shell. Your child looks at each print and guesses what made it. A right guess earns a point. Then switch, and the child makes prints for the parent to guess.

Scripture. “Or speak to the earth, and it shall teach thee: and the fishes of the sea shall declare unto thee.” (Job 12:8, KJV)

The earth can teach us if we look closely. A footprint in stone is a small lesson from God’s world.

Practice answers

1. No. A footprint (track) is a fossil that is not a bone. A leaf print or shell print is another.
2. A flat stone with three-toed footprints on it.
3. Your foot has 5 toes; the track has 3. Your foot has 2 more.
4. Mold; cast.
5. If it stays wet and open, rain, water and other feet wash it away or smear it. Drying or quick covering keeps the shape until the mud hardens into rock.

7.3 SHELLS FAR FROM THE SEA

OBJECTIVES

- Tell how Nicolas Steno showed that “tongue stones” found in rocks were really shark teeth.
- Explain that sea shells in rocks on hills and mountains show that water once covered that land.
- Make layers in a jar and see how shells get buried in mud and sand.

Warm-up. Put a few seashells (or pasta shells) in a bowl. Ask: where do shells like these come from? Then show a map or globe and point to a place far from any ocean, such as the middle of your country. If you found sea shells in a rock there, how could they have gotten there?

Video. Coming soon. Fossil sea shells found on mountains and inland, and Nicolas Steno’s tongue stones, for young children: search Smithsonian, USGS, Institute for Creation Research SciShow Kids and Homeschool Pop (Alternate); look for footage of fossil shells in limestone and shark teeth fossils.

KEY TERMS

shell

The hard outside covering that keeps a soft sea animal, like a clam or snail, safe.

layer

One flat sheet of mud, sand or rock lying on top of another, like the layers in a cake.

limestone

A rock that often has sea shells in it. Many buildings and gravel paths are made of it.

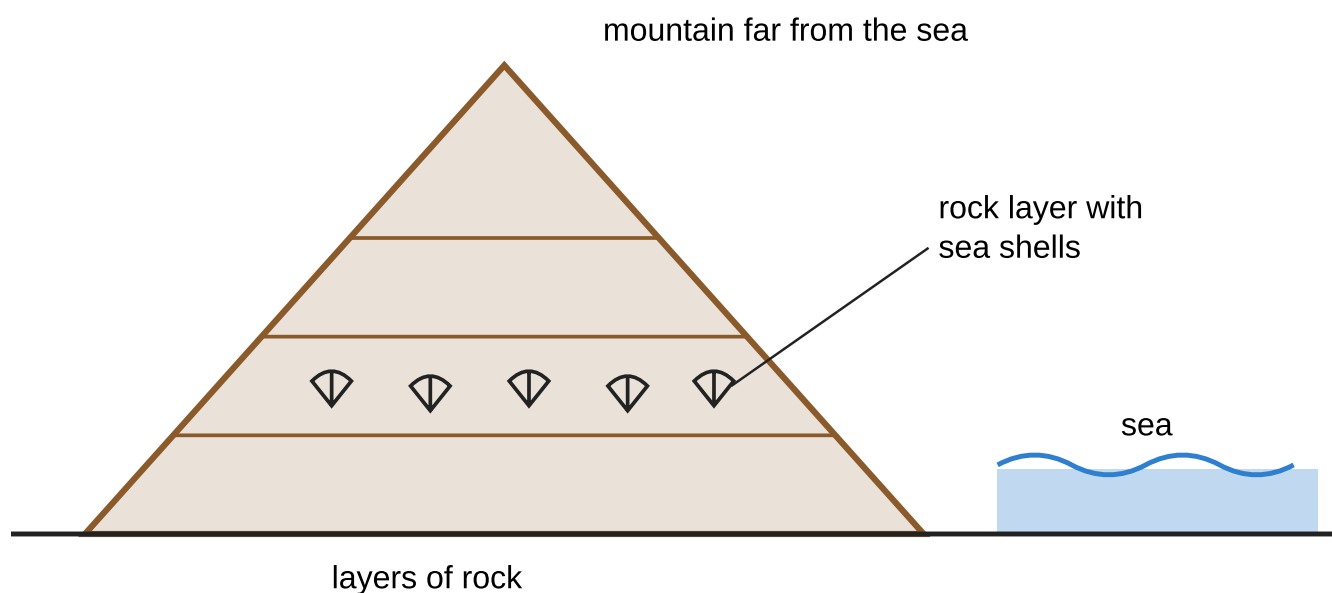
CORE IDEAS

The story. In 1666 fishermen in Italy caught a giant shark. Its head was sent to a young scientist in Florence named Nicolas Steno. Steno looked inside the shark’s mouth and saw rows and rows of pointed, triangle-shaped teeth. They reminded him of something. People in those days found little stones shaped just like that in rocks on hills, far from the sea. They called them “tongue stones” and thought they grew inside the rock.

How they figured it out. Steno held a tongue stone next to a shark tooth. They matched! The tongue stones were not stones that grew in rock. They were real shark teeth that had been buried in mud long ago, and the mud had turned to rock. So a shark had once swum where that hill now stands. Steno began to ask more questions about how mud and sand settle in water and pile up in **layers**. He became one of the first great rock scientists.

The big idea. Fossil hunters find sea shells, shark teeth and other sea creatures in rocks all over the world, far from the sea. They find them in deserts, on farms and on hillsides. Near the top of Mount Everest, the highest mountain on earth, the rock holds fossils of sea animals. Sea creatures do not crawl up mountains! Shells in high rock tell us that water once covered that land, and mud buried the shells.

God's handiwork. The Bible tells of a great Flood in the days of Noah, when "all the high hills, that were under the whole heaven, were covered" (Genesis 7:19). Many Christians think that is how so many sea shells ended up buried in rock layers far from the sea. Next time you see a rock wall or a gravel path, look closely. You may find a shell that once lived in the sea.



Sea shells in a rock layer high on a mountain, far from the sea.

Thinking About Time

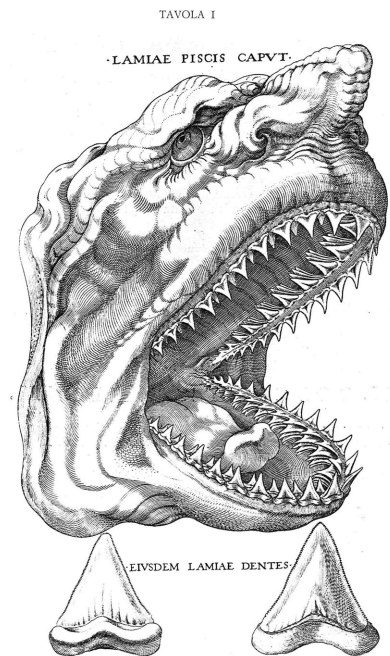
What the sign says. Some museum signs say the sea came and went over the land many times, over a very, very long time.

What we observe. We find sea shells and shark teeth in rock layers on hills and mountains, far from any sea today.

How Christians read it. Many Christians believe the water of Noah's Flood covered the whole earth, even the mountains, and buried sea creatures in mud that became rock.

Try it. Stack a few books flat. Which book went down first? In rock layers, the bottom layer was laid down first too.

PICTURE STUDY



Head of a Shark, with Its Teeth, Engraving printed in Nicolas Steno's book about the shark, 1667 · Engraving · Printed in Florence in Steno's book on muscles and the shark's head

This picture was printed with Steno's report about the shark head. It shows the shark's open mouth full of teeth, and single teeth drawn by themselves.

People could hold a tongue stone up to this picture and see for themselves that it was the same shape as a shark tooth.

Look closely

- Find the shark's eye and its open mouth.
- Look at the rows of teeth. Are there just a few, or many?
- Find the teeth drawn by themselves. What shape are they?
- Is this picture in color, or made only with lines?

Talk about it

1. How did comparing a shark tooth and a tongue stone help Steno solve the puzzle?
2. Why is a drawing helpful when you want other people to check your idea?

Safety first. Use a plastic jar, not glass, and an adult should tighten the lid well. Wipe up spills so no one slips.

MAKE AND DO: SHELLS IN A JAR

You will make a little “flood” in a jar and watch mud and sand bury shells in layers.

You will need

- A clear plastic jar with a tight lid (a peanut butter jar works well)
- Small gravel or pebbles, sand and garden soil (a handful of each)
- A few small shells (or pasta shells)
- Water
- Crayons and paper

Steps

1. Put the gravel, sand, soil and shells in the jar.
2. Fill the jar almost to the top with water. A parent tightens the lid.
3. Shake the jar hard while you count to ten. Watch the muddy water swirl.
4. Set the jar on a table and do not touch it. Watch for a few minutes. What falls to the bottom first?
5. Leave it until the next day. Look at the side of the jar. How many layers can you see?
6. Look for your shells. Are any of them buried under sand or mud?
7. Draw the jar and color each layer. Draw the shells where you see them.

Tips

- Heavy pebbles usually sink first and fine mud settles last, on top.
- Bonus walk: look at a limestone wall, gravel path or stone step. Can you find any fossil shells?

Check your work

- I saw the jar make layers.
- I found where my shells ended up.
- I can tell how sea shells get buried in rock layers.

FIELD NOTEBOOK

1. Draw a shark tooth and a tongue stone side by side. Write “They match!”
2. Draw a mountain with a layer of shells inside it, and the sea far away.
3. Draw your shells-in-a-jar layers and label the bottom layer and the top layer.

From history. Long before Steno, the painter Leonardo da Vinci also noticed sea shells in the mountains of Italy. He wrote in his notebooks that they had once been living sea animals, not stones that grew in the rock. Steno later became a priest and a bishop, and he gave the rest of his life to serving God and caring for the poor.

WORKED EXAMPLES

Example 1. On a walk along a gravel path, Ana found 4 shell fossils, 2 shark teeth and 1 sea lily stem. Which did she find the most of? How many fossils did she find in all?

1. Line up the numbers: shells 4, shark teeth 2, sea lily stem 1.
2. Find the biggest number: 4 is bigger than 2 and bigger than 1. So shells are the most.
3. Count them all: start at 4, count on 2 more (5, 6), then 1 more (7).

Answer: Ana found the most shell fossils. She found 7 fossils in all.

PRACTICE

1. **EASY** What were “tongue stones” really?
2. **EASY** Point to the shell layer in the mountain picture. Is it near the sea or far from it?
3. **MEDIUM** Sort these into “lives in the sea” and “lives on land”: clam, shark, rabbit, sea snail, robin, crab.
4. **MEDIUM** Draw three layers in a cake or a jar. Point to the layer that was put down first.
5. **HARD** Tell in your own words: if you find a sea shell inside a rock on a hill, what does that tell you?

COMMON MISTAKES

- Thinking fossil shells grew inside the rock. They were once real living animals.
- Thinking sea animals walked or crawled up to the mountains. Water and mud carried and buried them.
- Thinking the top layer of rock was laid down first. The bottom layer was put down first.

Make it a game • Tongue Stone Detective. Lay out pairs of things that match, such as two buttons, two spoons, two shells and two coins, mixed up on a tray. The child closes their eyes while the parent hides one of each pair under a towel. The child picks one thing from the tray, then feels under the towel to find its match, just as Steno matched a tongue stone to a shark tooth. One point for each match.

Scripture. “And the waters prevailed exceedingly upon the earth; and all the high hills, that were under the whole heaven, were covered.” (Genesis 7:19, KJV)

The Flood covered even the high hills. Sea shells high in the rocks remind us of this true story.

Practice answers

1. Shark teeth that had turned into fossils in rock.
2. Far from the sea, up in the mountain.

3. Sea: clam, shark, sea snail, crab. Land: rabbit, robin.
4. The bottom layer was put down first.
5. Water once covered that place, and mud or sand buried the shell before it turned to rock.

7.4 DINOSAUR EGGS IN THE GOBI DESERT

OBJECTIVES

- Tell how Roy Chapman Andrews and his team found nests of dinosaur eggs in the Gobi Desert in 1923.
- Explain that dinosaurs laid eggs in nests, and that fossil hunters sometimes change their minds when they find new clues.
- Count eggs in a nest picture by twos.

Warm-up. Hold a chicken egg (raw or hard-boiled) gently in your hand. Feel the shell. Is it smooth or bumpy? Heavy or light? Now ask: what other animals lay eggs? Name as many as you can in one minute.

Video. Coming soon. Roy Chapman Andrews, the Flaming Cliffs of the Gobi Desert and fossil dinosaur eggs and nests, for young children: search American Museum of Natural History, Smithsonian, SciShow Kids, Homeschool Pop (Alternate); look for old expedition film of cars and camels and footage of fossil egg nests.

KEY TERMS

desert

A very dry place with little rain, where few plants grow.

expedition

A long trip made by a team to explore and find out new things.

nest

A place an animal makes to lay its eggs and keep them safe.

egg

A shell with a baby animal growing inside. Birds, turtles and dinosaurs lay eggs.

