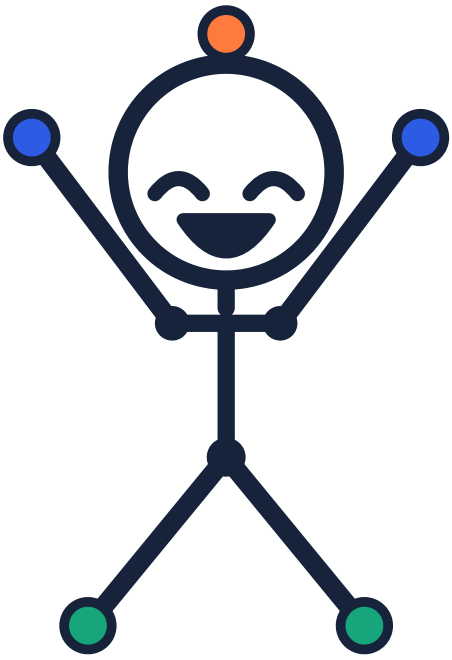
Young Innovators
FOR CHANGE
innovateyouth.org

A FULL-YEAR SCIENCE PROGRAM · GRADE 5

Too Small to See

36 weekly investigations into what you cannot see: particles, plants, Earth's water and the stars.



This book belongs to

_____

Something too small to see _____

Something too far to see _____

Teacher _____

School year _____

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START HERE HOW THIS BOOK WORKS

Reason about what you cannot see.

Two pages a week, front and back. About thirty-five minutes.

The shape of a week

Page 1 teaches one idea, and most weeks it gives you a small investigation to try. **Page 2** has a table of results to think about, two questions to talk about and a harder challenge, and many weeks add a page for your Model Book. No computer needed.

Part 1 is matter: what everything is made of, and why nothing is lost when it changes. Part 2 follows matter and energy through plants, animals and decomposers. Part 3 is Earth's rock, water, air and life, and gravity. Part 4 is the sky: shadows, day and night, and the stars.

The boxes on the page

SITS BESIDE	The California science standard the week teaches. This book sits beside your science lessons, not instead of them.
NOTICE FIRST	Two minutes of looking before any explaining. Every scientist starts by noticing.
TRY IT	What you need for the week's investigation. Most of it is already in a classroom or a kitchen, and the teacher guide lists the few things to gather.
WORDS TO KEEP	One or two words pinned down properly.
PRACTICE DATA	Results made up for the page so everyone can answer the same questions. Your own results will be different, and yours are the real ones.
MODEL BOOK	The one thing you build all year, in a notebook your teacher gives you: 18 pages of drawings of things you cannot see, each with its evidence.
TALK ABOUT IT	Two questions to talk over with someone at home or at school.
STUCK? TRY THIS	A way in when the page stops making sense.
CHALLENGE ZONE	Harder, and usually open. For whoever finishes early.

The one question of the whole year

What is the evidence? Particles are too small to see and stars are too far to visit, so every week asks what you CAN see that tells you about what you cannot. And every test changes one thing at a time, so you know what caused what.

WEEK	TITLE	TOPIC	STANDARD
PART 1 · WEEKS 1–10 · WHAT MATTER IS MADE OF			
1	**Too Small to See**	Matter	5-PS1-1
2	**Air Is Something**	Matter	5-PS1-1
3	**Where Did the Sugar Go?**	Matter	5-PS1-1
4	**Weigh It Before and After**	Matter	5-PS1-2
5	**Nothing Lost**	Matter	5-PS1-2
6	**Tell Them Apart**	Matter	5-PS1-3
7	**Properties as Evidence**	Matter	5-PS1-3
8	**Mix and Watch**	Matter	5-PS1-4
9	**New, or Just Mixed?**	Matter	5-PS1-4
10	**A Model of the Invisible**	Review	5-PS1-1
PART 2 · WEEKS 11–19 · FROM MATTER TO LIVING THINGS			
11	**Where a Tree Gets Its Mass**	Organisms	5-LS1-1
12	**Built From Air and Water**	Organisms	5-LS1-1
13	**Energy From the Sun**	Organisms	5-PS3-1
14	**Food Is Stored Sunlight**	Organisms	5-PS3-1
15	**Who Eats Whom**	Organisms	5-LS2-1
16	**The Decomposers**	Organisms	5-LS2-1
17	**Matter Goes Around**	Organisms	5-LS2-1
18	**A Model Ecosystem**	Organisms	5-LS2-1

WEEK	TITLE	TOPIC	STANDARD
19	**Follow One Particle**	Review	5-LS2-1
PART 3 · WEEKS 20–28 · EARTH'S SYSTEMS			
20	**Four Spheres**	Earth	5-ESS2-1
21	**Spheres Interact**	Earth	5-ESS2-1
22	**Where the Water Is**	Earth	5-ESS2-2
23	**Fresh Water Is Rare**	Earth	5-ESS3-1
24	**Protecting a Resource**	Earth	5-ESS3-1
25	**What a Community Can Do**	Earth	5-ESS3-1
26	**Down Is Toward Earth**	Gravity	5-PS2-1
27	**Down Is Different Everywhere**	Gravity	5-PS2-1
28	**One System**	Review	5-ESS2-1
PART 4 · WEEKS 29–36 · PATTERNS IN THE SKY			
29	**Shadows Through the Day**	Sky	5-ESS1-2
30	**Graph a Shadow**	Sky	5-ESS1-2
31	**Day and Night**	Sky	5-ESS1-2
32	**Stars by Season**	Sky	5-ESS1-2
33	**Brighter Because Closer**	Sky	5-ESS1-1
34	**Near and Far Lights**	Sky	5-ESS1-1
35	**Design to Measure**	Design	3-5-ETS1-1
36	**Too Small, Too Far**	Review	5-ESS1-1

WEEK 1 MATTER

Too Small to See

You can smell something across a room without seeing anything cross it.

SITS BESIDE
Matter is made of particles (5-PS1-1)

NOTICE FIRST · 2 MINUTES
Someone peels an orange across the room. How do you know before you see it?

TRY IT · YOU WILL NEED

- a small bottle of vanilla
- a timer with seconds
- a tape measure

Safely: Never taste anything in an investigation, even food from the kitchen. Smell by waving the air toward your nose. Never sniff straight from a bottle.

WORDS TO KEEP

particle A piece of matter far too small to see. All matter is made of particles.



Something crossed the room

Open a bottle of vanilla at the front of the room. Everyone raises a hand the moment they smell it. Can't smell it? Watch your neighbor's hand.

Nobody sees anything leave the bottle, yet people at the back of the room smell it. Something crossed the room, and it was too small to see. Scientists call those tiny pieces **particles**.

Every solid, liquid and gas is made of particles. You cannot see one, so this whole year is about evidence: what you can see that tells you what you cannot.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

How long until the smell arrived?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class opened a bottle of vanilla and timed how long each group took to smell it. Each group sat at a different distance.

Distance from the bottle	Seconds until they smelled it
1 m	10
2 m	25
3 m	45
4 m	70
5 m	100

Which group waited the longest? _____

How many seconds after the 2 m group did the 4 m group smell it? _____

Nobody saw anything cross the room. What crossed it?

_____

▶ ADD TO YOUR MODEL BOOK

Start your Model Book. Draw the room with the vanilla bottle, and draw the particles nobody could see as dots. Label what told you they were there.

💬 TALK ABOUT IT

Name a smell that reaches you before you can see where it comes from.

Why do you think you can smell bread baking from another room?



STUCK? TRY THIS

Find the 2 m row and the 4 m row. Subtract the smaller number of seconds from the larger.

★ CHALLENGE ZONE

Predict how long the group at 6 m would wait. Look at how much longer each meter takes than the one before.

WEEK 2 MATTER

Air Is Something

You cannot see air, but it takes up space and it has mass.

SITS BESIDE
Matter is made of particles (5-PS1-1)

NOTICE FIRST · 2 MINUTES
Blow up a paper bag or squeeze an empty bottle. What is inside pushing back?

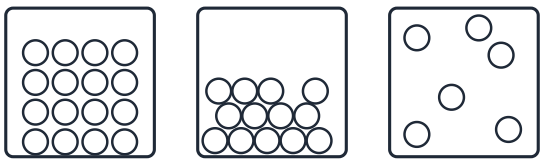
TRY IT · YOU WILL NEED

- a clear cup
- a paper towel
- a tub of water

Safely: Wipe up spills so nobody slips.

WORDS TO KEEP

matter	Anything that has mass and takes up space: every solid, liquid and gas.
mass	How much matter something has. A scale measures it in grams.



The dry paper towel

Stuff a paper towel into the bottom of a cup. Turn the cup upside down and push it straight down into a tub of water.

Lift it straight out. The towel is dry, because the cup was already full of air and the water could not get in. Air takes up space. It is **matter**.

In a solid, particles are packed tightly and held in place. In a liquid they touch but slide past each other. In a gas, like air, they are far apart and fly around. Air is matter even though you can see through it.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Pumping air into a ball

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class let air out of a ball until it was soft, weighed it, then pumped air back in five pumps at a time.