CORE IDEAS

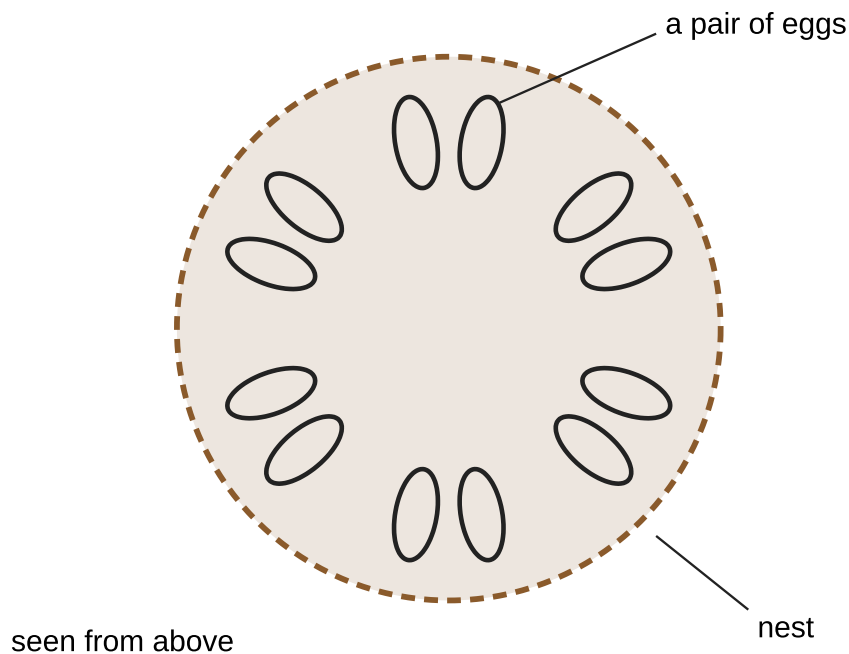
The story. Roy Chapman Andrews was an explorer from the American Museum of Natural History in New York. He led a team into the Gobi Desert in Mongolia, a wide, dry, windy land in Asia. They drove cars across the sand and gravel. Long lines of camels walked ahead with gasoline and food for the trip. In 1923, at red cliffs Andrews called the Flaming Cliffs, a team member named George Olsen found something amazing: a nest of fossil dinosaur eggs!

How they figured it out. The eggs were long and oval, with bumpy shells, and they lay in groups, like eggs in a nest. Near one nest the team found the skeleton of a small dinosaur with a toothless beak. The scientists thought it had been caught stealing eggs, so they named it **Oviraptor**, which means “egg thief.” Many years later, fossil hunters found a tiny baby of a close cousin of this dinosaur still curled up inside an egg just like these. Others

found another close cousin sitting right on top of its nest, with its arms spread over the eggs like a mother hen. The “egg thief” was really a parent keeping its eggs safe!

The big idea. The eggs in these nests had hard shells, like bird eggs. Some made nests and set their eggs in pairs in a ring. Fossil eggs can tell us how big a dinosaur baby was and how its parents cared for it. And when new clues are found, good scientists are willing to change their minds.

God’s handiwork. God made the land animals on the sixth day “after their kind” (Genesis 1:25). He gave each one a way to care for its young. A dinosaur sitting on its nest reminds us that God made His creatures with care, and gave them care for one another.



Some dinosaurs set their eggs in pairs in a ring, like this nest seen from above.

Thinking About Time

What the sign says. Museum signs say these dinosaurs lived in the “Cretaceous,” a very, very long time ago, before people.

What we observe. We find whole nests of eggs, and even dinosaurs sitting on their nests, buried in sandstone. Something buried them fast, before they could get up and run.

How Christians read it. Many Christians believe God made dinosaurs with the other land animals, and that these nests were buried quickly by sand around the time of Noah’s Flood.

Try it. Bury a toy in a pan of sand with one big scoop. Could it have run away in time?

Genesis 1:25

PICTURE STUDY



A Caravan in the Gobi Desert, Photograph from Roy Chapman Andrews's Central Asiatic Expeditions, 1922–1924 (printed in *Natural History* magazine, 1924) · Black-and-white photograph · Printed in *Natural History*, the magazine of the American Museum of Natural History, New York

Roy Chapman Andrews took cameras on his trips so the whole world could see the Gobi Desert. This photograph shows part of the camel caravan that traveled with the team. The man in the white sun helmet is Henry Fairfield Osborn, the president of the museum, who came to visit the expedition. He is greeting a Mongol camel rider.

Cars were still new in those days, and there were no gas stations in the desert. So camels carried the gasoline, food and tents for the trip.

Look closely

- Count the humps on one camel. How many does it have?
- Find the big bundles on the camels' backs. What do you think is inside them?
- Find the rider sitting on a camel. What is he wearing on his head?
- Look at the ground. Do you see trees and grass, or open, dry land?

Talk about it

1. Why do you think the team needed both cars and camels?
2. What would you pack for a fossil-hunting trip in the desert?

Safety first. Keep vinegar away from eyes, and wear old clothes. Small toys can be a choking danger for little brothers and sisters, so put them away after the activity.

MAKE AND DO: HATCH A DINOSAUR EGG

You will hide a toy dinosaur inside a pretend egg, then “hatch” it with fizzing vinegar, like a baby dinosaur breaking out of its shell.

You will need

- One box of baking soda (about 2 cups)
- A few spoonfuls of water
- Two or three small toy dinosaurs
- Food coloring (optional)
- A baking pan or tray
- White vinegar in a cup, and a spoon or squeeze bottle

Steps

1. In a bowl, mix the baking soda with a little water, one spoonful at a time, until it sticks together like wet sand. Add a drop of food coloring if you like.
2. Press a handful of the mix around a toy dinosaur and shape it into a long, oval egg. Make sure the toy is covered.
3. Make two eggs and set them side by side in the pan, like a pair in a dinosaur nest.
4. Put the pan in the freezer for an hour (or let the eggs sit until firm).
5. Spoon or squeeze vinegar over an egg. Listen to it fizz! Keep going until the baby dinosaur hatches out.
6. Count how many spoonfuls of vinegar it took to hatch each egg. Which egg hatched first?

Tips

- If the mix is too crumbly, add a few drops of water. If it is too runny, add more baking soda.
- The eggs found in the Gobi nests had hard shells, like a chicken egg.

Check your work

- I made two eggs and set them as a pair.
- I hatched a dinosaur and counted the spoonfuls.
- I can tell what the team found at the Flaming Cliffs.

FIELD NOTEBOOK

1. Draw a dinosaur nest from above with eggs in pairs around a ring.
2. Draw the expedition: cars, camels and the red Flaming Cliffs.
3. Draw a dinosaur sitting on its nest. Write “Not a thief!”

From history. When Roy Chapman Andrews was a young man, he went to the American Museum of Natural History and asked for a job. There were no openings, so he offered to

scrub the floors, and the museum let him. He worked hard, learned all he could, and years later he led the Gobi expeditions and became the director of the whole museum.

WORKED EXAMPLES

Example 1. Look at the nest picture. The eggs are in pairs. Count the eggs by twos. How many eggs are in the nest?

(Use the map or drawing “Count the eggs by twos, going around the ring.” shown earlier in this lesson.)

1. Find one pair of eggs at the top of the nest.
2. Go around the ring, touching one pair at a time and counting by twos: 2, 4, 6, 8, 10, 12.
3. You touched 6 pairs, and you ended at 12.

Answer: There are 12 eggs in the nest (6 pairs).

PRACTICE

1. **EASY** In what desert did Roy Chapman Andrews’s team find dinosaur eggs?
2. **EASY** What two kinds of helpers carried the team across the desert?
3. **MEDIUM** Sort these into “lays eggs” and “has live babies”: chicken, dinosaur, turtle, dog, ichthyosaur, cow.
4. **MEDIUM** Count by twos: a nest has 4 pairs of eggs. How many eggs is that?
5. **HARD** Oviraptor means “egg thief.” Tell why that name turned out to be a mistake.

COMMON MISTAKES

- Thinking the Gobi dinosaur eggs were soft or squishy. They had hard shells, like bird eggs.
- Thinking all dinosaur eggs were huge. Many were about the size of a big potato or smaller, because baby dinosaurs started out small.
- Thinking scientists are never wrong. Scientists make the best guess they can and change their minds when they find new clues, as with the “egg thief.”

Make it a game • Guard the Nest. Make a nest of pillows and put a few socks rolled up like eggs inside, in pairs. The child is the parent dinosaur sitting on the nest. The other players tiptoe close and try to take an egg. If the parent dinosaur taps them first, they must go back to start. When the game is over, count the eggs left by twos.

Scripture. “Behold now behemoth, which I made with thee; he eateth grass as an ox.” (Job 40:15, KJV)

God told Job to look at a great beast He had made. Some Christians think behemoth may have been a big dinosaur, and others think it was an elephant or a hippo. Either way, God

made it, and He made all the great creatures of the land.

Practice answers

1. The Gobi Desert, in Mongolia.
2. Cars and camels.
3. Lays eggs: chicken, dinosaur, turtle. Has live babies: dog, ichthyosaur, cow.
4. 2, 4, 6, 8. That is 8 eggs.
5. Later fossil hunters found a baby of a close cousin of that dinosaur inside an egg just like these, and found another close cousin sitting on its nest. It was caring for its own eggs, not stealing them.

UNIT 7 REVIEW

Read each question aloud and let your child answer in their own words, pointing or drawing where it helps. Give full points for a clear answer with the main idea. The review is worth 20 points.

1. (3 pts) Tell me the story of how Mary Anning and her brother Joseph found the ichthyosaur.
2. (3 pts) Was the ichthyosaur a fish, a dinosaur or a sea reptile? How do you know?
3. (3 pts) Show me with your hand and some clay (or tell me) how a footprint can become a fossil.
4. (3 pts) Name three things that can become fossils besides bones.
5. (3 pts) What were “tongue stones,” and how did Steno find out?
6. (3 pts) If we find sea shells in a rock on a hill, what does that tell us?
7. (2 pts) What did Roy Chapman Andrews’s team find at the Flaming Cliffs in the Gobi Desert? Why was the “egg thief” really not a thief?

UNIT PROJECT: MY FOSSIL MUSEUM

Set up a small fossil museum on a shelf or table. Include your clay fossil prints, your dug-out sea monster skeleton, your shells-in-a-jar, and a hatched dinosaur egg. Give each item a label card with its name and one fact. Then invite your family to the museum and be the guide: tell the story of Mary Anning, Steno or Roy Chapman Andrews, and let visitors play “whose print is it?”

- **Fossils:** The museum has at least four items, including at least two clear clay fossil prints.
- **Labels:** Each item has a label card with its name and one true fact (a parent may write what the child says).
- **Telling:** The child tells one fossil hunter’s story clearly in their own words and explains what one fossil teaches us.
- **Care:** Items are set out neatly and handled gently, like a real museum.

Answer key

1. In the cliffs at Lyme Regis by the sea, Joseph found a skull with a long snout and a big eye hole. About a year later Mary found the rest of the body, and men from town helped dig it out.
2. A sea reptile. It breathed air and had reptile bones and teeth; it lived in the sea, not on land like dinosaurs.
3. A foot presses into soft mud and leaves a print. The mud dries or is covered quickly, then hardens into rock with the print in it.
4. Any three: footprints (tracks), shells, leaves, teeth, eggs.
5. They were fossil shark teeth. Steno looked at the teeth in a real shark’s head and saw that they matched the tongue stones.

6. Water once covered that land, and mud buried the shells before it turned to rock. Many Christians think of Noah's Flood.
7. Nests of fossil dinosaur eggs. Later fossils showed close cousins of that dinosaur sitting on their own nests, and a baby of the same family inside an egg like these, so it was caring for its eggs, not stealing them.

WEATHER WATCHERS

Every morning the weather is waiting for you outside the door. Is it hot or cold? Wet or dry? Sunny, cloudy or snowy? In this unit you will learn to watch the weather the way real scientists do: with a **thermometer**, a sharp eye and a notebook. You will meet Daniel Gabriel Fahrenheit, who made thermometers that agreed with each other, and you will build a bottle thermometer of your own. You will learn to dress for every kind of weather and find out a surprise: a coat does not make heat, *you* do!

Then you will travel to a snowy farm in Vermont, where Wilson “Snowflake” Bentley took the first photograph of a single snowflake in 1885, and you will count the six arms that almost every snowflake has. Last of all, you will keep a whole month of weather on a chart, just as Thomas Jefferson and George Washington kept weather notes, and you will count your sunny, cloudy, rainy and snowy days on a picture graph. All through the unit you will remember that God “giveth snow like wool” (Psalm 147:16) and promised that “cold and heat, and summer and winter” shall not cease (Genesis 8:22).

BEFORE YOU BEGIN

- Can count objects to 20 and count on from a number
- Knows the cloud names cumulus, stratus and cirrus (Unit 4)
- Has made or used a rain gauge (Lesson 4.3)
- Knows that water can freeze into ice and melt back into water

MASTERY CHECKLIST

- I can tell what a thermometer measures and show that the liquid goes up when it is warm and down when it is cold.
- I can say which of two thermometers shows the warmer place.
- I can choose clothes for hot, cold, rainy and windy days and tell that clothes hold in my body heat.
- I can tell the story of Wilson Bentley and show that a snowflake has six arms.
- I can keep a weather chart with symbols and read a picture graph of my month.

OPTIONAL BOOKS AND RESOURCES

- **NOAA SciJinks** (<https://scijinks.gov/>): Free. Weather pages, pictures and games from NOAA and NASA, written for students. Parents can find simple read-aloud explanations of temperature, snow and weather.
- **National Weather Service** (<https://www.weather.gov/>): Free. Type in your town to see today’s weather and the temperature. Compare it with your own thermometer and weather chart.

8.1 A THERMOMETER ★

OBJECTIVES

- Tell what a thermometer measures and how the liquid inside moves up when it is warm and down when it is cold.
- Read a simple thermometer by looking at how high the liquid goes and say which of two places is warmer.
- Make a bottle thermometer and watch it rise and fall.

Warm-up. Fill three bowls: one with cold water and ice, one with warm tap water, and one with water in between. Put one hand in the cold bowl and one hand in the warm bowl and count slowly to twenty. Now put both hands in the middle bowl. Does the water feel the same to both hands? (It feels warm to the cold hand and cool to the warm hand!) Our hands can be fooled, so scientists use a tool that is never fooled: a thermometer.

Video. Coming soon. How a thermometer works for kids (liquid rising and falling, reading the lines, hot and cold); search NOAA SciJinks, SciShow Kids, Homeschool Pop (Alternate), Science Max and Crash Course Kids.

KEY TERMS

thermometer

A tool that measures how hot or cold something is.

temperature

How hot or how cold something is.

degree

One small step on a thermometer. We count degrees to tell the temperature.

freezing

Cold enough for water to turn into ice.