Pumps of air	Mass of the ball
0	410 g
5	412 g
10	414 g
15	416 g
20	418 g

How many grams did 20 pumps of air add? _____

How many grams did every 5 pumps add? _____

Is air matter? How does the table show it?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Air Is Matter: draw the cup in the water, with the air inside drawn as particles, and explain why the towel stayed dry.

💬 TALK ABOUT IT

Name three things around you that are full of air.

Why does a bicycle tire go flat when it gets a hole?



STUCK? TRY THIS

Subtract the first row's mass from the last row's mass.

★ CHALLENGE ZONE

How many pumps would it take to add 10 grams? Explain how you used the table.

WEEK 3 MATTER

Where Did the Sugar Go?

Stir a sugar cube into water and it vanishes. The sugar is still there.

SITS BESIDE
Matter is made of particles (5-PS1-1)

NOTICE FIRST · 2 MINUTES
Watch a sugar cube in a glass of water for one minute without stirring. What do you see at the bottom?

TRY IT · YOU WILL NEED

- sugar cubes
- two clear cups
- cold water and warm tap water
- a spoon
- a timer with seconds

Safely: Never taste anything in an investigation, even food from the kitchen. Use warm tap water only, never hot.

WORDS TO KEEP

dissolve To break apart into particles too small to see and spread all through a liquid.

Gone, but not gone

Drop a sugar cube into water and stir. Soon you cannot see it at all.

The sugar did not disappear. It broke apart into particles far too small to see, and they spread out between the particles of the water. That is what **dissolve** means.

Here is the evidence. Put a few drops of the sugar water on a dark plate and leave it for a day. When the water is gone, the sugar is still on the plate.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Cold, cool and warm

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class stirred one sugar cube into each cup the same way and timed how long it took to vanish. Only the water's temperature changed.

Water	Temperature	Seconds to dissolve
cold	40°F	180
room temperature	70°F	95
warm	100°F	50

In which water did the cube dissolve fastest? _____

How many seconds faster in warm water than in cold? _____

The cube vanished. How could you show the sugar is still in the water?

_____

TALK ABOUT IT

Why do you think sugar is easier to stir into hot cocoa than into iced tea?

Name something besides sugar that dissolves in water.



STUCK? TRY THIS

Fastest means the fewest seconds. For the second question, subtract the warm time from the cold time.

★ CHALLENGE ZONE

Would a spoonful of loose sugar dissolve faster than a cube? Plan a fair test: what would you change, and what would you keep the same?

WEEK 4 MATTER

Weigh It Before and After

Melt it, tear it or dissolve it. Weigh it again, and the mass has not changed.

SITS BESIDE
Matter is conserved (5-PS1-2)

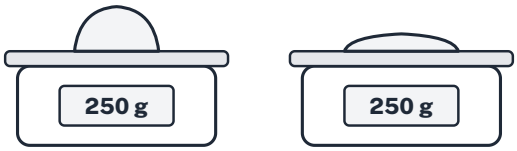
NOTICE FIRST · 2 MINUTES
A puddle on the playground is gone by the afternoon. Where do you think the water went?

TRY IT · YOU WILL NEED

- a zipper bag
- 3 ice cubes
- a kitchen scale

WORDS TO KEEP

evaporate To change from a liquid into a gas that mixes into the air.



ice in a bag — the same bag, melted

Nothing goes missing

Seal three ice cubes in a zipper bag and weigh it. Leave it until the ice has melted, then weigh it again.

The mass is the same. The ice changed into a liquid, but every particle is still in the bag. When matter changes, the particles move around, and none of them vanish.

So when something seems to lose mass, ask where the particles went. Water in an open dish can **evaporate** into the air, and the dish gets lighter because some of the water is somewhere else.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four changes, weighed twice

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class weighed four things, made a change, and weighed them again.

	The change	Before	After
a	ice melting in a sealed bag	250 g	250 g
b	sugar stirred into a cup of water	320 g	320 g
c	a sheet of paper torn into pieces	5 g	5 g
d	water left in an open dish for a week	200 g	140 g

In which change did the mass go down? _____

How many grams did it go down? _____

Where did those grams of water go?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Nothing Lost: draw the ice in its bag before and after melting, with the particles, and write both weights.

💬 TALK ABOUT IT

Why do wet clothes get lighter as they dry on a line?

If you cut an apple into slices, does the apple weigh less? How could you check?



STUCK? TRY THIS

Compare the before and after columns row by row. Only one row changes.

★ CHALLENGE ZONE

How could you change row d so the mass stays the same? What would you have to stop?

WEEK 5 MATTER

Nothing Lost

Mix two things and watch them change. If nothing escapes, the mass stays the same.

SITS BESIDE
Matter is conserved (5-PS1-2)

NOTICE FIRST · 2 MINUTES
Think of opening a bottle of soda water. What do you hear? What is leaving the bottle?

TRY IT · YOU WILL NEED

- a quarter cup of milk
- two spoonfuls of vinegar
- two cups
- a kitchen scale

Safely: Never taste anything in an investigation, even food from the kitchen. Keep vinegar away from your eyes. Anyone with a milk allergy watches and records.



Weigh before and after

Pour milk into one cup and vinegar into the other. Weigh both cups together.

Pour the vinegar into the milk and swirl the cup gently. Do not use a spoon: milk left on it would leave the scale. White lumps form, with properties the milk did not have. Put both cups back on the scale, the empty one too. The mass is the same, because every particle is still in the cups.

Some mixings make a gas. Baking soda and vinegar fizz, and in an open cup the gas goes into the air, so the cup gets lighter. Catch the gas in a balloon, and none of the mass goes missing.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Closed and open

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class mixed the same amounts of baking soda and vinegar twice: once in a bottle with a balloon, and once in an open cup.

Setup	Mass before mixing	Mass after mixing
bottle and balloon	512 g	512 g
open cup	486 g	481 g

Which setup weighed less after mixing? _____

How many grams less? _____

Where did those grams go?

_____

💬 **TALK ABOUT IT**

Why does a bottle of soda water go flat if you leave the cap off?

What else have you seen fizz? Where did the bubbles go?



STUCK? TRY THIS

Subtract the after number from the before number for each setup. Only one is not zero.

★ **CHALLENGE ZONE**

Someone says the open cup proves that mixing destroys matter. Write two sentences to explain why they are wrong.

WEEK 6 MATTER

Tell Them Apart

Four powders look alike at a glance. Their properties are not alike.

SITS BESIDE
Identifying materials by their properties (5-PS1-3)

NOTICE FIRST · 2 MINUTES
Look closely at sugar, then at flour. What can you tell apart just by looking?

TRY IT · YOU WILL NEED

- small spoonfuls of sugar, flour, sand and baking soda
- vinegar
- water
- four clear cups
- a spoon

Safely: Never taste anything in an investigation, even food from the kitchen. Keep vinegar away from your eyes.

WORDS TO KEEP

property Something you can observe or measure about a material, like its color, its hardness or whether it dissolves.

Test, do not guess

Put a little of each powder in its own cup. Test each one three ways.

Does it **dissolve** in water? Does it fizz when you add a few drops of vinegar? Does it feel gritty or smooth between your fingers?

Each answer is a **property**. One property may not be enough to tell two powders apart, but a few together can be. That is how scientists identify a material they cannot name by looking.

NOTES AND DRAWINGS

Three mystery powders

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class tested four known powders, then three mystery powders.

Known powder	Dissolves	Fizzes in vinegar	Feels
sugar	yes	no	gritty
sand	no	no	gritty
flour	no	no	smooth
baking soda	yes	yes	smooth

Mystery	Dissolves	Fizzes in vinegar	Feels	It is
P	no	no	gritty	
Q	yes	yes	smooth	
R	no	no	smooth	

Fill in what each mystery powder is.

Which ONE property, by itself, tells baking soda apart from all three others?

_____

TALK ABOUT IT

Name two things in a kitchen that look alike but are different.

Why do you think labels matter on things that look the same?



STUCK? TRY THIS

Match each mystery row to the known row with the same three answers.

★ CHALLENGE ZONE

Salt is another white powder. It dissolves, does not fizz, and feels gritty. Which known powder could be mixed up with it? Name a new test that might tell them apart.

WEEK 7 MATTER

Properties as Evidence

A recycling center sorts a mountain of trash without reading a single label.

SITS BESIDE
Identifying materials by their properties (5-PS1-3)

NOTICE FIRST · 2 MINUTES
Look at the recycling at school. How many different materials can you name?

TRY IT · YOU WILL NEED

- a magnet
- a steel paper clip
- an aluminum pull tab from a can
- a cork
- a glass marble
- a bowl of water

Safely: Keep small magnets out of your mouth.

Sorting by property

A recycling center gets steel, aluminum, glass and other materials all mixed together. Machines sort them by their properties.

A big magnet pulls out the steel, because steel is pulled by a magnet. Pieces that float are skimmed off a tank of water. Some machines sort by how much light passes through a piece.

Test your four objects: does a magnet pull it, and does it float when you drop it into the water? Steel and aluminum are both metals, but only one is pulled by a magnet.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Four pieces to sort

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class tested a small piece of each material.