CORE IDEAS

The story. Long ago, people could feel hot and cold, but they could not measure it. One person's "warm" was another person's "cool." Around 1714, an instrument maker named Daniel Gabriel Fahrenheit, who worked in Holland, made a thermometer with a shiny silver liquid metal called mercury inside. His thermometers were made so carefully that they agreed with each other. Two people far apart could read the same number on a day that was just as warm. In America we still use his Fahrenheit numbers today.

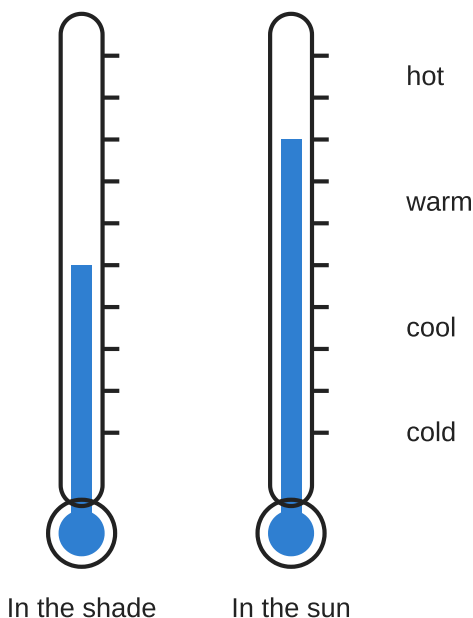
How they figured it out. Look closely at a thermometer. It has a thin tube with a little round bulb at the bottom. Inside is a colored liquid. Most thermometers today use red liquid, not mercury, because mercury is not safe. When the liquid gets warm, it spreads out and needs more room. The only place it can go is up the thin tube, so it climbs. When the liquid

gets cold, it shrinks and slides back down. The little lines on the side are **degrees**. They help us count how far the liquid went.

The big idea. A thermometer measures **temperature**: how hot or cold something is. Higher liquid means warmer. Lower liquid means colder. There is a special line on a thermometer where water turns to ice. That is **freezing**. If the liquid is below that line, puddles can freeze and snow can stay on the ground.

Try it and see. Put one thermometer in the sunshine and one in the shade. Wait a little while. Which liquid climbed higher? The one in the sun is warmer. Weather watchers put their thermometers in the shade, so the sun does not shine right on them. That way they measure the air, not the sunshine.

God's handiwork. After the Flood, God promised Noah that "cold and heat" and "summer and winter" would not stop (Genesis 8:22). Every time you read a thermometer, you are watching that faithful promise: warm days and cold days, coming and going just as God said.



Higher liquid means warmer. Count the marks to see how high each one went.

PICTURE STUDY



Snap the Whip, Winslow Homer, 1872 · Oil on canvas · Butler Institute of American Art, Youngstown, Ohio (a smaller version is at the Metropolitan Museum of Art, New York)

Winslow Homer was an American painter who loved to paint people outdoors. Here he shows a group of schoolboys playing a game called Snap the Whip. They hold hands and run in a line. The boy at the front stops and swings the line around, and the boys at the end go flying!

Homer did not paint a thermometer, but he painted many clues about the weather. Look for them like a weather watcher.

Look closely

- Find the boys with bare feet. Would you go barefoot on a cold day?
- Look at the boys' clothes. Do you see any heavy coats, hats or mittens?
- Look at the grass and the trees. Are they green or bare?
- Find the shadows on the ground. What do shadows tell you about the sun?

Talk about it

1. Is this a warm day or a cold day? Which clues tell you?
2. If we put a thermometer in this field, would the liquid be high or low?
3. What game would you play on a day like this?

Safety first. Use a thermometer filled with red or blue liquid, or a digital one. Never use an old thermometer with silver liquid inside, because that is mercury. If a glass thermometer breaks, step away and call a grown-up. A grown-up should run the hot tap water. Never look straight at the sun.

MAKE AND DO: MAKE A BOTTLE THERMOMETER

You will build a thermometer of your own from a bottle and a straw. Then you will warm it and cool it and watch the water climb and fall, just like the liquid in a real thermometer.

You will need

- A small clear plastic bottle (a little water bottle works well)
- Cold water and a few drops of food coloring
- A clear drinking straw
- A lump of modeling clay or play dough
- A marker
- Two bowls: one with hot tap water (a grown-up fills it) and one with ice water
- A real thermometer, if you have one

Steps

1. Fill the bottle all the way to the top with cold water. Add two drops of food coloring and swirl.
2. Push the straw into the bottle so the bottom of the straw is in the water but not touching the bottom of the bottle.
3. Press clay around the straw to seal the top of the bottle tight. Some colored water should climb a little way up the straw. If it does not, add a few more drops of water down the straw.
4. Mark the water line on the straw with the marker. This is your starting line.
5. Set the bottle in the bowl of hot tap water. Watch the straw for a few minutes. Does the water climb above your line?
6. Now set the bottle in the bowl of ice water. Watch again. Does the water slide back down?
7. If you have a real thermometer, dip it in each bowl too. Point to the liquid. Is it high or low?

Tips

- A thin straw and a small bottle make the water move more. Be patient: it climbs slowly.
- A grown-up may add a spoonful of rubbing alcohol to the water to make it climb faster. Rubbing alcohol is not for drinking, so a grown-up handles it.

Check your work

- I can show that the water climbs when the bottle is warm.
- I can show that the water slides down when the bottle is cold.
- I can tell how my bottle thermometer is like a real one.

FIELD NOTEBOOK

1. Draw a thermometer. Color the liquid high and write “warm.” Draw another one with the liquid low and write “cold.”
2. Draw your bottle thermometer and color the line where the water was before and after the hot bowl.
3. Put a thermometer outside in the shade in the morning and again after lunch. Draw both. Which was higher?

From history. Before Fahrenheit, the Italian scientist Galileo Galilei played with a glass tube of air and water that moved up and down as the air warmed and cooled. It showed warmer and cooler, but it had no numbers. Later, in 1742, Anders Celsius of Sweden made a different set of numbers with 100 steps between freezing water and boiling water. Most of the world uses Celsius today, and scientists everywhere use it too. Many thermometers in America show both kinds of numbers, Fahrenheit on one side and Celsius on the other.

WORKED EXAMPLES

Example 1. Look at the two thermometers in the picture. One was in the shade. One was in the sun. Which place was warmer? How many marks higher did its liquid go?

(Use the map or drawing “Count the marks from the bottom up.” shown earlier in this lesson.)

1. Find the top of the liquid in the shade thermometer. Count the marks from the bottom up to it: 1, 2, 3, 4, 5. It reaches the 5th mark.
2. Find the top of the liquid in the sun thermometer. Count: 1, 2, 3, 4, 5, 6, 7, 8. It reaches the 8th mark.
3. Higher liquid means warmer. 8 is more than 5, so the sun was warmer.
4. Count up from 5 to 8: 6, 7, 8. That is 3 more marks.

Answer: The sun was warmer. Its liquid went 3 marks higher (8 marks compared with 5 marks).

PRACTICE

1. **EASY** What does a thermometer measure?
2. **EASY** Point up or point down: When a thermometer gets warm, which way does the liquid go? When it gets cold?
3. **MEDIUM** A thermometer in a cup of ice water reaches 2 marks. A thermometer in a cup of warm water reaches 9 marks. Which cup is warmer? How many more marks is that?
4. **MEDIUM** Sort these by where the liquid would be, high or low: a snowy morning, a beach in summer, a cup of hot cocoa, an ice cube tray.

5. **HARD** Tell in your own words why weather watchers put their thermometers in the shade.

COMMON MISTAKES

- Thinking your hand can tell the exact temperature. Hands can be fooled (the warm-up showed it); a thermometer is never fooled that way.
- Thinking the liquid is pushed up by the sun or by a little motor. The liquid climbs by itself because it spreads out when it gets warm.
- Thinking a thermometer in the sun tells the temperature of the air. The sun warms the thermometer itself, so air temperature is measured in the shade.

Make it a game • I Am the Thermometer. You are the liquid in a thermometer. Crouch down low like a little ball. A parent calls out a place or a thing: “an ice cube,” “a hot bath,” “a snowman,” “a sunny beach,” “a cool cellar.” If it is hot, stretch up tall on your tiptoes. If it is cold, shrink down low. If it is in between, stand halfway. Then trade places and let the parent be the thermometer.

Scripture. “While the earth remaineth, seedtime and harvest, and cold and heat, and summer and winter, and day and night shall not cease.” (Genesis 8:22, KJV)

God promised that cold and heat would keep coming in their turn. A thermometer lets us watch His promise kept, day after day.

Practice answers

1. Temperature: how hot or cold something is.
2. Warm: the liquid goes up. Cold: the liquid goes down.
3. The warm water cup. 9 is 7 more than 2, so it is 7 marks higher.
4. High: a beach in summer, a cup of hot cocoa. Low: a snowy morning, an ice cube tray.
5. So the sun does not shine right on the thermometer and make it read too warm. In the shade it measures the temperature of the air.

8.2 DRESS FOR THE WEATHER

OBJECTIVES

- Choose the right clothes for hot, cold, rainy and windy weather and tell why.
- Explain that clothes do not make heat; they hold in the warmth our bodies make.
- Test whether a mitten makes heat, using a thermometer.

Warm-up. Look out the window, or step outside for one minute. Is it hot, warm, cool or cold? Is it dry, rainy, snowy or windy? Now open the closet and pick out one thing you would wear outside today. Tell why you picked it.

Video. Coming soon. Dressing for the weather and how layers and wool keep us warm, for young children; search NOAA SciJinks, SciShow Kids, Homeschool Pop (Alternate), Science Max and nature footage of traditional Arctic fur clothing.

KEY TERMS

weather

What the air outside is like right now: hot or cold, wet or dry, still or windy.

body heat

The warmth your own body makes all the time.

layers

Clothes worn one on top of another, like a shirt, a sweater and a coat.

waterproof

Made so that water cannot soak through.

CORE IDEAS

The story. Far in the cold North, around the Arctic, live the Inuit people. Winter there is long, dark and very cold. Long ago, Inuit women sewed winter clothes from the skins of caribou, a kind of reindeer. A winter parka often had two layers. The inside layer had the soft fur turned in, toward the body. The outside layer had the fur turned out, toward the snow. Boots were made of sealskin, which keeps water out. Families could travel and hunt on the ice in clothes like these.

How they figured it out. Here is a surprise: a coat does not make any heat at all. *You* make the heat! Your body makes warmth all the time. That is **body heat**. Fur, wool and fluffy coats are full of tiny pockets of air. The air gets caught and stays still, and it holds your warmth close to you so it cannot slip away into the cold. The Inuit parka had two layers of fur, so it held lots of still air.

The big idea. We dress for the **weather**. On a cold day, wear **layers**: a shirt, a sweater, a coat, plus a hat and mittens. Mittens keep fingers warmer than gloves, because the fingers

stay together and share their heat. On a rainy day, wear something **waterproof**, like a raincoat and rubber boots. Wet clothes make you cold fast. On a windy day, a jacket stops the wind from blowing your warmth away. On a hot, sunny day, wear light, loose clothes and a hat that shades your face. Light colors stay cooler in the sun than dark colors.

Try it and see. Wrap a thermometer in a mitten for a while. Does it get warmer? No! The mitten has no heat to give. Now put your hand inside the mitten. Your hand stays toasty, because the mitten holds in the heat your hand makes.

God's handiwork. God gave sheep thick wool and caribou warm fur. He also gave people the wisdom to make clothes and to choose the right ones for each day. The Bible says, "He giveth snow like wool" (Psalm 147:16).

PICTURE STUDY



The Hunters in the Snow, Pieter Bruegel the Elder, 1565 · Oil on wood panel · Kunsthistorisches Museum, Vienna, Austria

Pieter Bruegel was a painter in the Low Countries, the land we now call Belgium and the Netherlands. He painted a set of pictures about the times of the year. This one shows a cold winter day. Hunters are coming home through the snow, and down below, whole families are out on the ice.

Look at how every person in the picture is dressed for the cold.

Look closely

- Find the three hunters. What are they wearing on their heads and bodies?
- Find the fire near the inn on the left. Who is standing near it, and why?
- Look down at the frozen ponds. Can you find people skating and playing?

- Find the trees. Do they have leaves? What sits in the branches?

Talk about it

1. Is this a hot day or a cold day? How can you tell?
2. If you stepped into this picture, what clothes would you want to put on?
3. Would a thermometer in this picture be high or low? Is it below the freezing line? How do you know?

Safety first. On very cold days, come inside if fingers, toes, ears or noses hurt, turn pale or feel numb, and warm them slowly. Take off wet clothes and put on dry ones. On hot days, drink water and rest in the shade. If you hear thunder, go indoors.

MAKE AND DO: DRESS THE WEATHER DOLL AND THE MITTEN TEST

First you will make a paper doll and a set of paper clothes for every kind of weather. Then you will do a real test to find out whether a mitten makes heat.

You will need

- Cardstock or a cereal box panel for the doll
- Paper, crayons and child-safe scissors
- A thermometer
- A wool mitten or a thick sock
- A timer or clock

Steps

1. Draw a simple person on the cardstock, about as tall as your hand, and cut it out. This is your weather doll.
2. On paper, draw and cut out clothes for your doll: a sun hat, shorts, a T-shirt, a raincoat, rain boots, a sweater, a winter coat, a warm hat and mittens.
3. A parent calls out a weather: “hot and sunny,” “rainy,” “windy and cool,” or “snowy and cold.” Dress the doll for it and tell why you chose each piece.
4. Now the mitten test. Read the thermometer and remember where the liquid is.
5. Ask: if we put the thermometer inside a mitten, will it get warmer? Say your guess.
6. Slide the thermometer into the mitten and lay it on the table. Wait for 15 minutes.
7. Take it out and read it right away. Did the liquid climb? (It stays about the same, because the mitten does not make heat.)
8. Put your own hand in the mitten for a few minutes. Does your hand feel warm? Tell who made that warmth.

Tips

- Keep the clothes in an envelope so you can play the dress-up game all week.

- Some children are sure the mitten will warm the thermometer. That is a fine guess. Scientists test their guesses, and it is good to find out you were surprised.

Check your work

- I can dress my doll for hot, rainy, windy and cold weather.
- I can tell why a raincoat helps on a rainy day.
- I can tell that a mitten does not make heat; it holds in the heat my body makes.

FIELD NOTEBOOK

1. Draw yourself dressed for today's weather. Write or tell what the weather is.
2. Draw an Inuit parka with two layers of fur: fur turned in, and fur turned out.
3. Draw the mitten test: the thermometer before and after. Was the liquid the same?

From history. In 1823, a Scottish chemist named Charles Macintosh found a way to make cloth that rain could not soak through. He spread a layer of rubber between two layers of cloth. Coats made from it kept people dry in the wet Scottish weather, and to this day many people in Britain call a raincoat a “mac” or a “mackintosh.”

WORKED EXAMPLES

Example 1. On a snowy morning, Ben puts on an undershirt, a sweater and a winter coat. On a hot afternoon he wears only a T-shirt. How many layers does Ben wear on his body on the snowy morning? How many more is that than on the hot afternoon?

1. Count the snowy-morning layers: undershirt (1), sweater (2), coat (3).
2. Count the hot-afternoon layers: T-shirt (1).
3. Compare: 3 is more than 1. Count up from 1 to 3: 2, 3. That is 2 more.

Answer: Ben wears 3 layers on the snowy morning, which is 2 more than the 1 layer he wears on the hot afternoon. Cold days need more layers to hold in body heat.

PRACTICE

1. **EASY** Match the weather to the clothes: rainy, snowy, hot and sunny. Clothes: sun hat, raincoat, mittens.
2. **EASY** Does a coat make heat? Where does the warmth come from?
3. **MEDIUM** Sort these into two piles, “for a cold day” and “for a hot day”: wool hat, shorts, scarf, sandals, mittens, sun hat, boots, T-shirt.
4. **MEDIUM** Five children go sledding. Each child needs 2 mittens. Count by twos: how many mittens do they need in all?
5. **HARD** Tell why mittens keep your hands warmer than gloves.

COMMON MISTAKES

- Thinking a coat or blanket makes heat. Clothes make no heat; they trap still air that holds in the heat your body makes.
- Thinking dark clothes are best on a hot, sunny day. Dark colors soak up more sunshine and get warmer; light colors stay cooler.
- Thinking cold air gives you a cold. Colds come from germs, not from cold air. Still, staying warm and dry on a cold day is wise and keeps you comfortable and safe.

Make it a game · Weather Closet Relay. Pile up real clothes at one end of the room: a raincoat, a sun hat, mittens, a scarf, boots, sunglasses and a sweater. A parent calls out a weather, such as “Rain is pouring!” or “It is snowing and windy!” Run to the pile, grab one thing that fits that weather, put it on, and run back. Tell why you chose it to score a point. Play until the pile is gone.

Scripture. “He giveth snow like wool: he scattereth the hoarfrost like ashes.” (Psalm 147:16, KJV)

God sends the snow, and He also gave us wool and the wisdom to make warm clothes. Hoarfrost is the white frost that covers grass and windows on a cold morning.

Practice answers

1. Rainy: raincoat. Snowy: mittens. Hot and sunny: sun hat.
2. No. The warmth comes from your own body. The coat holds it in.
3. Cold day: wool hat, scarf, mittens, boots. Hot day: shorts, sandals, sun hat, T-shirt. (4 in each pile.)
4. 2, 4, 6, 8, 10. They need 10 mittens.
5. In a mitten, your fingers stay together and share their warmth. In a glove, each finger is alone, so more heat slips away.

8.3 SNOWFLAKES (WILSON BENTLEY, 1885)

OBJECTIVES

- Tell the story of Wilson Bentley, the farmer who took the first photograph of a single snowflake in 1885.
- Explain that a snowflake is made of ice crystals that grow in a cloud and that snowflakes have six sides or six arms.
- Catch and look at snowflakes, or make a six-armed paper snowflake.

Warm-up. Find a photograph of a real snowflake in a book, or look at the Bentley snowflakes in today’s picture study. Count the arms with your finger. How many did you count? Hold up that many fingers. Keep that number in mind, because it is the secret of every snowflake.

Video. Coming soon. Wilson “Snowflake” Bentley and how snowflakes form with six arms, for young children; search NOAA SciJinks, Smithsonian, SciShow Kids, Homeschool Pop (Alternate), and slow-motion or microscope nature footage of snow crystals growing.

KEY TERMS

snowflake

A tiny piece of ice that grows in a cloud and falls to the ground as snow.

crystal

A solid with a neat, repeating shape, like ice in a snowflake.

microscope

A tool that makes very small things look big so we can see them.

six-sided

Having six sides or six arms, like almost every snowflake.

CORE IDEAS

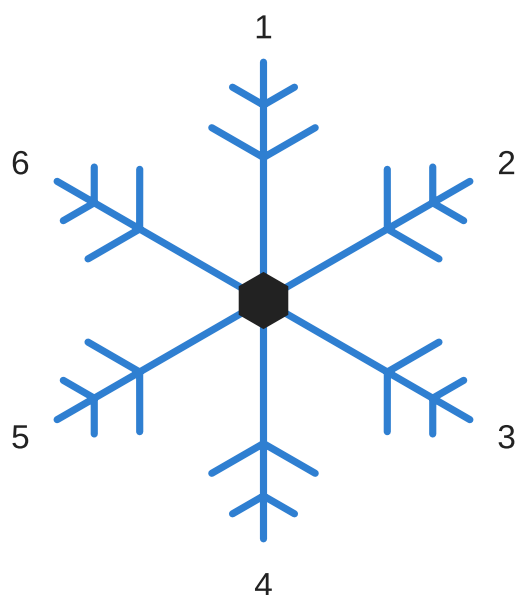
The story. Wilson Bentley grew up on a farm in Jericho, Vermont, where the winters are long and snowy. When he was a boy, his mother gave him a microscope. He looked at many tiny things, but he loved snowflakes best. He tried to draw them, but they melted before he could finish. So he wanted to take their picture. With a big camera fixed to his microscope, he tried again and again. At last, on January 15, 1885, he made the first photograph of a single snowflake ever taken.

How they figured it out. Bentley worked out in the cold, so the snow would not melt. He caught falling flakes on a board covered with black cloth. He found a good one and lifted it gently with a very thin stick. He even held his breath, so his warm breath would not melt it! Over many winters he took thousands of snowflake pictures. People called him “Snowflake Bentley.” He said he never found two snowflakes exactly alike.

The big idea. A snowflake is not frozen rain. It grows high in a cold cloud. Water in the air, so small that we cannot see it, freezes onto a tiny speck and makes an ice **crystal**. More water freezes on, and the crystal grows. Almost every snowflake is **six-sided**: it has six sides or six arms. Some are flat like little plates. Some are long like needles. Some are lacy stars. The shape depends on how cold and how damp the cloud is.

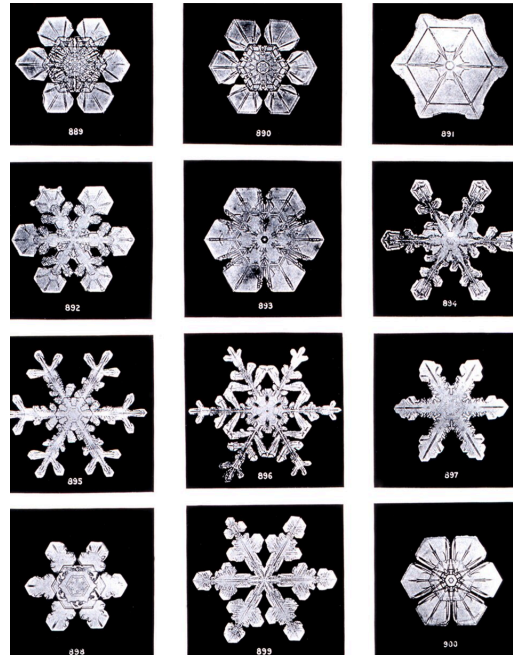
Try it and see. On a snowy day, chill a piece of black paper or cloth in the freezer. Take it outside and let snowflakes land on it. Look fast with a magnifying glass. Count the arms!

God's handiwork. God asked Job, "Hast thou entered into the treasures of the snow?" (Job 38:22). Bentley called snowflakes tiny miracles of beauty. More snowflakes than anyone could count fall in one storm, and God made each one with care.



A snowflake has six arms. Count them with your finger.

PICTURE STUDY



Snow Crystals, Wilson A. Bentley, taken over many winters, beginning in 1885 · Photographs taken through a microscope on glass plates · Many of Bentley's glass plates are kept at the Buffalo Museum of Science, Buffalo, New York

These are real snowflakes, photographed by Wilson Bentley on his farm in Vermont. Most were smaller than your littlest fingernail, but Bentley's microscope made them look big. He set each white snowflake on a black background so its shape would show clearly.

Bentley shared his pictures with scientists, teachers and artists. Many people saw the true shape of a snowflake for the first time in his photographs.

Look closely

- Pick one snowflake. Count its arms or sides with your finger.
- Find a snowflake that looks like a star with long, feathery arms.
- Find a snowflake that looks like a flat plate or a little hexagon.
- Look for two snowflakes that are exactly the same. Can you find any?

Talk about it

1. How are all these snowflakes the same? How are they different?
2. Why did Bentley put the snowflakes on a black background?
3. Which snowflake is your favorite? Tell what you like about it.

Safety first. Scissors are for a grown-up to help with. When catching snowflakes, dress warmly and come in if fingers hurt or feel numb. Do not eat snow from the ground or from roads.

MAKE AND DO: CATCH A SNOWFLAKE AND FOLD A SIX-ARMED SNOWFLAKE

If it is snowing, you will catch real snowflakes like Snowflake Bentley. On any day, you will fold and cut a paper snowflake with six arms, just like the real thing. Most paper snowflakes people make have four or eight arms, but you will make a true one.

You will need

- Black paper or a piece of dark cloth on a piece of cardboard
- A magnifying glass
- A square of thin white paper (a coffee filter works well)
- Child-safe scissors and a grown-up helper
- A pencil

Steps

1. If it is snowing: put the black paper in the freezer for 10 minutes so it is cold. Take it outside and hold it out to catch a few flakes.
2. Look quickly with the magnifying glass. Do not breathe on them! Count the arms of one snowflake. Draw what you see in your sketchbook.
3. Paper snowflake: fold the square of paper in half corner to corner to make a triangle.
4. Fold the triangle in half to make a smaller triangle. The square corner where the folds meet is the center of your snowflake.
5. Now fold the triangle into three equal parts, like a fan, with the center corner at the bottom. A grown-up can help line up the edges. Flatten it.
6. Cut off the uneven top at a slant. Then cut small notches and shapes along the sides. Do not cut all the way across.
7. Open it slowly. Count the arms: 1, 2, 3, 4, 5, 6!
8. Make a second paper snowflake with different cuts. Are your two snowflakes the same or different?

Tips

- Snowflakes on a very cold day are easier to catch whole. On a warm, wet day they melt fast or stick together in clumps.
- If your paper snowflake has eight arms, the folds were in fourths instead of thirds. Try again with three fan folds.

Check your work

- I can tell who Wilson Bentley was and what he did in 1885.
- I can count six arms on a snowflake.
- I can tell that snowflakes grow in clouds and are not frozen rain.

FIELD NOTEBOOK

1. Draw a snowflake with six arms. Number the arms 1 to 6.

2. Draw Wilson Bentley at work: the black board, the snowflake, the thin stick and the camera.
3. Glue your paper snowflake into your sketchbook and write the date. If it snowed, draw a real snowflake you caught.

From history. Long before Bentley's camera, the great Christian astronomer Johannes Kepler wondered about snowflakes. In 1611 he wrote a little book called *The Six-Cornered Snowflake* as a New Year's gift for a friend. He asked why snowflakes always have six corners and never five or seven. Later, Robert Hooke drew snowflakes he saw through his microscope in his book *Micrographia*. Bentley's photographs, gathered in the book *Snow Crystals* in 1931, finally let everyone see them clearly.

WORKED EXAMPLES

Example 1. Look at the snowflake picture. How many arms does one snowflake have? How many arms do two snowflakes have together?

(Use the map or drawing "Count around the snowflake." shown earlier in this lesson.)

1. Put your finger on arm number 1 at the top. Go around: 1, 2, 3, 4, 5, 6. One snowflake has 6 arms.
2. A second snowflake has 6 arms too.
3. Count on from 6: 7, 8, 9, 10, 11, 12.

Answer: One snowflake has 6 arms. Two snowflakes have 12 arms together ($6 + 6 = 12$).

PRACTICE

1. **EASY** Who was "Snowflake Bentley," and what was he the first to do?
2. **EASY** Hold up the number of arms a snowflake has.
3. **MEDIUM** Where does a snowflake grow: in a puddle, in a cloud, or on the ground?
4. **MEDIUM** Three snowflakes land on your mitten. Each has 6 arms. Count on to find how many arms in all.
5. **HARD** Tell why Bentley held his breath and worked out in the cold.

COMMON MISTAKES

- Thinking snowflakes have four, five or eight points. Real snowflakes almost always have six sides or six arms.
- Thinking snow is frozen raindrops. Snowflakes grow as ice crystals right in the cloud. Frozen raindrops are little ice pellets called sleet.
- Thinking all snowflakes are lacy stars. Many are flat plates, little columns or thin needles, and many stick together in clumps.