Piece	A magnet pulls it	It floats in water	You can see through it
steel	yes	no	no
aluminum	no	no	no
glass	no	no	yes
cork	no	yes	no

Which property pulls out the steel? _____

Which piece floats? _____

Aluminum and glass both sink, and a magnet pulls neither. Which property tells them apart? _____

TALK ABOUT IT

Why is it worth sorting trash before it is recycled?

Name a material you could sort out of a pile with a magnet.



STUCK? TRY THIS

Read down one column at a time. Look for the column where only one piece says yes.

★ CHALLENGE ZONE

Design a sorting machine for these four pieces in three steps. Which property does each step use?

WEEK 8 MATTER

Mix and Watch

Some mixing makes a substance that was not there before.

SITS BESIDE
Mixing can make a new substance (5-PS1-4)

NOTICE FIRST · 2 MINUTES
Think of a cake. Can you get the eggs and the flour back out of it?

TRY IT · YOU WILL NEED

- baking soda
- vinegar
- a clear cup
- a spoon

Safely: Never taste anything in an investigation, even food from the kitchen. Keep vinegar away from your eyes.

WORDS TO KEEP

reaction A change in which substances mix and make a new substance with different properties.

Clues to a new substance

Put a spoonful of baking soda in a cup and add a little vinegar. Watch and listen.

It fizzes. The bubbles are a gas that was not in the baking soda or the vinegar before. Mixing them made a new substance. That is a **reaction**.

Clues that a new substance formed: a gas you did not put in, a solid that appears in a liquid, a new color or smell, or the mixture getting warmer or colder on its own. Feel the cup: it may be a little colder.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Five mixings

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class mixed five pairs of kitchen materials and wrote down what they saw.

	What was mixed	What they saw	New substance?
a	sand and water	the sand sinks to the bottom	
b	baking soda and vinegar	bubbles of gas	
c	salt and water	the salt dissolves	
d	milk and vinegar	white lumps form	
e	sugar and water	the sugar dissolves	

How many mixings made a new substance? _____

Which TWO? _____

What clue did each of those two give?

_____

TALK ABOUT IT

Name something cooked that cannot be turned back into what it was made from.

Is dissolving a reaction? Use row c or row e to explain.



STUCK? TRY THIS

A new substance gives a clue: a gas, a new solid, a new color or smell. Dissolving is not one.

★ CHALLENGE ZONE

Rust forms when steel stays wet for a long time. Is rust a new substance? Name one clue that tells you.

WEEK 9 MATTER

New, or Just Mixed?

A mixture can be taken apart again, because every part keeps its own properties.

SITS BESIDE
Mixing can make a new substance (5-PS1-4)

NOTICE FIRST · 2 MINUTES
Look at a bowl of trail mix or a jar of buttons. Could you sort it back into its parts?

TRY IT · YOU WILL NEED

- a spoonful of sand
- a spoonful of salt
- a few paper clips
- a magnet
- a coffee filter
- two cups
- water

Safely: Never taste anything in an investigation, even food from the kitchen.

WORDS TO KEEP

mixture Two or more substances mixed together, each one keeping its own properties.

Take it apart

Stir sand, salt and paper clips together. Can you get each one back?

A magnet pulls out the paper clips. Add water and the salt dissolves, so pour it through a coffee filter: the sand stays in the filter and the salty water runs through. Leave that water on a sunny windowsill for a few days, and when it has evaporated the salt is left behind.

Each part kept its own properties the whole time. That is a **mixture**. Baking soda and vinegar are different: after the fizz, no step gets them back.

NOTES AND DRAWINGS

Taking apart 100 grams

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class mixed paper clips, sand and salt into 100 grams of mixture, then took it apart.

Part	How they got it back	Mass
paper clips	a magnet	30 g
sand	water and a filter	45 g
salt	letting the water dry up	25 g

How many grams did they get back in all? _____

Was any of the mixture lost? _____

Which step got the salt back? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called Mixed or New: draw this week's mixture as particles, each kind keeping its own shape, then draw baking soda and vinegar making particles of a new kind.

💬 TALK ABOUT IT

Name a mixture you have seen or used today.

Why does the salt pass through the filter when the sand does not?



STUCK? TRY THIS

Add the three masses. Compare the total with the mass they started with.

★ CHALLENGE ZONE

Which property of each part did each step use? Name the property for the paper clips, the sand and the salt.

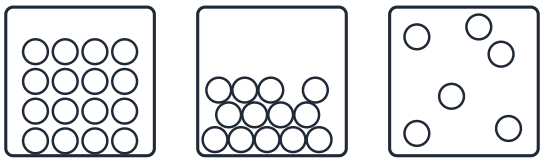
WEEK 10 REVIEW

A Model of the Invisible

Nine weeks in one idea: matter is made of particles too small to see.

SITS BESIDE
Matter is made of particles (5-PS1-1)

NOTICE FIRST · 2 MINUTES
Breathe on a cold window. Where did the cloudy patch come from, and where does it go?



Part 1 on one card

All **matter** is made of **particles** far too small to see. In a gas they are far apart. Air is invisible, and it still has mass.

When something **dissolves** or **evaporates**, its particles spread out. They do not vanish.

Weigh matter before and after a change. If nothing can get in or out, the mass stays the same.

A **mixture** can be taken apart. A **reaction** makes a new substance.

NOTES AND DRAWINGS

Two jars of water

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class put the same amount of water in two jars, closed one with a lid, and weighed both every day.

Day	0	1	2	3	4
Open jar	300 g	290 g	281 g	270 g	261 g
Closed jar	300 g	300 g	300 g	300 g	300 g

How many grams did the open jar lose in 4 days? _____

Between which two days did the open jar lose the most? _____

Why did the closed jar stay the same?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called My Particle Model: three things from Part 1, each drawn as particles, with one sentence of evidence for each.

💬 TALK ABOUT IT

Explain to someone at home why a puddle dries up, using the word particles.

What is one thing you now think is made of particles that you did not before?



STUCK? TRY THIS

Subtract each day's open-jar mass from the day before. The biggest difference answers the second question.

★ CHALLENGE ZONE

Draw what the particles of water are doing in each jar on day 4.

WEEK 11 ORGANISMS

Where a Tree Gets Its Mass

A huge tree grows from a tiny seed. Very little of it came from the soil.

SITS BESIDE
Plants are built from air and water (5-LS1-1)

NOTICE FIRST · 2 MINUTES
A giant tree started as a seed smaller than your fingernail. Where did all that wood come from?

TRY IT · YOU WILL NEED

- a dry bean
- a clear cup of soil
- water
- a ruler

Safely: Never taste anything in an investigation, even food from the kitchen. Never eat dry beans: raw, they can make you sick.

Weigh the soil

Most people guess a plant is made from soil. A class can test that guess with a kitchen scale.

Weigh a pot of soil, plant a seed, and water it for weeks. Then weigh the plant and the soil separately. The plant gains far more mass than the soil loses. Page 2 has one class's numbers.

So where did the plant's mass come from? Mostly from two things you cannot hold in your hand while it happens: the water it drinks and a gas it takes in from the air. Next week is about that gas.

DRAW IT
Draw your bean each week. Write its height beside each drawing.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Eight weeks of a bean plant

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class weighed a pot of soil and a bean seed, gave the plant 900 g of water over 8 weeks, then weighed the soil and the plant again.

	At the start	After 8 weeks
Soil	2,000 g	1,998 g
Bean plant	1 g	60 g

How many grams did the plant gain? _____

How many grams did the soil lose? _____

Could the soil alone have built the plant? Use the numbers.

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Where It Came From: draw your bean plant with arrows showing what came in from the air, from the water, and a little from the soil.

💬 TALK ABOUT IT

Ask someone at home where they think a tree's wood comes from. Then tell them what the soil test shows.

Why do you think plants in a pot still need water every week?



STUCK? TRY THIS

Subtract the start from the end for the plant, and the end from the start for the soil. Compare the two answers.

★ CHALLENGE ZONE

The plant drank 900 g of water but only weighs 60 g. Where could the rest of the water have gone? Use a word from Part 1.

WEEK 12 ORGANISMS

Built From Air and Water

A plant takes in a gas from the air and water from the ground, and builds itself.

SITS BESIDE
Plants are built from air and water (5-LS1-1)

NOTICE FIRST · 2 MINUTES
Look at a leaf up close. It has tiny holes you cannot see. What do you think goes in and out?

TRY IT · YOU WILL NEED

- two small plants of the same kind
- a ruler
- a dark closet
- water

WORDS TO KEEP

carbon dioxide — A gas in the air. Plants take it in and, with water and the energy of light, build their bodies from it.



What a leaf does

A plant takes in **carbon dioxide** from the air through tiny holes in its leaves, and water through its roots.

Using the energy of light, it builds them into sugar, its own food. It gives off another gas, oxygen, which is the gas you breathe in. The sugar becomes the plant's leaves, stems and roots.

Test the light part. Put one plant in a sunny window and one in a dark closet. Give both the same water for a week, then compare.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Bubbles from a water plant

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class put a water plant in water near a lamp and counted the bubbles of oxygen it gave off each minute. Only the lamp's distance changed.

Lamp's distance	Bubbles each minute
10 cm	30
20 cm	18
30 cm	9
40 cm	4

How many more bubbles a minute at 10 cm than at 30 cm? _____

Finish the sentence: the farther the lamp, _____

What gas is in the bubbles? _____

TALK ABOUT IT

Why do you think houseplants are usually kept near windows?

Plants give off oxygen. Why does that matter to animals?



STUCK? TRY THIS

Find the 10 cm row and the 30 cm row, and subtract.

★ CHALLENGE ZONE

Your plant in the closet had water but no light. Predict what it looked like after a week, and explain using this week's card.

WEEK 13 ORGANISMS

Energy From the Sun

Follow the energy in any food far enough back and you reach the sun.

SITS BESIDE
Energy in food came from the sun (5-PS3-1)

NOTICE FIRST · 2 MINUTES
Look at a tree or a plant in sunlight. Where is it getting its energy right now?



Every food starts with sunlight

A plant uses the energy of sunlight to make its food. That energy is now stored in the plant.

When a cow eats grass, the energy moves into the cow. When you drink the cow's milk or eat cheese made from it, some of that energy moves into you.

Pick any food and trace it back: an animal ate a plant, or ate an animal that ate a plant. At the start of the chain is always a plant or algae, and it got its energy from the sun.

NOTES AND DRAWINGS

Four foods, traced back

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Each row traces one food back to where its energy began.

	Food	Where its energy came from
a	an apple	sun → apple tree → you
b	cheese	sun → grass → cow → you
c	an egg	sun → corn → hen → you
d	a fish	sun → algae → small fish → big fish → you

In every chain, what comes first? _____

Which food's chain has the most living things before you? _____

Which food's chain has only one living thing before you? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called Sunlight on Your Plate: choose a food you like and draw its chain all the way back to the sun.

💬 TALK ABOUT IT

Pick a food you like and trace its energy back to the sun out loud.

Is there any food whose energy did not start with the sun? Try to think of one.



STUCK? TRY THIS

Count only the living things in each chain. Leave out the sun and leave out you.

★ CHALLENGE ZONE

Draw the longest food chain you can think of that ends with you. How many living things are in it?

WEEK 14 ORGANISMS

Food Is Stored Sunlight

Energy moves up a food chain, and at every step most of it goes somewhere else.

SITS BESIDE
Energy in food came from the sun (5-PS3-1)

NOTICE FIRST · 2 MINUTES
Rub your hands together fast for ten seconds. What do you feel, and where did it come from?

WORDS TO KEEP

producer	A living thing that makes its own food using the energy of light, like a plant.
consumer	A living thing that gets its energy by eating other living things.



Where the energy goes

Grass is a **producer**: it makes its own food from light. A rabbit is a **consumer**: it gets energy by eating.

Most of the energy a rabbit takes in goes into hopping, breathing and keeping warm, and that warmth spreads into the air around it. Some leaves in its droppings. Only a small part is stored in the rabbit's growing body.

So when a fox eats the rabbit, the fox gets only that small part. That is why there is far more grass than rabbits, and far more rabbits than foxes.

NOTES AND DRAWINGS

Energy up a food chain

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

These made-up energy units show about how much energy each living thing in the chain takes in.

Living thing	Energy units it takes in
grass (from sunlight)	1,000
rabbit (from the grass)	100
fox (from the rabbit)	10

How many units reach the rabbit? _____

How many times more energy is in the grass than reaches the fox? _____

The rabbit got 100 units and passed on 10. Where did the rest go?

_____

TALK ABOUT IT

Why do you think there are fewer lions than zebras?

Why do you feel warm after you exercise?



STUCK? TRY THIS

Divide the grass's units by the fox's units.

★ CHALLENGE ZONE

A hawk eats foxes. Using the same pattern, about how many units would reach the hawk? Explain the pattern you used.

WEEK 15 ORGANISMS

Who Eats Whom

In a real pond, most animals eat more than one thing, and most are eaten by more than one.

SITS BESIDE
Matter moving through an ecosystem (5-LS2-1)

NOTICE FIRST · 2 MINUTES
Think of a pond, a park or a garden. Name three living things there, and one thing each of them eats.

WORDS TO KEEP

food web	All the feeding links in one place: who eats whom.

From chain to web

A food chain follows one path. A real pond has many paths that cross.

A duck eats snails, tadpoles and small fish. A small fish eats algae and tadpoles. Draw every link and you get a **food web**.

Each arrow carries matter as well as energy: the particles in a snail become part of the duck that eats it. A web shows why losing one living thing can change life for many others.

DRAW IT
Draw this pond's food web, with an arrow from each food to the animal that eats it.

A pond food web

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

The table shows who eats each living thing in one pond.

Living thing	It is eaten by
algae	snail, tadpole, small fish
tadpole	small fish, duck
snail	duck
small fish	heron, duck

Which living thing is eaten by the most others? _____

Which animal eats the most kinds of food? _____

If every snail disappeared, which animal would lose one of its foods? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called A Web Near You: draw a food web of at least four living things that live near your school, with an arrow from each food to what eats it.

💬 TALK ABOUT IT

Why might farmers care about the birds that eat insects on their land?

Name an animal that eats both plants and animals.



STUCK? TRY THIS

For the second question, turn the table around: count how many times each animal appears in the right-hand column.

★ CHALLENGE ZONE

Herons are not eaten by anything in this pond. If the herons left, what might happen to the small fish, and then to the algae?

WEEK 16 ORGANISMS

The Decomposers

Dead leaves fall every year, and the forest floor does not pile up to the treetops.

SITS BESIDE
Matter moving through an ecosystem (5-LS2-1)

NOTICE FIRST · 2 MINUTES
Find an old leaf on the ground. How is it different from a leaf on a tree?

TRY IT · YOU WILL NEED

- two slices of the same bread
- two zipper bags
- a spray bottle of water
- a ruler

Safely: Never taste anything in an investigation, even food from the kitchen. Seal both bags and never open them. Throw them away still sealed.

WORDS TO KEEP

decomposer — A living thing that breaks down dead plants and animals, like mold, mushrooms and worms.



The clean-up crew

Mold, mushrooms, worms and living things too small to see break down dead plants and animals. They are **decomposers**.

As they feed, they return the particles to the soil and the air, where plants can use them again. Without decomposers, dead things would pile up and the matter in them would be stuck.

Spray one slice of bread with water and leave the other dry. Seal each in its own bag, keep them side by side, and check them every two days without opening the bags.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Damp bread and dry bread

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class drew a grid of 100 squares over each slice and counted the squares with mold. Only the water changed.

Day	0	2	4	6	8
Damp bread	0	5	20	45	80
Dry bread	0	0	0	2	5

On day 8, how many more squares had mold on the damp bread? _____

Between which two days did the damp bread change the most?

_____

Why does the forest floor not pile up higher every year?

_____

TALK ABOUT IT

Why do you think bread is sold in a sealed bag?

Where have you seen mold or mushrooms growing outdoors?



STUCK? TRY THIS

Subtract each day's number on the damp row from the next one. The biggest difference answers the second question.

★ CHALLENGE ZONE

Plan a fair test of whether warmth changes how fast mold grows. What would you change, and what would you keep the same?

WEEK 17 ORGANISMS

Matter Goes Around

The particles in a leaf can end up in the air, then in a plant, then in you.

SITS BESIDE
Matter moving through an ecosystem (5-LS2-1)

NOTICE FIRST · 2 MINUTES
Look at a pile of fallen leaves or grass clippings. What will it look like in a year?

TRY IT · YOU WILL NEED

- a clear jar with a lid
- soil
- a few dead leaves
- water

Safely: Rest the lid on loosely, and never open the jar once mold appears. Wash your hands after touching soil.

WORDS TO KEEP

cycle A path that comes back to where it started, again and again.



Around and around

Matter in an ecosystem moves in a **cycle**.

A plant builds itself from air and water. An animal eats the plant. When the plant or the animal dies, decomposers break it down. As they feed, they give off carbon dioxide and water into the air and leave matter in the soil.

Then a plant takes in that carbon dioxide and that water, and the cycle starts again. The same particles get used over and over.

DRAW IT

Draw your jar now. In two weeks, draw it again beside the first drawing.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

A compost pile

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A school weighed its compost pile of leaves and food scraps every two weeks.

Week	Mass of the pile
0	12 kg
2	9 kg
4	7 kg
6	6 kg
8	5 kg

How many kilograms smaller was the pile after 8 weeks? _____

Between which two weeks did it lose the most? _____

Where did the missing matter go?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Around and Around: draw matter's path from the air to a plant to an animal to a decomposer, and back to the air.

💬 TALK ABOUT IT

Why do some people put food scraps in a compost bin instead of the trash?

Name one thing in the room that was once part of a living thing.



STUCK? TRY THIS

Subtract each row from the one before. Remember the decomposers breathe out a gas.

★ CHALLENGE ZONE

Draw the path of one particle that starts in a fallen apple and ends up in a new apple. Name every stop.

WEEK 18 ORGANISMS

A Model Ecosystem

Seal a bottle with soil, plants and water, and it can keep going on its own.