Make it a game · Snowflake Twins. A parent draws six snowflakes on cards, making two of them exactly the same and the rest a little different (one has bumps on its arms, one has long needles, one is a plate). Lay the cards face up. Find the twins! Then count the arms on every card. Remember, in real snow Bentley never found two that were exactly alike.

Scripture. “Hast thou entered into the treasures of the snow? or hast thou seen the treasures of the hail,” (Job 38:22, KJV)

God asked Job this question to show him how wise and great the Maker of the weather is. Wilson Bentley spent his life looking into the treasures of the snow, and he found them full of beauty.

Practice answers

1. Wilson Bentley, a farmer in Vermont. In 1885 he was the first to take a photograph of a single snowflake.
2. Six fingers.
3. In a cloud. Water in the cold cloud freezes into an ice crystal that grows and then falls.
4. 6, then 7 to 12, then 13 to 18. There are 18 arms in all ($6 + 6 + 6 = 18$).
5. Snowflakes melt very fast. His warm breath or a warm room would have melted them before he could take their picture.

8.4 A MONTH OF WEATHER

OBJECTIVES

- Keep a weather chart every day for a month, using simple weather symbols.
- Count the days of each kind of weather and read a picture graph to tell which kind came most often.
- Tell how Thomas Jefferson and today's volunteer weather watchers keep weather records.

Warm-up. Go to the window and be a weather watcher for one minute. Is the sun out? Are there clouds? Is it raining or snowing? Do the trees move in the wind? Draw one small picture on a sticky note that shows today's weather. Now try to remember: what was the weather last Tuesday? It is hard to remember! That is why weather watchers write it down.

Video. Coming soon. Keeping a daily weather chart and weather symbols for young children; search NOAA SciJinks, National Weather Service education pages, SciShow Kids, Homeschool Pop (Alternate), and Monticello videos about Thomas Jefferson's weather records.

KEY TERMS

weather

What the air outside is like right now: sunny or cloudy, hot or cold, wet or dry, still or windy.

weather chart

A calendar or table where we write down the weather each day.

symbol

A small picture that stands for something, like a sun for a sunny day.

pattern

Something that happens again and again, so we can notice it and expect it.

CORE IDEAS

The story. On July 4, 1776, in Philadelphia, America declared its independence. Thomas Jefferson had written the Declaration of Independence. But that same day, Jefferson did something else. He bought a new thermometer, and he wrote down the temperature in his notebook four times. Jefferson kept weather notes for most of his life. He wrote down the temperature, the wind, the rain and the snow, day after day.

How they figured it out. One day of weather does not tell you much. But when you write the weather down every day, you start to see **patterns**. You can count how many days were rainy. You can see that one month was colder than the next. Weather watchers look at the sky

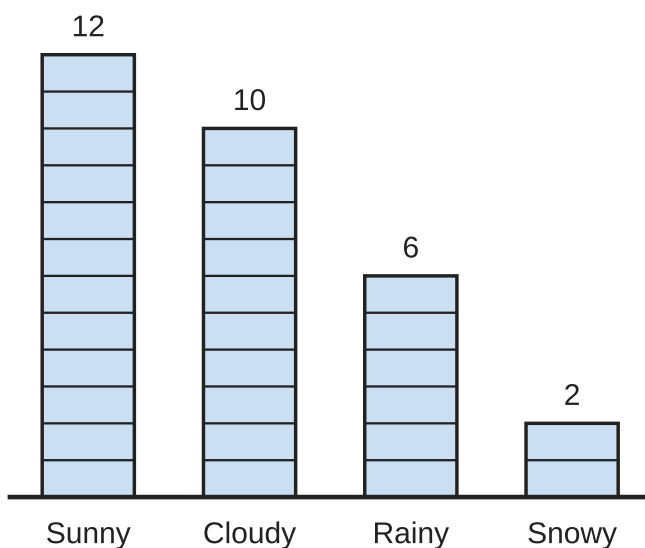
at the same time every day. They write it down right away, so they do not have to guess later. Jefferson's careful notes still help people learn what the weather was like long ago.

The big idea. Weather changes from day to day. You can keep a **weather chart** with easy **symbols**: a sun for sunny, a cloud for cloudy, a cloud with raindrops for rainy, a snowflake for snowy, and wavy lines for windy. Add your thermometer word: hot, warm, cool or cold. At the end of the month, count each symbol and make a picture graph. The tallest column shows the weather you had most often.

In the world today. All across America, thousands of volunteers read a thermometer and a rain gauge every day, at the same time, and send their numbers to the National Weather Service. Some of them are families with children. Your weather chart is real science, just like theirs.

God's handiwork. Jesus told the people that they could read the sky: a red sky in the evening often means fair weather (Matthew 16:2). God made weather with order and patterns, so we can watch it, learn it and thank Him for each kind of day.

Days in our month



Each box is one day. The tallest column shows the weather we had most often.

PICTURE STUDY



The Magpie, Claude Monet, 1868-1869 · Oil on canvas · Musée d'Orsay, Paris, France

Claude Monet was a French painter who loved to paint outdoors so he could catch the light and the weather just as they were. He painted this snowy scene in Normandy, in the north of France, standing outside in the cold.

Snow is not just white in this picture. Monet looked very carefully, like a weather watcher, and saw blue and purple in the shadows and warm sunshine on the snow.

Look closely

- Find the magpie. Where is it sitting? What colors is it?
- Look at the shadows on the snow. What color are they?
- Is the sun shining? How can you tell?
- Find the trees and the house. What is on top of them?

Talk about it

1. If you kept a weather chart on this day, which symbols would you draw? (Maybe a sun and a snowflake!)
2. Would the thermometer be high or low on this day?
3. Can a day be sunny and cold at the same time?

Safety first. When you look at the sky, never look straight at the sun. If you hear thunder or see lightning, stay indoors and watch from the window.

MAKE AND DO: MY MONTH OF WEATHER CHART

For one whole month, you will be a weather watcher like Thomas Jefferson. Each day you will look, draw a symbol and read your thermometer. At the end of the month, you will count and make a picture graph.

You will need

- A large paper calendar page for this month, or a grid with one box for each day
- Crayons or markers
- The thermometer from Lesson 8.1 (or any outdoor thermometer in the shade)
- Your rain gauge from Lesson 4.3, if you have it
- A second sheet of paper for the picture graph

Steps

1. Write the month's name at the top of your calendar. Draw a key at the bottom: sun = sunny, cloud = cloudy, cloud with drops = rainy, snowflake = snowy, wavy lines = windy.
2. Pick one time each day to watch, such as right after breakfast. Watch at that same time every day.
3. Go outside or to a window. Look at the sky (not at the sun). Draw the symbol in today's box. If it is windy too, add wavy lines.
4. Read the thermometer and write one word in the box: hot, warm, cool or cold.
5. If it rained, read your rain gauge and write the number. Then empty it.
6. Keep going every day until the month is done. If you miss a day, leave the box blank. Do not guess.
7. At the end of the month, count the suns, clouds, rain clouds and snowflakes.
8. Make a picture graph: draw one small box for each day in a column for each kind of weather. Which column is tallest?

Tips

- Hang the calendar near the door or window where you will see it every day.
- If a day is part sunny and part cloudy, choose what the sky looks like at your watching time. That is why we watch at the same time each day.

Check your work

- I drew a weather symbol on most days of the month.
- I can count how many days had each kind of weather.
- I can read my picture graph and tell which kind of weather came most often.

FIELD NOTEBOOK

1. Draw the five weather symbols and write the name under each one.

2. Draw Thomas Jefferson writing in his weather notebook with his new thermometer beside him.
3. At the end of the month, draw your favorite day of weather and tell why you liked it.

From history. George Washington was a weather watcher too. As a farmer at Mount Vernon in Virginia, he wrote about the weather in his diary on most days, because rain, frost and heat mattered for his crops. The very last thing he wrote in his diary, in December 1799, was a note about the weather and the snow.

WORKED EXAMPLES

Example 1. A family kept a weather chart for the month of April and made this picture graph. Which kind of weather came most often? How many more sunny days than rainy days were there?

(Use the map or drawing “Count the boxes in each column.” shown earlier in this lesson.)

1. Count the boxes in each column. Sunny: 12. Cloudy: 10. Rainy: 6. Snowy: 2.
2. The tallest column is Sunny, with 12 boxes. Sunny came most often.
3. Compare Sunny and Rainy. Start at 6 and count up to 12: 7, 8, 9, 10, 11, 12. That is 6 more.
4. Check: April has 30 days. $12 + 10 + 6 + 2 = 30$. Every day was counted.

Answer: Sunny weather came most often (12 days). There were 6 more sunny days than rainy days.

PRACTICE

1. **EASY** Draw the symbol for a sunny day, a rainy day and a snowy day.
2. **EASY** Point to the shortest column on the picture graph. What kind of weather is it, and how many days?
3. **MEDIUM** Look at the picture graph. Were there more cloudy days or rainy days? How many more?
4. **MEDIUM** In one week, a child drew 3 suns, 2 clouds and 2 rain clouds. How many days did the child record? Is that a whole week?
5. **HARD** Tell why a weather watcher writes the weather down every day at the same time instead of trying to remember it at the end of the month.

COMMON MISTAKES

- Thinking one day’s weather tells you about the whole month. Weather changes day to day; you need many days to see a pattern.
- Filling in missed days by guessing. A good weather watcher leaves a missed day blank so the record stays true.

- Thinking a sunny day must be warm. A day can be sunny and very cold, like the snowy day in Monet's painting.

Make it a game • Weather Charades. Write weather words on slips of paper: sunny, rainy, snowy, windy, cloudy, hot, cold, thunderstorm. Take turns drawing a slip and acting it out with no words: shade your eyes for sunny, shiver for cold, sway like a tree for windy. The others guess the weather and then name the symbol they would draw on a weather chart.

Scripture. “When it is evening, ye say, It will be fair weather: for the sky is red. And in the morning, It will be foul weather to day: for the sky is red and lowring.” (Matthew 16:2-3, KJV)

People in Jesus' day watched the sky and knew its signs, just as weather watchers do. “Lowring” means dark and gloomy. Jesus used this to teach that we should pay attention to God's signs too.

Practice answers

1. A sun (circle with rays); a cloud with raindrops under it; a six-armed snowflake.
2. Snowy, 2 days.
3. More cloudy days. Cloudy had 10 and rainy had 6, so there were 4 more cloudy days.
4. $3 + 2 + 2 = 7$ days. Yes, a week has 7 days.
5. It is easy to forget, and guessing later can be wrong. Watching at the same time each day makes the record fair, so the days can be compared.

UNIT 8 REVIEW

This is an oral review. A parent reads each question aloud, and the child answers by telling, pointing, drawing or showing. Accept answers in the child's own words. The review is worth 20 points.

1. (3 pts) What does a thermometer measure? What does the liquid do when it gets warm, and when it gets cold?
2. (3 pts) One thermometer's liquid reaches 4 marks. Another reaches 9 marks. Which place is warmer? How many marks higher is it?
3. (3 pts) Tell what you would wear on a snowy day, a rainy day and a hot, sunny day.
4. (3 pts) Does a mitten make heat? Tell what happened in the mitten test.
5. (3 pts) Who was Snowflake Bentley, and what did he do in 1885?
6. (2 pts) Draw a snowflake. How many arms does it have? Where did it grow?
7. (3 pts) Show me your weather chart. Which kind of weather did you have most often this month? Why do we watch at the same time every day?

UNIT PROJECT: MY WEATHER WATCHER'S JOURNAL

Put together a Weather Watcher's Journal. Include your month of weather chart with a symbol and a thermometer word for most days, and the picture graph you made at the end of the month. Add a drawing of your bottle thermometer, your weather doll with its clothes, your six-armed paper snowflake (and a drawing of a real snowflake if it snowed), and one page about Wilson Bentley. Then tell your family what you learned about thermometers, clothes, snowflakes and keeping a weather record.

- **Daily watching:** The weather chart has a symbol and a thermometer word for most days of the month, with missed days left blank, not guessed.
- **Counting and graphing:** Each kind of weather is counted correctly, and the picture graph has one box for each day.
- **Making and testing:** The journal shows the bottle thermometer, the mitten test and a true six-armed snowflake, each with a drawing and a sentence.
- **Telling back:** The child explains how a thermometer works, why clothes keep us warm, and the story of Snowflake Bentley in their own words.

Answer key

1. It measures temperature, how hot or cold something is. When it gets warm, the liquid spreads out and climbs up the tube. When it gets cold, it shrinks and goes down.
2. The one at 9 marks is warmer. It is 5 marks higher (9 is 5 more than 4).
3. Snowy: layers, a warm coat, hat, mittens and boots. Rainy: a raincoat and rubber boots (waterproof clothes). Hot and sunny: light, loose clothes and a sun hat. One point for each.
4. No. The thermometer inside the mitten stayed about the same. A mitten keeps your hand warm by holding in the heat your own body makes.

5. Wilson Bentley, a farmer in Jericho, Vermont. He took the first photograph of a single snowflake through a microscope, and he went on to photograph thousands more.
6. Six arms. It grew as an ice crystal in a cold cloud (it is not a frozen raindrop).
7. The child points to the tallest column of their picture graph and names it with the right count. We watch at the same time every day so the days are fair to compare and we do not have to guess.

BONUS: FIELD LAB

This bonus unit takes everything your child has learned this year and carries it outdoors. There are no new stories to memorize here, only real looking, measuring and recording, the way field scientists work. Each lesson is short and playful and can be done on any day the weather allows.

Your child will go on a slow rock walk and sort the finds into an egg carton, keep a rain gauge for a whole week, make a wind wand and keep a wind watch, and go out with you after sunset to watch the moon grow from a thin crescent toward full. Every lesson ends with a simple picture chart or drawing, so by the end your child will have a small field notebook of real observations of the world God made.