SITS BESIDE
Matter moving through an ecosystem (5-LS2-1)

NOTICE FIRST · 2 MINUTES
Look at an aquarium or a garden bed. What keeps it going without anyone adding food?

TRY IT · YOU WILL NEED

- a clear plastic bottle with its cap
- soil
- small plants or grass seeds
- water

A world in a bottle

Put soil, a few small plants and a little water in a clear bottle. Close the cap and set it in bright light, out of direct sun.

No matter goes in or out: only light comes in, and warmth leaves. The plants use water and carbon dioxide. Water evaporates, condenses on the sides and runs back down. Decomposers in the soil break down dead leaves. Matter cycles inside, and energy comes in as light.

A real ecosystem works the same way, and its living things affect each other. More of one animal can mean fewer of another.

DRAW IT
Draw your sealed bottle. Label where you think the water goes as it moves around.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Rabbits and foxes on an island

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Scientists counted the rabbits and the foxes on a small island every year for five years.

Year	1	2	3	4	5
Rabbits	40	70	100	60	40
Foxes	5	6	9	14	8

In which year were there the most rabbits? _____

In which year were there the most foxes? _____

Why do you think the rabbits went down in year 4?

_____

TALK ABOUT IT

Why do you think the foxes went down in year 5?

What would your bottle need if you never opened it again?



STUCK? TRY THIS

Find the biggest number in each row. Then compare the two years.

★ CHALLENGE ZONE

Predict the rabbits and the foxes in year 6. Explain your prediction using what happened in years 3, 4 and 5.

WEEK 19 REVIEW

Follow One Particle

Eight weeks in one journey: a particle goes from the air, through living things, and back.

SITS BESIDE
Matter moving through an ecosystem (5-LS2-1)

NOTICE FIRST · 2 MINUTES
Take a deep breath in and out. Where could the air you just breathed out go next?



Part 2 on one card

A plant is built mostly from **carbon dioxide** and water, using the energy of light. Very little of it comes from the soil.

The energy in every food was once sunlight. **Producers** make food; **consumers** eat. At every step most of the energy goes into moving and warmth.

A **food web** shows who eats whom. **Decomposers** break down dead things, and matter moves in a **cycle**: the same particles, used again and again.

NOTES AND DRAWINGS

One particle's journey

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

These six steps are out of order. Number them from 1 to 6 in the order they happen.

	What happens	Order
a	a rabbit eats the clover leaf	
b	the particle floats in the air, as part of the carbon dioxide	
c	decomposers break down the rabbit's body	
d	a clover leaf takes in the particle	
e	the particle goes back into the air	
f	the rabbit dies	

Which row happens first? _____

Which row happens last? _____

How many kinds of living things held the particle along the way, counting the decomposers? _____

TALK ABOUT IT

Tell someone at home the journey of one particle, from the air and back again.

Which part of Part 2 surprised you most?



STUCK? TRY THIS

Start with the air, because a plant takes the particle in from there. The air is also where it ends up.

★ CHALLENGE ZONE

Write a new journey for a particle of water instead. Where does it start, and where does it go?

WEEK 20 EARTH

Four Spheres

Scientists split the Earth into four big systems that overlap and act on each other.

SITS BESIDE
Earth's spheres interact (5-ESS2-1)

NOTICE FIRST · 2 MINUTES
Look out of a window. Find something solid, something wet, something in the air and something alive.

WORDS TO KEEP

geosphere	Earth's rock, soil and sand.
hydrosphere	All of Earth's water: oceans, lakes, rivers, ice and water underground.
atmosphere	The layer of air around Earth.
biosphere	All of Earth's living things.

Rock, water, air and life

The Earth is a system of four parts that scientists call spheres.

The **geosphere** is the rock and soil. The **hydrosphere** is the water, liquid or frozen. The **atmosphere** is the air. The **biosphere** is everything alive.

They are not separate. A fish lives in water, breathes oxygen from it, and swims over a rocky bottom. Next week is about how the spheres act on each other.

DRAW IT
Go outside for five minutes. Draw or list one thing from each sphere.

Sort into spheres

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Write which sphere each thing belongs to.

	Thing	Sphere
a	sand on a beach	
b	a lake	
c	the wind	
d	an oak tree	
e	a glacier	
f	a mountain	
g	a hawk	

Which sphere has only one row? _____

How many rows are the hydrosphere? _____

Name one thing that belongs to two spheres at once. _____

▶ ADD TO YOUR MODEL BOOK

Add a page called Four Spheres: draw one outdoor place you know, and label something from each sphere.

💬 TALK ABOUT IT

Which sphere do you think people depend on most? Explain your choice.

Name something in the room that came from the geosphere.



STUCK? TRY THIS

A glacier is frozen water. Ask whether each thing is rock, water, air or alive.

★ CHALLENGE ZONE

Draw a picture with all four spheres in it, and label one example of each.

WEEK 21 EARTH

Spheres Interact

Rain wears down a hill, roots crack a rock, wind raises waves. The spheres act on each other.

SITS BESIDE
Earth's spheres interact (5-ESS2-1)

NOTICE FIRST · 2 MINUTES
After a heavy rain, look at the ground near a slope. What did the water move?

TRY IT · YOU WILL NEED

- a tray of soil, piled into a hill at one end
- a cup of water
- a spray bottle
- a small stick

Safely: Wipe up spills so nobody slips.

One sphere changes another

Pile soil into a hill at one end of a tray. Spray it with water like rain, and watch where the soil goes.

The water, from the hydrosphere, carries soil, from the geosphere, down the slope. That is two spheres interacting.

It happens everywhere. Wind pushes on the ocean and makes waves. Plant roots crack rock. A volcano sends rock and ash into the air. Each change in one sphere can cause a change in another.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Which two spheres?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Write the two spheres that interact in each row.

	What happens	The two spheres
a	a puddle soaks into the ground	
b	a plant's roots crack a rock	
c	wind pushes ocean waves	
d	a volcano puts ash into the air	
e	a rabbit digs a burrow in the soil	

Which sphere is in the most rows? _____

How many rows include the biosphere? _____

Pick one row and say what moved from one sphere to the other.

_____

💬 TALK ABOUT IT

Name one way people change the geosphere.

How does the atmosphere affect the biosphere where you live?



STUCK? TRY THIS

Each row has exactly two spheres. Ask what is doing the acting and what is being acted on.

★ CHALLENGE ZONE

Write a chain of three interactions: one sphere acts on a second, and the second acts on a third.

WEEK 22 EARTH

Where the Water Is

Earth is covered in water, and almost none of it is fresh water you could drink.

SITS BESIDE
Where Earth's water is (5-ESS2-2)

NOTICE FIRST · 2 MINUTES
Look at a map or a globe. Is there more blue or more land?

TRY IT · YOU WILL NEED

- a 1-liter bottle of water
- a measuring cup
- three small cups
- a dropper or a spoon

WORDS TO KEEP

fresh water — Water with very little salt in it, like the water in rivers, most lakes, ice and most water underground.

All the water, in a bottle

Let a 1-liter bottle stand for all the water on Earth.

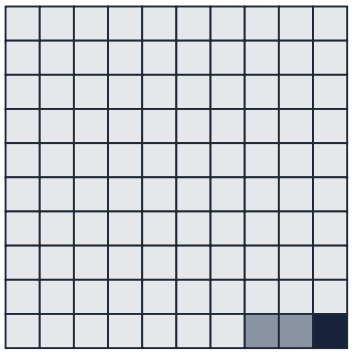
Pour out about 25 milliliters. Everything still in the bottle is salty, almost all of it ocean. The 25 milliliters you poured out is all the **fresh water**.

Now pour about 17 of those 25 milliliters into a second cup: that part is frozen, in ice and glaciers. Of the last 8 milliliters, almost all is underground. The water in every fresh lake and river on Earth would be one or two drops from your dropper.

NOTES AND DRAWINGS

Earth's water in 100 squares

Scientists estimate where all of Earth's water is. Rounded to whole squares out of 100, it looks about like this.



- salty ocean water
- fresh water, frozen as ice
- fresh water, liquid

Out of 100 squares, how many are fresh water? _____

How many of the fresh-water squares are frozen? _____

How many squares out of 100 are liquid fresh water? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called All the Water: draw a 100-square grid of your own, shade the fresh water, and write what each shade means.

💬 TALK ABOUT IT

Where does the water at your school come from? Find out if you can.

Why can people not simply drink ocean water?



STUCK? TRY THIS

Count the darker squares. Both darker shades are fresh water.

★ CHALLENGE ZONE

The real numbers are not exactly whole squares, which is why the page says “about.” Why do you think scientists still round them to explain them?

WEEK 23 EARTH

Fresh Water Is Rare

A school uses thousands of liters of fresh water every day. Measuring it is the first step to saving it.

SITS BESIDE
Communities protecting Earth's resources (5-ESS3-1)

NOTICE FIRST · 2 MINUTES
Turn on a drinking fountain and count to ten. How much water do you think came out?

TRY IT · YOU WILL NEED

- a measuring cup
- a timer with seconds

Safely: Ask before you use a fountain or a sink.

Measure a fountain

Hold a measuring cup under a drinking fountain for 10 seconds. How many milliliters did you catch?

Most of what comes out of a fountain is never drunk: it runs down the drain. Multiply what you caught in 10 seconds by every drink everyone at school takes in a day, and the number gets large.

All of that is fresh water, and you saw last week how little of Earth's water is fresh. A town has to collect it, clean it and pipe it to every building.

DRAW IT
Write how many milliliters you caught in 10 seconds. Then work out how many you would catch in one minute.

MY INVESTIGATION

I predict:

What happened:

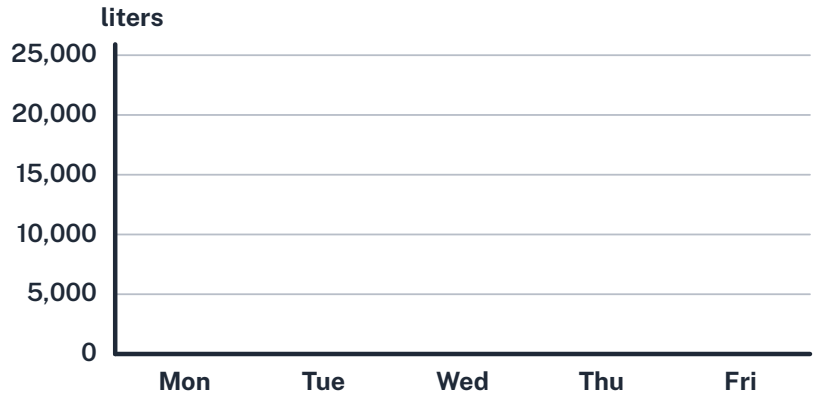
What I think caused it:

A school's water, day by day

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A school read its water meter every day for one week.

Day	Water used
Monday	9,000 liters
Tuesday	9,500 liters
Wednesday	24,000 liters
Thursday	9,200 liters
Friday	9,400 liters



Draw the bars. On which day did the school use the most water? _____

How many more liters on Wednesday than on Monday? _____

What might explain Wednesday? _____

TALK ABOUT IT

Where at school do you think the most water is used?

Name one time today you used fresh water.



STUCK? TRY THIS

Each line on the graph is 5,000 liters. Wednesday's bar goes almost to the top.

★ CHALLENGE ZONE

If the school used as much as Monday every day, how much would it use in five days? How much did it really use?

WEEK 24 EARTH

Protecting a Resource

Saving water is a design problem: a goal to reach and a limit on what it can cost.

SITS BESIDE
Communities protecting Earth's resources (5-ESS3-1)

NOTICE FIRST · 2 MINUTES
Walk past every sink and fountain at school. Do any of them drip?

WORDS TO KEEP

resource	Something from nature that people use, like water, soil, wood or air.

A goal and a budget

Fresh water is a **resource**, and so are soil, wood and clean air. Communities decide how to protect them.

A good plan has a goal you can measure and a limit you have to stay inside. A plan that saves a lot of water but costs more than anyone can pay will not happen. A plan that costs nothing but saves almost nothing is not worth much either.

So scientists and engineers measure both: how much a plan saves, and what it costs.

NOTES AND DRAWINGS

Four ways to save water

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A school wants to save at least 500 liters a week and can spend no more than $50.

	Idea	Liters saved each week	Cost
a	fix the leaking faucets	600	$10
b	put in new low-flow faucets	900	$200
c	water the field at night, when less evaporates	1,200	$0
d	put up signs about saving water	100	$5

Which TWO ideas meet the goal and stay inside the budget? _____

Which idea saves a lot but costs too much? _____

How many more liters a week does idea c save than idea a? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called Our Water Plan: one way your class could save water at school, how you would measure it, and what it would cost.

💬 TALK ABOUT IT

Which idea would you choose first for your school, and why?

Name a resource besides water that your school could save.



STUCK? TRY THIS

Check each idea against both rules: at least 500 liters, and $50 or less.

★ CHALLENGE ZONE

Idea b costs too much this year. Write a plan that could still make it happen in a few years.

WEEK 25 EARTH

What a Community Can Do

A town tries something to protect a beach. The numbers can show whether it helped.

SITS BESIDE
Communities protecting Earth's resources (5-ESS3-1)

NOTICE FIRST · 2 MINUTES
Look at the ground around your school, but pick nothing up. What is there that should not be?

Protecting a shared place

Trash on a beach washes into the ocean, where animals can swallow it or get tangled in it.

Communities try things to stop it: more trash cans, signs, clean-up days, rules about bags. Then they measure, before and after, to see what changed.

A drop in the numbers after a change is a clue that the change helped. It is not proof, because something else might have changed at the same time. A good scientist always asks what else it could be.

NOTES AND DRAWINGS

Bags of beach trash

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A town counted the bags of trash collected from its beach each month. In March, it put new trash cans along the beach.

Month	Bags of trash
January	40
February	38
March	30
April	22
May	15

How many fewer bags were collected in May than in February? _____

After the new trash cans, did the number of bags go down every month? _____

Name one other thing that could explain fewer bags.

_____

TALK ABOUT IT

What could your class do to keep the school grounds cleaner?

Why might fewer people visit a beach in some months?



STUCK? TRY THIS

February is the last month before the new cans. Compare it with May.

★ CHALLENGE ZONE

Plan how the town could find out whether the trash cans, and not something else, made the difference.

WEEK 26 GRAVITY

Down Is Toward Earth

Let go of anything and it falls the same way: down. Down has a direction.

SITS BESIDE
Gravity pulls objects toward Earth's center (5-PS2-1)

NOTICE FIRST · 2 MINUTES
Hold a pencil out and let it go. Which way did it go, and what made it go that way?

TRY IT · YOU WILL NEED

- two sheets of the same paper
- an eraser
- a string
- a washer or a key

Safely: Drop things from table height only.

WORDS TO KEEP

gravity	The pull between Earth and every object. It pulls objects toward the center of the Earth.

Which way is down?

Tie a washer to a string and hold the other end still. The string hangs straight down.

It points down because of **gravity**, the pull between Earth and every object. Everywhere on Earth, gravity pulls toward the center of the Earth, and that direction is what we call down.

Now drop a crumpled sheet of paper and a flat one from the same height. Gravity pulls on both. The flat sheet is slowed by the air pushing up against it.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four things, dropped

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class dropped four things from the same height, a table top about 75 cm high, and timed each fall with a slow-motion video.

Object	Seconds to fall
rubber ball	0.4
eraser	0.4
sheet of paper, crumpled	0.4
sheet of paper, flat	1.2

How many objects fell in less than half a second? _____

How much longer did the flat sheet take than the crumpled sheet? _____

The two sheets are the same paper. Why did one fall more slowly?

_____

TALK ABOUT IT

Why does a leaf take longer to fall than an acorn?

Can you think of anything that does not fall when you let go of it? What holds it up?



STUCK? TRY THIS

Half a second is 0.5 seconds. For the second question, subtract the crumpled sheet's time from the flat sheet's.

★ CHALLENGE ZONE

Design a fair test to show whether the shape of a piece of paper changes how fast it falls. What will you keep the same?

WEEK 27 GRAVITY

Down Is Different Everywhere

Down where you stand and down on the far side of the Earth point in opposite directions.

SITS BESIDE
Gravity pulls objects toward Earth's center (5-PS2-1)

NOTICE FIRST · 2 MINUTES
If you dug a hole straight down, through the center of the Earth, where would you come out?

TRY IT · YOU WILL NEED

- an orange or a ball
- four small paper people
- tape

Safely: Never taste anything in an investigation, even food from the kitchen.

Everyone stands up

Tape four paper people around an orange, feet on the skin and heads pointing out.

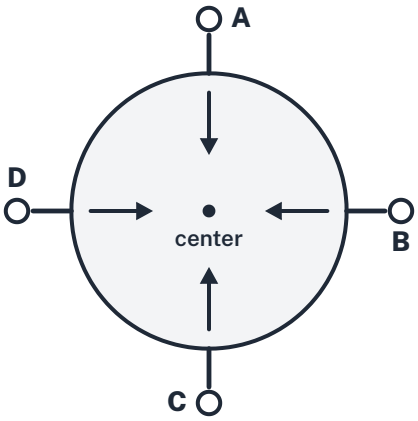
Each one is standing up. Each one's down points to the center of the orange. A person on the far side of the Earth is not hanging upside down: gravity pulls them toward the center, just as it pulls you.

So down is not one direction on a map. It is always toward the center of the Earth, from wherever you are.

NOTES AND DRAWINGS

Four people on the Earth

The arrows show which way each person's dropped ball falls.



Person C is at the bottom of the drawing. Which way does C's ball fall?

_____

Whose down points the opposite way from person B's? _____

Why does nobody on the bottom of the Earth fall off?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Which Way Is Down: draw the Earth with four people around it and an arrow at each showing which way their dropped ball falls.

💬 TALK ABOUT IT

If someone on the other side of the Earth drops a ball, which way does it fall for them?

Most maps put north at the top. Is the top of a map really up?



STUCK? TRY THIS

Every arrow points to the center. Opposite means across the center from each other.