BEFORE YOU BEGIN

- Can count objects to 12
- Can make tally marks and count them
- Has made a rain gauge (Lesson 4.3) or can help make one
- Can follow a grown-up on a short walk outdoors

MASTERY CHECKLIST

- I can go on a rock walk, sort my rocks and count each group.
- I can set up a rain gauge in an open place, read it each day and empty it.
- I can tell calm, breeze and windy by watching a wind wand and the trees.
- I can find the moon, draw its shape and tell that moonlight is sunlight bouncing off the moon.
- I can make a picture chart and tell which group or day had the most.

OPTIONAL BOOKS AND RESOURCES

- **NOAA SciJinks** (<https://scijinks.gov/>): Free. Short, child-friendly pages and pictures about rain, wind and weather from NOAA and NASA. A parent can read pages aloud for Lessons 9.2 and 9.3.
- **CoCoRaHS (Community Collaborative Rain, Hail and Snow Network)** (<https://www.cocorahs.org/>): Free. A national network of volunteers who read rain gauges every morning. Parents can look at the daily rain map with their child and see real reports from nearby during Rain Gauge Week.
- **NASA Moon** (<https://moon.nasa.gov/>): Free. Shows today's moon phase and good pictures of the moon. Use it to plan the first evening of Moon Watch Night (Lesson 9.4).

9.1 BACKYARD ROCK WALK

OBJECTIVES

- Take a slow rock walk outdoors and find rocks of different sizes, colors and shapes.
- Wash the rocks, sort them into an egg carton and count each group.
- Describe one rock with at least two describing words, such as gray and smooth.

Warm-up. Before you go outside, close your eyes and hold one small stone in your hand. Is it smooth or rough? Heavy or light? Warm or cool? Round or sharp? Say three describing words out loud. Real rock hunters use their hands and eyes before anything else.

Video. Coming soon. Rock collecting for kids: finding, washing and sorting rocks outdoors; search USGS, Smithsonian, SciShow Kids, Homeschool Pop (Alternate) and nature footage of pebbles on beaches and creek beds.

KEY TERMS

field trip

A trip outside to look at real things right where they are.

specimen

One thing a scientist collects to study, like one rock.

texture

How something feels when you touch it: smooth, rough, bumpy or sharp.

describe

To tell about something with words, like its color, size, shape and feel.

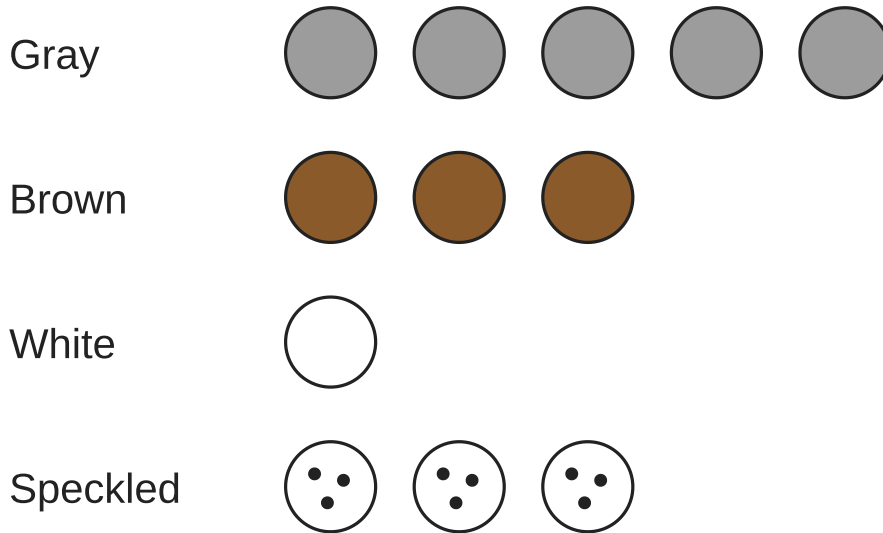
CORE IDEAS

Try it and see. A rock walk is a slow walk. You do not race. You look down. Rocks hide in many places: along a garden edge, by a fence post, at the side of a gravel path, under a rain spout or on a creek bank. Some are as big as a loaf of bread. Some are as tiny as a seed. Today you will take your egg carton and a small bag and walk with a grown-up around your yard, your street or a park where picking up rocks is allowed.

How they figured it out. Good rock hunters find treasures because they look carefully and ask questions. Pick up a rock and turn it in your hand. What color is it? Is it smooth or rough? Does it sparkle in the sun? Is it round or sharp? Rocks that were tumbled for a long time in a creek or on a beach are often round and smooth. Rocks that broke off not long ago often have sharp edges. Some rocks have tiny shiny specks that wink at you when you tip them.

God's handiwork. No two rocks are exactly alike, just as no two leaves are alike. When you get home, wash your rocks in a bowl of water. Wet rocks show their true colors best. Then sort them into your egg carton, one rock in each cup. You can sort by color, by size or by feel. A scientist counts and writes down what was found, so make a picture chart and count each group. The God who made the mountains also made the little pebble in your hand.

Sam's rocks by color



A picture chart of rocks sorted by color. Count each row.

PICTURE STUDY



The Stonebreaker, John Brett, 1857-1858 · Oil on canvas · Walker Art Gallery, Liverpool, England

John Brett was an English painter who loved to paint every stone, leaf and blade of grass exactly as it looked. Long ago, before machines did the job, people sat by the road and broke big stones into small ones with a hammer. The small stones were spread on country roads to make them firm. In this painting a boy is doing that work on a warm, bright day, with a little dog to keep him company.

Look closely

- Find the boy's hammer. What is he using it for?
- Look at the heap of stones. Are the stones big or small? Are they all the same color?
- Find the little dog. What is it doing?
- Look far away behind the boy. What do you see in the distance?

Talk about it

1. Why would someone break big stones into small ones?
2. If you could pick up one stone from the boy's heap, what words would you use to describe it?

Safety first. Walk with a grown-up and stay away from busy roads and deep water. Let a grown-up turn over big rocks or logs, because bugs, spiders or snakes sometimes hide underneath. Many parks do not allow taking rocks, so ask first, and ask before taking a rock from someone else's yard. Never put rocks or dirt in your mouth, and wash your hands when you come in.

MAKE AND DO: ROCK WALK AND EGG-CARTON SORT

You will go on a real field trip in your own neighborhood, bring home a small set of rocks, wash them, sort them and make a picture chart, just like a scientist.

You will need

- An empty egg carton with 12 cups
- A small bag or bucket
- A bowl of water and an old toothbrush
- An old towel
- Paper and crayons
- A magnifying glass, if you have one

Steps

1. Walk slowly with a grown-up for about fifteen minutes. Look along paths, fences, garden edges and gravel.
2. Pick up rocks small enough to fit in one egg cup. Try to find rocks that look different from each other. Stop when you have 12.

3. At home, wash each rock in the bowl and scrub it gently with the toothbrush. Dry it on the towel.
4. Look at each rock with your eyes and with the magnifying glass. Say two describing words for each one.
5. Sort your rocks into groups by color. Put each group into cups next to each other in the egg carton.
6. Draw a picture chart: one row for each color, with one circle for each rock. Count each row and write the number.

Tips

- Bricks, chunks of concrete and bits of blacktop are made by people. Leave them out, or keep them in a separate cup marked “made by people.”
- If a rock is too dry to show its color, dip it in water again and look quickly.

Check your work

- I went on a rock walk and found rocks that look different.
- I washed and sorted my rocks, one in each cup.
- I made a picture chart and counted each group.

FIELD NOTEBOOK

1. Lay your favorite rock on the page and trace around it. Then color in your drawing to look like the rock.
2. Draw a simple map of your rock walk. Put an X where you found your best rock.
3. Draw one smooth rock and one rough rock side by side. Under each, write or tell a grown-up one describing word.

From history. Hugh Miller was a stonemason in Scotland who cut stone in quarries for a living. He later wrote that in his first days of work in the quarry he noticed ripple marks in the rock, just like the ripples water makes in sand at the edge of the sea. He kept looking closely every day, found fossil fish in the stones, and became a famous writer about rocks. He was also a strong Christian who wrote about the Creator’s handiwork in the rocks. It all began with a working man who took the time to look.

WORKED EXAMPLES

Example 1. Sam went on a rock walk and found 12 rocks. Sam sorted them by color and made a picture chart. Which color did Sam find the most of? How many more gray rocks than white rocks did Sam find?

(Use the map or drawing “Sam’s rocks sorted by color.” shown earlier in this lesson.)

1. Count the circles in each row. Gray: 5. Brown: 3. White: 1. Speckled: 3.
2. Find the biggest number. 5 is bigger than 3 and bigger than 1, so gray is the most.
3. Compare gray and white. Gray has 5 and white has 1. Count up from 1 to 5: 2, 3, 4, 5. That is 4 more.
4. Check the total: $5 + 3 + 1 + 3 = 12$. That fills the whole egg carton.

Answer: Gray is the most (5 rocks). Sam found 4 more gray rocks than white rocks.

PRACTICE

1. **EASY** Hold two of your rocks. Point to the one that feels rough and the one that feels smooth.
2. **EASY** Your rocks fill 7 cups of a 12-cup egg carton. How many cups are still empty?
3. **MEDIUM** Here are three rocks: a round, smooth pebble; a sharp chip with pointy edges; and a rough lump. Which one was most likely tumbled in a creek?
4. **MEDIUM** Dip a dry rock into water and look at it. What changes?
5. **HARD** Tell a grown-up why a scientist writes down where each rock was found.

COMMON MISTAKES

- Thinking all rocks are plain and gray. Wash them and look closely: rocks can be red, white, pink, black, green or speckled.
- Calling bricks, concrete and blacktop rocks. They are made by people from rock materials, so a careful collector keeps them separate.
- Thinking rocks never change. Water, ice and rolling wear rocks down, knock off corners and break them into smaller pieces.

Make it a game • Rock Twin Hunt. A grown-up shows you one rock from your egg carton. You have one minute outside to find a “twin” rock that matches it in color, size or feel. Bring it back and say which way it matches. Take turns, then switch: you pick the rock and the grown-up hunts.

Scripture. “He is the Rock, his work is perfect: for all his ways are judgment: a God of truth and without iniquity, just and right is he.” (Deuteronomy 32:4, KJV)

Moses called God “the Rock” because a rock is strong and does not move. Every rock you hold can remind you that God is strong and that His work is perfect.

Practice answers

1. Answers will vary. A rough rock feels bumpy or scratchy. A smooth rock feels slippery, a little like glass.
2. 5 cups. Count up from 7 to 12: 8, 9, 10, 11, 12.
3. The round, smooth pebble. Rolling in water knocks off the sharp corners.
4. The colors look brighter or darker, and the rock looks shiny. Wet rocks show their colors best.
5. So the scientist remembers where it came from, can go back to find more, and can compare rocks from different places.

9.2 RAIN GAUGE WEEK

OBJECTIVES

- Set a rain gauge in a good open place outdoors.
- Read the rain gauge at the same time each day for a week, write the number and empty it.
- Make a picture chart of the week and tell which day had the most rain.

Warm-up. Look out the window and make a guess: how many days will it rain this week? Hold up that many fingers, and have a grown-up write your guess on a sticky note. At the end of the week you will check your guess against your rain gauge.

Video. Coming soon. How to set up and read a rain gauge for kids; search NOAA SciJinks, the National Weather Service, CoCoRaHS rain gauge training, SciShow Kids and Homeschool Pop (Alternate).

KEY TERMS

rain gauge

A straight-sided jar or tube with marks on it that catches rain so we can measure how much fell.

measure

To find out how much or how long something is, using marks or a ruler.

record

To write or draw what you found so you will not forget it.

dry day

A day when no rain falls, so the gauge reads zero.

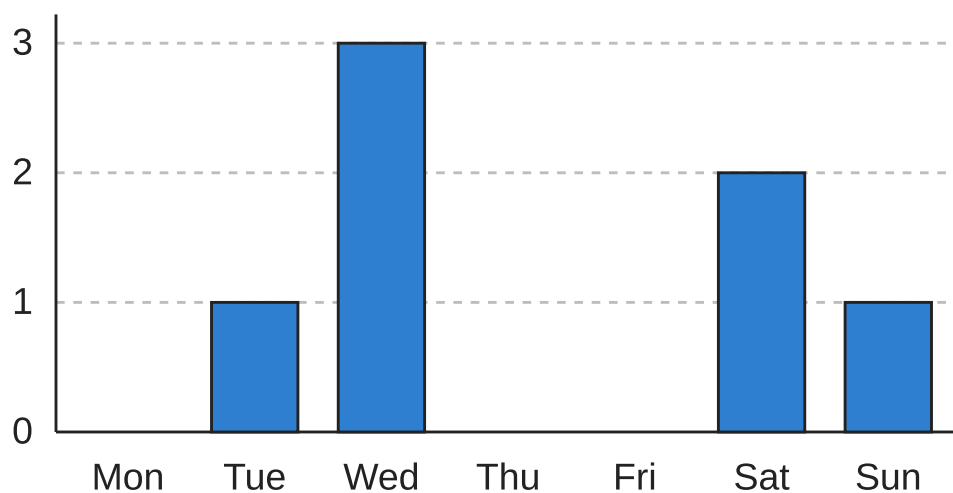
CORE IDEAS

Try it and see. This week your rain gauge goes outside to do real work. Where you put it matters. Find an open spot in the yard, away from the house, the fence and trees. A roof can block the rain, and a tree can drip extra water into the jar. Set the gauge in a flowerpot of sand or tie it to a stake so the wind cannot knock it over. Make sure the top is open to the sky.

How they figured it out. Weather watchers learned that rain numbers are only fair if everyone reads them the same way. So read your gauge at the same time every day, such as right after breakfast. Squat down so your eyes are even with the top of the water. Read the mark. Write the number on your chart. Then pour the water out, so tomorrow's rain starts from zero. Today many families and volunteers across America read their rain gauges every morning and send the numbers to weather scientists.