★ CHALLENGE ZONE

Draw the Earth with eight people evenly spaced around it. Draw each one's dropped ball falling.

WEEK 28 REVIEW

One System

Eight weeks in one bottle: rock, water, air and life, all acting on each other.

SITS BESIDE
Earth's spheres interact (5-ESS2-1)

NOTICE FIRST · 2 MINUTES
Look at your sealed bottle from week 18. Find each of the four spheres inside it.

Part 3 on one card

Earth has four spheres: the **geosphere**, the **hydrosphere**, the **atmosphere** and the **biosphere**. Each one changes the others.

About 97 of every 100 liters of Earth's water are salty. **Fresh water** is rare, and most of it is frozen or underground.

A **resource** is protected by a plan with a goal you can measure and a cost you can pay.

Gravity pulls everything toward the center of the Earth. That is what down means, everywhere.

NOTES AND DRAWINGS

Two bottle worlds

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class built two bottles the same way, with soil, plants and water. They left one open and capped the other, and weighed both every week.

Week	0	1	2	3	4
Capped	850	850	850	850	850
Open	850	842	835	826	818

How many grams did the open bottle lose in 4 weeks? _____

Between which two weeks did it lose the most? _____

Name two spheres inside the capped bottle, and one thing from each.

_____

TALK ABOUT IT

Explain to someone at home why the capped bottle never needs watering.

Which sphere did you think about most before this year? Which one now?



STUCK? TRY THIS

The masses are in grams. Subtract each week's open-bottle number from the week before.

★ CHALLENGE ZONE

Where did the open bottle's missing grams go? Name the sphere they went into, and the word from Part 1 for how they got there.

WEEK 29 SKY

Shadows Through the Day

Your shadow is long in the morning, short in the middle of the day, and long again by evening.

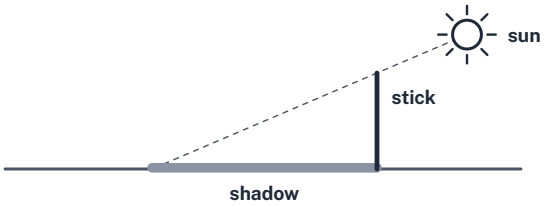
SITS BESIDE
Patterns of shadows, day and night, and stars (5-ESS1-2)

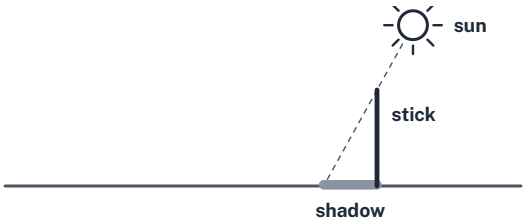
NOTICE FIRST · 2 MINUTES
Go outside at recess. Where is your shadow, and how long is it compared with you?

TRY IT · YOU WILL NEED

- a pencil standing in a lump of clay
- a sheet of paper
- a ruler
- a sunny spot

Safely: Never look straight at the sun.





A low sun, a long shadow

Stand a pencil in clay on a sheet of paper in the sun. Trace its shadow and write the time at the tip. Do it again every hour.

When the sun is low in the sky, the light comes in at a slant and the shadow stretches out. When the sun is high, the shadow is short. The shadow always points away from the sun.

Keep the paper in exactly the same place all day, so the only thing that changes is the time.

DRAW IT

Trace your shadows here if you cannot use paper outside. Write the time at each tip.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

A meter stick's shadow

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class stood a meter stick, 100 cm tall, straight up and measured its shadow five times in one day.

Time	Length of the shadow
9 a.m.	180 cm
11 a.m.	90 cm
1 p.m.	70 cm
3 p.m.	120 cm
5 p.m.	260 cm

At what time was the shadow shortest? _____

How much longer was the shadow at 5 p.m. than at 1 p.m.? _____

Where was the sun when the shadow was shortest? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called My Shadow Clock: draw the pencil and every shadow you traced, with the time written at each tip.

💬 TALK ABOUT IT

When during the day do you think a building's shadow covers the most ground?

Why do you think it is cooler in the morning, when the sun is low?



STUCK? TRY THIS

Shortest means the smallest number of centimeters.

★ CHALLENGE ZONE

At 9 a.m. the shadow was longer than the stick. At about what time in the morning do you think the shadow was exactly as long as the stick? Explain.

WEEK 30 SKY

Graph a Shadow

A graph turns a day of shadows into a shape you can read at a glance.

SITS BESIDE
Patterns of shadows, day and night, and stars (5-ESS1-2)

NOTICE FIRST · 2 MINUTES
Look at your shadow tracings from last week. Which way did the morning shadows point?

TRY IT · YOU WILL NEED

- your pencil and clay from last week
- a ruler
- a sunny spot

Safely: Never look straight at the sun.

Length and direction

A shadow changes two ways during the day: how long it is, and which way it points.

The sun rises in the east, so a morning shadow points roughly west. In California the sun is highest near noon in winter, and near 1 p.m. in the months on daylight saving time, and the shadow then points north. By afternoon the sun is in the west and the shadow points roughly east.

Measure your shadow every hour and turn the numbers into a bar graph. The shape of the bars is the pattern.

DRAW IT
Measure your shadow every hour you can. Write each time and length.

MY INVESTIGATION

I predict:

What happened:

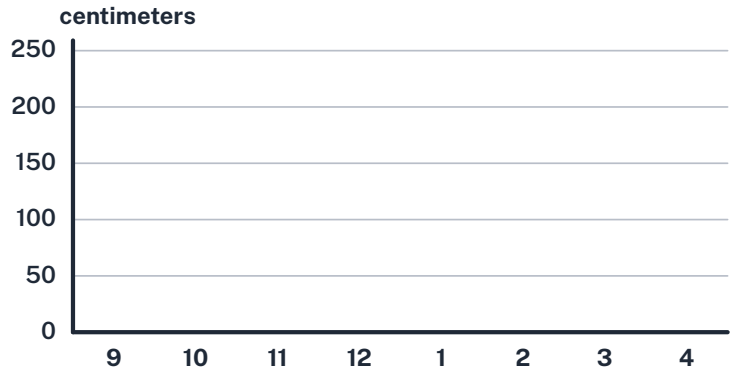
What I think caused it:

A day of shadows

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class measured a meter stick's shadow every hour from 9 a.m. to 4 p.m.

Time	9 a.m.	10 a.m.	11 a.m.	12 noon	1 p.m.	2 p.m.	3 p.m.	4 p.m.
Shadow (cm)	220	140	100	80	75	85	115	170



Draw the bars. At what time was the shadow shortest? _____

Between which two hours did the shadow change the most? _____

What will the shadow do after 4 p.m.? _____

TALK ABOUT IT

Why do you think sundials were used to tell time long ago?

Which way do the shadows point outside your classroom in the morning?



STUCK? TRY THIS

For the second question, find the difference between each hour and the next, whether the shadow grew or shrank.

★ CHALLENGE ZONE

Sketch what the bar graph might look like on a winter day, when the sun stays lower all day. Explain your sketch.

WEEK 31 SKY

Day and Night

The sun does not travel around us. The Earth spins, and carries us into and out of its light.

SITS BESIDE
Patterns of shadows, day and night, and stars (5-ESS1-2)

NOTICE FIRST · 2 MINUTES
Watch the shadows stretch at the end of the day. Is the sun moving, or are you?

TRY IT · YOU WILL NEED

- a flashlight
- a ball or a globe
- a small sticker

Safely: Point the flashlight at the ball, never into anyone's eyes.

WORDS TO KEEP

rotate To spin around a center line. Earth rotates once every 24 hours.

A spinning Earth

Put a sticker on a ball for your town. In a dark room, shine a flashlight at the ball and turn the ball slowly.

The sticker moves into the light (sunrise), across it (day) and out of it (sunset). The flashlight never moved. The Earth **rotates** once every 24 hours, so the sun only seems to cross the sky.

Half of the Earth is always in daylight and half is in night. Right now, somewhere, the sun is rising.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Daylight in four seasons

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class wrote down the sunrise and sunset times for one day in each season, rounded to the hour.

Season	Sunrise	Sunset	Hours of daylight
winter	7 a.m.	5 p.m.	
spring	7 a.m.	7 p.m.	
summer	6 a.m.	8 p.m.	
fall	7 a.m.	7 p.m.	

How many hours of daylight in summer? _____

Which TWO seasons have the same amount of daylight? _____

How many more hours of daylight in summer than in winter? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called Day and Night: draw the Earth and the sun from above, shade the night half, and mark where your town is at noon and at midnight.

💬 TALK ABOUT IT

Why is it still dark at 6:30 a.m. on a winter morning?

When it is noon here, where on Earth is it night?



STUCK? TRY THIS

Count the hours from sunrise to noon, then from noon to sunset, and add them.

★ CHALLENGE ZONE

The Earth turns once every 24 hours. How many hours of night were there in winter? Show how you know.

WEEK 32 SKY

Stars by Season

The stars overhead on a winter evening are not the ones overhead on a summer evening.

SITS BESIDE
Patterns of shadows, day and night, and stars (5-ESS1-2)

NOTICE FIRST · 2 MINUTES
Think of the night sky. Have you ever noticed a group of stars you could see only at one time of year?

TRY IT · YOU WILL NEED

- a chair to stand for the sun
- four pictures to tape on the walls

WORDS TO KEEP

orbit To travel around another object. Earth orbits the sun once a year.

Facing a different way

The Earth **orbits** the sun once a year. At night, your side of the Earth faces away from the sun, out into space.

As the Earth moves around its orbit, the night side faces a different part of space. So the stars you see in the evening change slowly from season to season, and come back a year later.

Try it. Put a chair in the middle of the room for the sun and a picture on each wall for the stars. Walk around the chair. At each place, turn your back to the sun: which picture do you face?

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

The Lantern

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class looked every other month for a group of stars they named the Lantern, at the same time each evening.

Month	Could they see the Lantern?
January	yes
March	yes
May	no
July	no
September	no
November	yes

In how many of the six months could they see the Lantern? _____

In which months could they not see it? _____

Why can you see different stars in different seasons?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Stars by Season: draw the sun, the Earth at two places in its orbit, and an arrow from each Earth's night side to the stars it faces.

💬 TALK ABOUT IT

Why might people long ago have used the stars to know when to plant crops?

What would the night sky look like if the Earth did not orbit the sun?



STUCK? TRY THIS

Count the yes rows. Then list the months that say no.

★ CHALLENGE ZONE

Predict whether the Lantern could be seen next January. Use the word orbit in your answer.

WEEK 33 SKY

Brighter Because Closer

The sun is a star. The stars at night are suns, very far away.

SITS BESIDE
The sun is a star, bright because it is close (5-ESS1-1)

NOTICE FIRST · 2 MINUTES
Picture a streetlight close up, then one at the far end of a street. Are they really different?

TRY IT · YOU WILL NEED

- a flashlight
- a sheet of white paper
- a tape measure
- a dark room

Safely: Point the flashlight at the paper, never into anyone's eyes.

WORDS TO KEEP

star A huge ball of hot, glowing gas that gives off its own light. The sun is a star.

The same light, farther away

Shine a flashlight on a sheet of paper from 1 meter away, then from 2 meters. Watch the bright spot.

From farther away, the same light spreads over a bigger patch, so each part of the paper gets less. The flashlight did not change. Only the distance did.

The sun is a **star**. Every star you see at night is a sun too, so far away that it looks like a tiny dot. The sun looks so much brighter because it is so much closer.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

One flashlight, three distances

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class measured how bright one flashlight looked with a light meter, at three distances. Only the distance changed.

Distance	Light meter reading
1 m	400
2 m	100
4 m	25

How many times brighter was it at 1 m than at 2 m? _____

How many times brighter was it at 1 m than at 4 m? _____

Finish the sentence: the farther the light, _____

💬 **TALK ABOUT IT**

Why do car headlights look dim far away and blinding up close?

Why do you think we cannot see stars during the day?



STUCK? TRY THIS

Divide the reading at 1 m by the reading at the other distance.

★ **CHALLENGE ZONE**

Each time the distance doubled, what happened to the reading? Predict the reading at 8 m and explain.

WEEK 34 SKY

Near and Far Lights

How bright a light looks depends on how much light it gives off and how far away it is.

SITS BESIDE
The sun is a star, bright because it is close (5-ESS1-1)

NOTICE FIRST · 2 MINUTES
On a clear night, are all the stars equally bright? What could make one look brighter than another?

TRY IT · YOU WILL NEED

- two battery tea lights that are the same
- a partner
- a long, dark hallway

Safely: Use battery tea lights only, never real candles. Never open the battery cover.

Two things decide

Switch on two matching battery tea lights. Keep one beside you, and have your partner carry the other to the far end of a dark hallway. The far one looks dimmer, though the two are the same.

So when one light looks brighter than another, there are two possible reasons: it gives off more light, or it is closer. A weak light up close can look as bright as a strong light far away.

The sun looks brighter than every other star. Many stars give off far more light than the sun does. The sun looks brightest because it is so much closer to us than any other star.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four lamps

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class measured how much light four lamps give off, how far away each was, and how bright each looked from where they stood.

Lamp	Light it gives off	Distance	How bright it looked
A	100	1 m	100
B	400	2 m	100
C	100	2 m	25
D	900	3 m	100

Which lamp looked dimmest? _____

Which TWO lamps give off more light than A but looked just as bright? _____

Lamps A and C give off the same light. Why did C look dimmer?

_____

▶ ADD TO YOUR MODEL BOOK

Add a page called Near and Far: draw the sun and one faraway star, and explain why the sun looks brighter even though the star may give off more light.

💬 TALK ABOUT IT

Why does a star look like a tiny dot even though it is enormous?

If you moved closer to another star, what would happen to how bright it looked?



STUCK? TRY THIS

Compare the last column first. Then look at the second column for the lamps that looked the same.

★ CHALLENGE ZONE

Lamp D gives off 9 times as much light as A and is 3 times as far away. Explain why they looked the same.

WEEK 35 DESIGN

Design to Measure

Before anyone builds a shadow clock, decide what it must do and what it must not cost.

SITS BESIDE
Defining a design problem (3-5-ETS1-1)

NOTICE FIRST · 2 MINUTES
Look at a clock in the room. What does it need to do well for you to trust it?

TRY IT · YOU WILL NEED

- a paper plate
- a pencil
- a lump of clay
- a ruler
- a sunny spot

Safely: Never look straight at the sun.

WORDS TO KEEP

criteria	What a design must do to count as a success.
constraint	A limit on a design, like its cost, its size or the materials allowed.

Define the problem first

The problem: tell the time during the school day from a shadow.

Before building, write the **criteria**, what the clock must do: be readable to the nearest hour, and work from 9 a.m. to 3 p.m. Then write the **constraints**, the limits: cost no more than $3, and be no wider than 30 centimeters so it fits on a desk.

Now any design can be checked against the same list, and nobody has to argue about which one is best.

DRAW IT
Draw your shadow clock. Label the hour marks you will test.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four shadow clocks

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class checked four designs. The constraints were $3 or less and 30 cm wide or less.

Design	Readable to the hour	Works 9 to 3	Cost	Width
A	yes	yes	$2	25 cm
B	yes	no	$1	20 cm
C	yes	yes	$5	25 cm
D	no	yes	$1	40 cm

Which design meets every criterion and every constraint? _____

Which design meets both criteria but breaks a constraint? _____

How many designs break at least one rule? _____

▶ ADD TO YOUR MODEL BOOK

Add a page called My Shadow Clock Plan: write your criteria and constraints, draw your design, and mark which ones it passed.

💬 TALK ABOUT IT

Name something at school that has a constraint on its size or its cost.

Why is it useful to agree on the criteria before you start building?



STUCK? TRY THIS

Check each design against all four rules. A design has to pass every one.

★ CHALLENGE ZONE

Design B fails one criterion. Suggest one change that might fix it without breaking a constraint.

WEEK 36 REVIEW

Too Small, Too Far

A whole year of reasoning about things nobody can look at directly.

SITS BESIDE
The sun is a star, bright because it is close (5-ESS1-1)

NOTICE FIRST · 2 MINUTES
Think back to week 1 and the vanilla. What do you know now that you did not know then?

The year on one card

Some things are **too small** to see: the particles that make up all matter. This book asked you to reason about them from smells, masses and things that vanished and came back.

Some things are **too far** to visit: the sun and the other stars. It asked you to reason about them from shadows, daylight and how bright a light looks.

Both times the method was the same: find the evidence you can see, and build a model of what you cannot.

NOTES AND DRAWINGS

Too small, or too far?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

For each thing below, write whether you explain it with the too-small model or the too-far model.

	What you notice	Too small or too far?
a	a puddle dries up on a sunny day	
b	the sun looks brighter than every other star	
c	sugar vanishes in water	
d	you see different stars in winter and in summer	
e	a tree grows heavy from air and water	
f	shadows are shortest in the middle of the day	
g	a sealed bag of ice weighs the same after it melts	

How many rows need the too-small model? _____

How many need the too-far model? _____

Pick one too-far row and explain it.

_____

💬 **TALK ABOUT IT**

Explain one thing from this year to someone at home, using a drawing.

What is one question about something too small or too far that you still have?



STUCK? TRY THIS

Ask yourself: is this about particles, or about the sun, the Earth and the stars?

★ **CHALLENGE ZONE**

Write a new row of your own for each model, and explain both.

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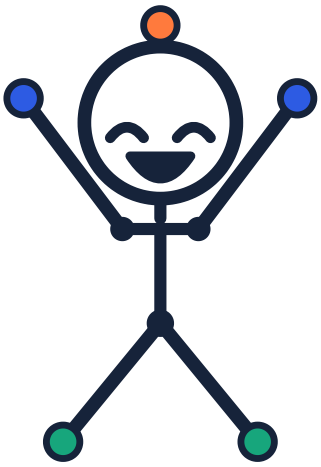
Grade 5 · Too Small to See

Certificate of Completion

This is to certify that

_____

practiced reasoning about what nobody can see for thirty-six weeks.



Teacher _____ Date _____

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