God's handiwork. Rain falls on your whole yard, on the garden and on the fields far away. Your little gauge catches just a sample of it, and that sample tells you how much fell everywhere nearby. At the end of the week you will look at your chart and see which day was wettest and which days were dry. God sends the rain to water the earth, and now you can measure His gift.

Rain in our gauge this week (centimeters)



One week of rain. Taller bars mean more rain.

PICTURE STUDY



Sudden Shower over Shin-Ōhashi Bridge and Atake, Utagawa Hiroshige, 1857 · Woodblock print, from the series *One Hundred Famous Views of Edo* · Prints are in many museums, including the Brooklyn Museum, New York

Hiroshige was an artist in Japan. He drew his pictures, then craftsmen carved them into blocks of wood, put ink on the blocks and pressed paper on top to make many prints. In this print a sudden rain shower has caught people on a bridge. The artist Vincent van Gogh loved this picture so much that he painted his own copy of it.

Look closely

- Find the rain. How did the artist draw it? Are the lines straight or curvy?
- Look at the top of the picture. What color is the sky?
- Find the people on the bridge. How are they keeping dry?
- Find the man on the river. What is he standing on?

Talk about it

1. Does this look like a gentle rain or a hard rain? How can you tell?
2. If there had been a rain gauge on that bridge, would it have caught a little water or a lot?

Safety first. Use a plastic jar, not glass, outdoors. Check the gauge only when there is no thunder or lightning; if you hear thunder, stay inside until the storm has passed. Empty the gauge every day so mosquitoes cannot lay eggs in standing water.

MAKE AND DO: MY RAIN GAUGE WEEK

You will keep a real rain record for seven days in a row and turn it into a chart.

You will need

- Your rain gauge from Lesson 4.3, or a clear plastic jar with straight sides
- A ruler and a strip of masking tape with marks, if your jar has none
- A flowerpot filled with sand or soil, or a stake and string
- A chart with seven boxes, one for each day of the week
- Blue crayon

Steps

1. Choose an open spot away from roofs, fences and trees. Set the gauge firmly in the pot of sand or tie it to a stake.
2. Pick a reading time, such as right after breakfast, and use it every day.
3. Each day, squat down so your eyes are even with the top of the water. Read the mark.
4. Write the number in that day's box. If there is no water, write 0 and draw a sun.
5. Color a blue bar for each day as tall as the rain was. Then pour the water out.
6. On the seventh day, look at your chart. Find the wettest day and count the dry days. Check your guess from the warm-up.

Tips

- Put a reminder by the breakfast table so you do not forget a day.
- If it rains during the reading time, read the gauge anyway, then empty it and keep going.

Check your work

- I put my gauge in an open place.
- I read and emptied my gauge at the same time each day.
- I can point to the wettest day on my chart and count the dry days.

FIELD NOTEBOOK

1. Draw your rain gauge in its spot in the yard. Show what is near it.
2. Draw the sky on the wettest day of your week and on one dry day.
3. Draw raindrops landing in your gauge and a tree dripping beside it. Draw an X on the tree to show why the gauge should not go there.

From history. In 1441 King Sejong of Korea, a ruler who loved learning, had rain gauges made of metal and set on stone stands. Copies were sent to towns all over his kingdom, and local officials measured the rain and sent the numbers to the capital. Farmers

depended on the rain, and the king wanted to know how much fell in every part of the land. It was one of the first times a whole country measured rain the same way.

WORKED EXAMPLES

Example 1. Here is one week of rain from a family's rain gauge. Which day had the most rain? How many days were dry?

(Use the map or drawing "One week of rain in centimeters." shown earlier in this lesson.)

1. Look at the bars. The tallest bar is over Wednesday. It reaches the 3 line.
2. No other bar is that tall, so Wednesday had the most rain: 3 centimeters.
3. A dry day has no bar at all. Point to them: Monday, Thursday, Friday.
4. Count them: 1, 2, 3.

Answer: Wednesday had the most rain (3 centimeters). There were 3 dry days: Monday, Thursday and Friday.

PRACTICE

1. **EASY** Where is the best place for a rain gauge: under a tree, next to the house, or in the open middle of the yard? Point to show.
2. **EASY** Look at the chart. How much rain fell on Saturday? How much on Sunday? Put them together.
(Use the map or drawing "Use the chart to answer." shown earlier in this lesson.)
3. **MEDIUM** On Monday the gauge read 2. Someone forgot to empty it. On Tuesday it read 5. How much rain really fell on Tuesday?
4. **MEDIUM** Why do we read the rain gauge at the same time every day?
5. **HARD** Draw a picture chart for three days: 1 raindrop for the first day, no raindrops for the second day, and 2 raindrops for the third day. Which day was wettest?

COMMON MISTAKES

- Putting the gauge under a tree or by the house. Trees add drips and roofs block rain, so the number is not fair.
- Forgetting to empty the gauge. Then the water from different days adds up and you cannot tell how much fell each day.
- Thinking a wide jar shows more rain than a thin one. If the sides are straight, rain fills both to the same height, so both read the same.

Make it a game • Guess the Rain. While you hide your eyes, a grown-up pours some water into the empty gauge. Open your eyes and guess the number before you read it. Then squat down, read it at eye level, and see how close you were. Take turns being the pourer. Closest guess scores a point.

Scripture. “Who giveth rain upon the earth, and sendeth waters upon the fields:” (Job 5:10, KJV)

This verse tells us that God gives the rain. Every drop in your gauge is part of His gift to water the fields and gardens.

Practice answers

1. In the open middle of the yard. A tree drips extra water in, and the house roof blocks some of the rain.
2. Saturday 2 and Sunday 1. Together that is 3 centimeters.
3. 3. The 2 was already in the jar from Monday, and 5 take away 2 is 3. That is why we empty the gauge every day.
4. So each number counts the rain from one whole day, and the days can be compared fairly.
5. The drawing shows 1 drop, then a sun or empty box, then 2 drops. The third day was wettest.

9.3 WIND WATCH

OBJECTIVES

- Tell whether the wind is calm, a breeze or windy by watching a wind wand, trees and flags.
- Keep a tally chart of the wind three times a day and count which kind of wind came most.

Warm-up. Hold a tissue by one corner in front of your face. Blow on it very softly, then a little harder, then as hard as you can. Watch how the tissue moves each time. You cannot see your breath, but you can see what it does.

Video. Coming soon. What makes wind and how to tell how strong the wind is, for kids; search NOAA SciJinks, the National Weather Service, SciShow Kids, Homeschool Pop (Alternate) and nature footage of trees and flags in the wind.

KEY TERMS

wind

Air that is moving.

calm

No wind at all. Leaves are still and smoke goes straight up.

breeze

A gentle wind that makes leaves rustle and small twigs wiggle.

gust

A sudden, quick push of stronger wind.

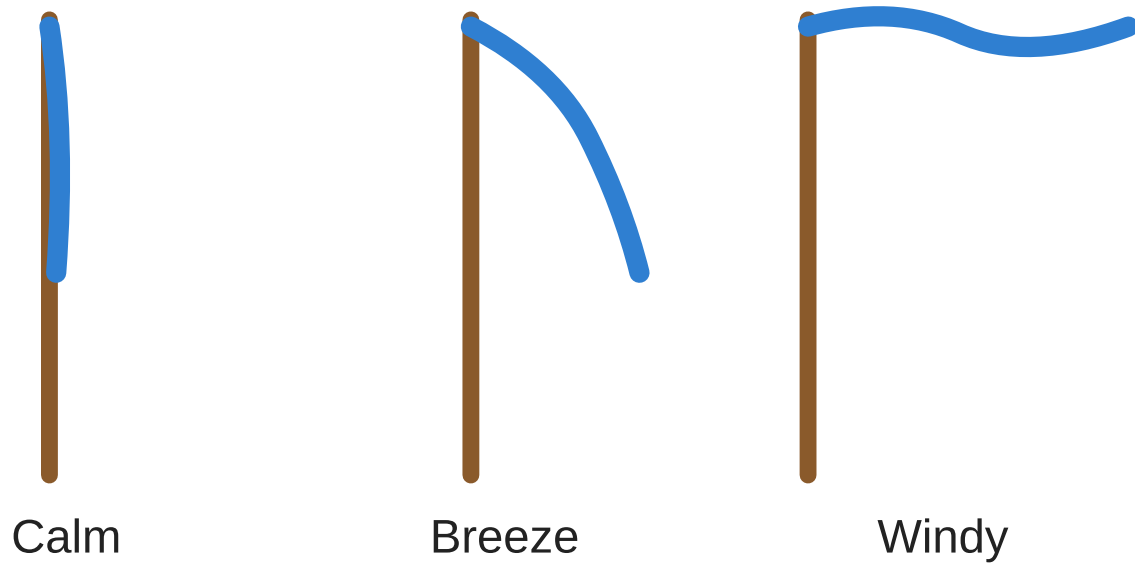
CORE IDEAS

Try it and see. We cannot see the air, but we can see what it moves. Today you will make a wind wand: a long ribbon tied to the top of a stick. Hold it up high outdoors and watch. If the ribbon hangs straight down, the air is **calm**. If it lifts and flutters, there is a **breeze**. If it streams straight out like a flag, it is **windy**. Look around too. Are the leaves still? Are small twigs wiggling? Are big branches swaying?

How they figured it out. Long ago, sailors watched their sails and the waves to judge the wind. Farmers watched smoke from the chimney and the tops of the trees. Smoke going straight up means calm. Leaves rustling means a breeze. Whole trees bending and hats flying off mean a strong wind. You can be a wind watcher too. Go out three times a day, in the morning, at lunch and before supper, and make a tally mark for what you see.

God's handiwork. Where does wind come from? The sun warms the ground, but not all the same. A dark parking lot gets hotter than a shady wood. Warm air rises, and cooler air

rushes in to take its place. That moving air is the wind. God made the sun and the air work together to move rain clouds, carry seeds and turn windmills.



How a wind wand looks when the air is calm, in a breeze and on a windy day.

PICTURE STUDY



Ejiri in Suruga Province (from Thirty-six Views of Mount Fuji), Katsushika Hokusai, about 1830-1832 · Woodblock print · Prints are in many museums, including the Metropolitan Museum of Art, New York

Hokusai was a Japanese artist who made a famous set of prints showing Mount Fuji from many places. In this one, a sudden gust of wind has surprised some travelers on a road. You

cannot see the wind itself, but Hokusai shows you everything it is doing.

Look closely

- Find the papers flying in the sky. Where did they come from?
- Find the hat blowing away. Who lost it?
- Look at the trees. Which way are they leaning?
- Look at how the people are standing. Are they standing straight or bending over?

Talk about it

1. Is this a calm day, a breezy day or a windy day? Point to three clues.
2. If you held your wind wand on this road, what would the ribbon do?

Safety first. Do wind watching with a grown-up. Stay far away from power lines, and stay inside during thunder, lightning or very strong wind, when branches can fall. Hold your wind wand upright and walk, do not run, with it.

MAKE AND DO: MAKE A WIND WAND AND KEEP A WIND WATCH

You will make a simple tool that shows the wind, then use it for two or three days to keep a real wind record.

You will need

- A long stick, a wooden spoon or a ruler
- A ribbon, a strip of crepe paper or a strip cut from a plastic bag, about as long as your arm
- Tape or string
- A wind watch chart with three rows: Calm, Breeze, Windy
- A pencil

Steps

1. Tie or tape the ribbon to the top of the stick. Your wind wand is ready.
2. Go outside in an open spot away from walls. Hold the wand up high and stand still.
3. Watch the ribbon. Hanging down means calm. Fluttering out a little means breeze. Streaming straight out means windy.
4. Look at the trees too, and check that they agree with your ribbon.
5. Make one tally mark in the right row of your chart.
6. Do this three times a day: morning, lunch and before supper. After two or three days, count each row.

Tips

- A light ribbon works best. A heavy one will hang down even in a breeze.

- Wind often grows stronger in the afternoon and calmer at night. See if your chart shows it.

Check your work

- I made a wind wand.
- I can tell calm, breeze and windy by looking at my wand and the trees.
- I kept tally marks and counted which kind of wind came most.

FIELD NOTEBOOK

1. Draw your wind wand three ways: on a calm day, a breezy day and a windy day.
2. Draw a tree in a strong wind. Show which way its branches bend and add lines for the wind.
3. Draw three things you saw the wind move today, such as leaves, a flag or a kite.

From history. In 1805 Francis Beaufort, an officer in Britain's navy, wrote down a scale for judging wind at sea by watching how a ship's sails behaved. Later the scale was changed so people on land could use it by watching smoke, leaves, branches and whole trees, just as you did with your wind watch. Weather watchers still use the Beaufort scale today.

WORKED EXAMPLES

Example 1. Jo watched the wind three times a day for three days and made tally marks. Calm: ||. Breeze: |||||. Windy: ||. Which kind of wind came most? How many times did Jo look in all?

1. Count the tally marks in each row. Calm: 2. Breeze: 5. Windy: 2.
2. Find the biggest number. 5 is the biggest, so breeze came most.
3. Count all the marks together: $2 + 5 + 2$. Count on from 2: 3, 4, 5, 6, 7, then 8, 9.
4. Check: three looks a day for three days is 3, 6, 9. It matches.

Answer: Breeze came most (5 times). Jo looked 9 times in all.

PRACTICE

1. **EASY** Look at the three wind wands. Point to the one that shows a windy day.
(Use the map or drawing "Point to the windy day." shown earlier in this lesson.)
2. **EASY** Smoke from a chimney goes straight up into the sky. Is it calm, breezy or windy?
3. **MEDIUM** Leaves are rustling and small twigs are wiggling, but big branches are still.
What kind of wind is it?
4. **MEDIUM** You check the wind 3 times a day for 2 days. How many tally marks will you make?

5. **HARD** Tell a grown-up how you know the wind is real even though you cannot see it.

COMMON MISTAKES

- Thinking the trees make the wind by waving their branches. It is the other way around: the moving air pushes the trees.
- Thinking the wind blows the same all day. It can be calm in the morning and gusty by afternoon, and it can change direction.
- Thinking air is nothing. Air is real stuff; when it moves, it can push sails, windmills and hats.

Make it a game • Wind Wand Says. One person is the wind wand. A grown-up calls out “calm,” “breeze,” “windy” or “gust!” For calm, stand still with arms hanging down. For breeze, flutter your fingers and sway a little. For windy, stretch your arms straight out to the side. For a gust, spin around once. Then switch who calls.

Scripture. “Fire, and hail; snow, and vapour; stormy wind fulfilling his word:” (Psalm 148:8, KJV)

Even the stormy wind obeys God. It goes where He sends it and does what He made it to do.

Practice answers

1. The third wand, where the ribbon streams straight out.
2. Calm. There is no wind to push the smoke sideways.
3. A breeze.
4. 6. Count three, then three more: 1, 2, 3, 4, 5, 6.
5. We can see what the wind moves (leaves, flags, a ribbon, smoke) and feel it push on our faces. Air is real even when we cannot see it.

9.4 MOON WATCH NIGHT

OBJECTIVES

- Find the moon in the evening sky and draw its shape on several nights.
- Put moon shapes in order from a thin crescent to a full moon.
- Tell that the moon does not make its own light; it shines with light from the sun.

Warm-up. In a dim room, have a grown-up shine a flashlight on a ball from across the room. Walk slowly around the ball and watch the bright part. Sometimes you see a lot of the bright side, sometimes only a sliver. The ball does not glow by itself. It only shines where the light hits it, just like the moon.

Video. Coming soon. Moon phases and moon watching for kids, why the moon changes shape; search NASA Space Place, NASA Moon, SciShow Kids, Homeschool Pop (Alternate) and time-lapse footage of the moon rising.

KEY TERMS

moon

The big round ball of rock that travels around the earth. God made it to give light by night.

crescent

A thin, curved moon shape, like a fingernail clipping or a banana.

full moon

When the whole round face of the moon looks bright.

moonlight

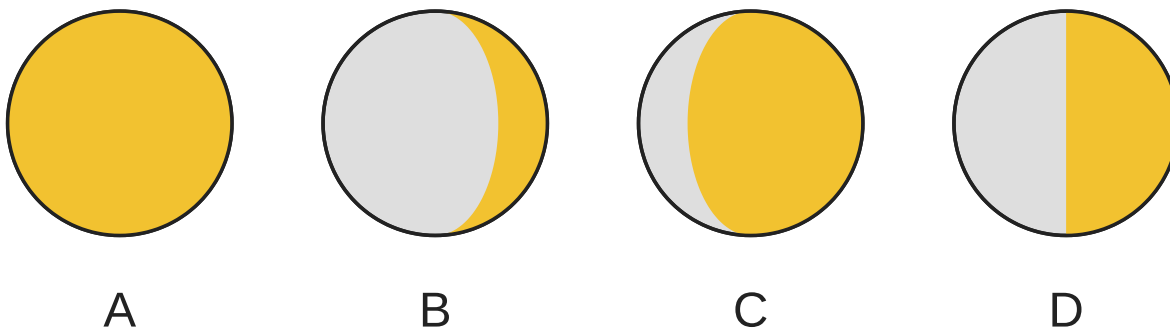
Sunlight that bounces off the moon and comes down to us.

CORE IDEAS

Try it and see. Moon watching is best in the evening, just after sunset. Ask a grown-up to look at a calendar for a day or two after the new moon. That evening, look low in the west where the sun went down. You may see a thin, bright crescent. Draw it and draw the tree or rooftop below it. Go out at the same time on the next nights. Each night the moon is a little higher in the sky and a little fatter. In about a week it looks like a half circle. In about two weeks it is full and round, rising in the east as the sun sets in the west.

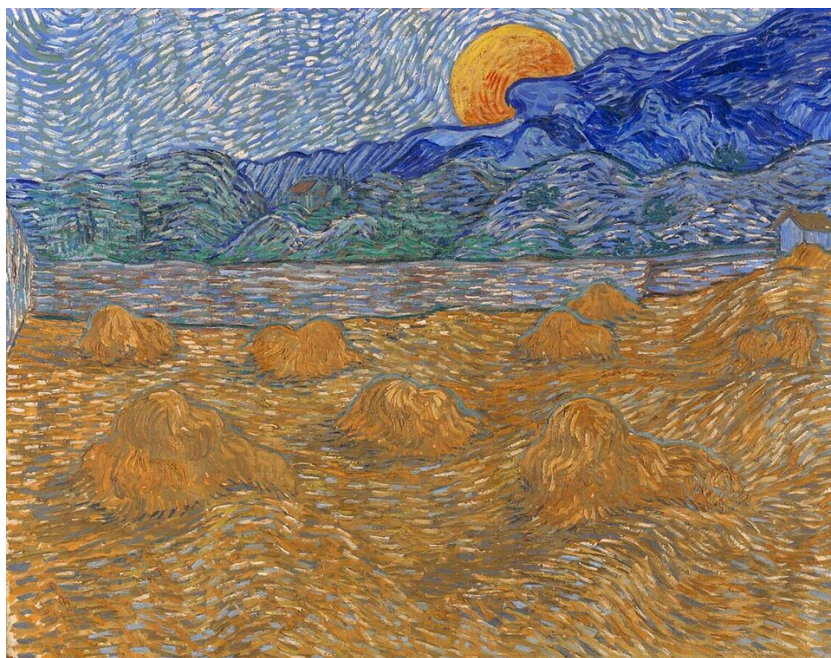
The big idea. The moon does not make its own light. It is a ball of rock, and the sun shines on it. One half of the moon is always lit by the sun, like the half of the ball that faced the flashlight. As the moon travels around the earth, about once a month, we see different amounts of that bright half. That is why the moon seems to change shape. In the evening, the bright side of a growing moon faces the sunset.

God's handiwork. On the fourth day of creation God made "the lesser light to rule the night" (Genesis 1:16). The moon keeps its schedule so faithfully that farmers, sailors and travelers have used it since long ago to mark the months and light their way. When you step outside and find the moon, you are looking at a lamp God hung in the sky.



Four moon drawings, mixed up. The yellow part is the part we see lit by the sun.

PICTURE STUDY



Landscape with Wheat Sheaves and Rising Moon, Vincent van Gogh, 1889 · Oil on canvas · Kröller-Müller Museum, Otterlo, the Netherlands

Vincent van Gogh was a Dutch painter who lived for a while in the south of France. One summer evening he painted a wheat field where the farmers had tied the wheat into bundles, called sheaves. Over the mountains, a big, round moon was rising.

Van Gogh painted with thick, swirling strokes you can almost feel. Look at how the moon peeks up from behind the mountain, just as a full moon rises in the east in the evening.

Look closely

- Find the moon. What shape is it, and what color?
- Is the moon high in the sky or just coming up over the mountains?
- Count the wheat sheaves you can see in the field.
- Look at the sky. Is it black like midnight, or still light?

Talk about it

1. Is this early evening or the middle of the night? What clues help you decide?
2. A full moon rises in the east as the sun sets in the west. Which way do you think van Gogh was facing?
3. Why might a rising moon look so big and orange?

Safety first. Go moon watching only with a grown-up, and bring a flashlight so you can see where you step in the dark. Stay in your yard or another safe place away from roads. Sometimes the moon is in the sky during the day; never look at the sun, even for a moment.

MAKE AND DO: MY MOON WATCH CALENDAR

You will be a moon watcher for one or two weeks, drawing the moon's shape each clear evening and seeing it grow.

You will need

- A sheet of dark blue or black paper folded into 8 boxes, or a page with 8 boxes
- A white or yellow crayon, or a white colored pencil
- A flashlight
- A calendar that shows the moon phases (many calendars do)

Steps

1. With a grown-up, find a day on the calendar just after a new moon. That is your first moon watch night.
2. Go outside just after sunset. Look low in the west for a thin crescent.
3. Draw the moon's shape in the first box. Write the date. Draw a little tree or roof to show where the moon was.
4. Go out at about the same time on the next clear nights and draw the moon again in the next box.
5. If clouds hide the moon, draw a cloud in the box instead.
6. When your boxes are full, look at all your drawings. Tell a grown-up how the moon changed.

Tips

- The moon may be easier to see if you stand where trees and houses do not block the western sky.
- Notice which side of the moon is bright. In the evening, the growing moon is bright on the side toward where the sun went down.

Check your work

- I found the moon and drew it on several nights.
- I can show how the moon grew from thin to fat.
- I can tell that moonlight is really sunlight bouncing off the moon.

FIELD NOTEBOOK

1. Draw the moon you saw tonight. Draw your house or a tree underneath to show where it was in the sky.
2. Draw a flashlight shining on a ball. Color the side of the ball that the light hits.
3. Draw the moon rising over the hills in van Gogh's painting. Then draw yourself looking at the moon.

From history. When the moon is a thin crescent, you can sometimes see the dark part of the moon glowing very faintly, like a ghost moon. In the early 1500s Leonardo da Vinci wrote in his notebook that this faint glow is sunlight that bounces off the earth onto the moon, and then back to our eyes. He was right. Today it is called earthshine, and you may see it yourself on your moon watch.

WORKED EXAMPLES

Example 1. Mia drew the moon on four nights, but the drawings got mixed up. Put them in order from the thinnest moon to the fullest moon.

(Use the map or drawing "Put the moons in order from thinnest to fullest." shown earlier in this lesson.)

1. Look at how much of each moon is bright. A is all bright. B is only a thin sliver. C is almost all bright. D is half bright.
2. The smallest bright part is B, the thin crescent. It comes first.
3. Next is D, the half moon.
4. Then C, the fat moon that is almost full.
5. Last is A, the full moon, all bright.

Answer: B, D, C, A: thin crescent, half moon, fat moon, full moon.

PRACTICE

1. **EASY** Point to the full moon in the picture of four moons.

(Use the map or drawing "Which one is the full moon?" shown earlier in this lesson.)

2. **EASY** Does the moon make its own light? Where does moonlight come from?
3. **MEDIUM** You planned to watch the moon for 10 nights, but clouds hid it on 3 nights. How many moon drawings did you make?
4. **MEDIUM** The sun is setting in the west. Where should you look to see the full moon rising?
5. **HARD** Tell a grown-up how the moon's shape changed during your moon watch, using the words crescent, half and full.

COMMON MISTAKES

- Thinking the moon makes its own light like a lamp. It shines only because the sun lights it up.
- Thinking the earth's shadow makes the moon's shapes. The shapes come from how much of the moon's sunny half we can see as it travels around the earth.
- Thinking the moon only comes out at night. The moon is often in the sky during the day too; look for a pale moon in the afternoon or morning sky.

Make it a game · Moon Shape Freeze. Hold a paper plate for the moon and a dark paper circle the same size. A grown-up calls out "crescent," "half," "fat moon" or "full!" Slide the dark circle over the plate to show that shape, then freeze. If you show it right, you call the next shape.

Scripture. "When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained;" (Psalm 8:3, KJV)

David looked up at the moon and stars and remembered that God made them with His own fingers. On your moon watch night, you can look up and remember the same thing.

Practice answers

1. A, the moon that is round and bright all over.
2. No. Moonlight is sunlight that bounces off the moon.
3. 7. Ten take away three is seven.
4. Low in the east, on the opposite side of the sky from the sunset.
5. It began as a thin crescent, grew a little fatter each night to a half moon, then grew fatter still until it was a full moon.

UNIT 9 REVIEW

This is an oral review. Read each question aloud and let your child answer in their own words, pointing to their charts and drawings when it helps. Give full points for answers that show the main idea. The review is worth 20 points.

1. (3 pts) Pick one rock from your rock walk. Tell me two describing words for it, and show me where it sits in your egg carton.
2. (4 pts) Why are some rocks round and smooth while others are sharp?
3. (3 pts) Where should a rain gauge go, and why do we empty it every day?
4. (3 pts) Your gauge read 2 on Monday and 0 on Tuesday. Which day was wetter? What do we call a day with 0?
5. (4 pts) We cannot see the wind. How can you tell if it is calm, a breeze or windy?
6. (3 pts) Where does moonlight come from? Name the moon shapes you saw, from thinnest to fullest.

UNIT PROJECT: MY FIELD LAB NOTEBOOK

Gather your child's work from all four field labs into one folder or notebook: the rock picture chart and a photo or drawing of the egg-carton collection, the rain gauge week chart, the wind watch tally chart and wind wand drawings, and the moon watch calendar. Add a cover with your child's name and a drawing of their favorite thing they saw outdoors. Then let your child "present" the notebook to the family, telling one thing they found out in each lab.

- **Observing:** Each chart or drawing shows real things the child saw, felt or measured outdoors.
- **Records:** Charts have a box or row for each day or group, with tally marks, bars or drawings filled in.
- **Telling:** The child can tell one thing learned from each lab in a clear sentence or two.
- **Care:** Pages are neat, colorful and kept together, like a real scientist's field notebook.

Answer key

1. Answers will vary. Any two describing words that fit, such as gray and smooth, or speckled and rough. The rock should be in its sorted group.
2. Round, smooth rocks were tumbled in water, like a creek or the sea, which knocked off their corners. Sharp rocks broke off not long ago and have not been worn down.
3. In an open place away from trees, roofs and fences. We empty it so each day's rain starts from zero and can be measured on its own.
4. Monday was wetter. A day with 0 is a dry day.
5. Watch what the wind moves. Calm: the wand ribbon hangs down, leaves are still, smoke goes straight up. Breeze: the ribbon flutters, leaves rustle. Windy: the ribbon streams straight out and big branches sway.
6. Moonlight is sunlight bouncing off the moon. The shapes go thin crescent, half moon, fat moon, full moon.