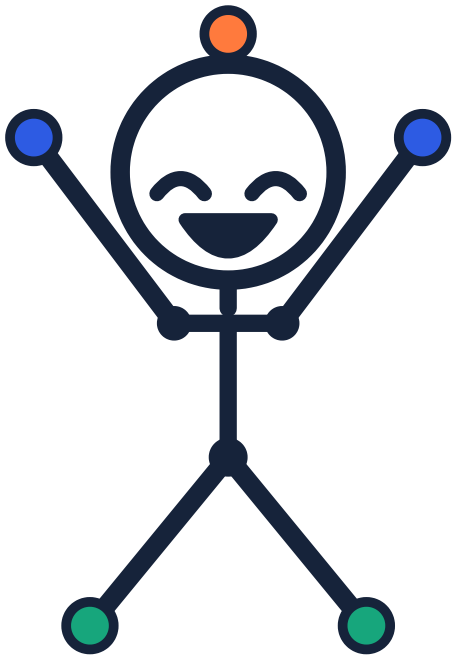
Young Innovators
FOR CHANGE
innovateyouth.org

A FULL-YEAR SCIENCE PROGRAM · GRADE 4

Where Did It Go?

36 weekly investigations into where energy goes: collisions, circuits, landscapes, waves and senses.



This book belongs to

_____

Energy I followed _____ Where it went _____

Teacher _____ School year _____

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START HERE HOW THIS BOOK WORKS

Energy is never used up.

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 to your Energy Log. No computer needed.

Part 1 is speed and collisions: faster things have more energy, and it moves when they hit. Part 2 follows energy as sound, light, heat and current, and asks where it comes from. Part 3 reads landscapes. Part 4 is waves, and the waves of an earthquake. Part 5 is senses, light and signals.

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.
ENERGY LOG	The one thing you build all year, in a notebook your teacher gives you: 19 pages of your own investigations.
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

Where did the energy go? It is never used up. It moves from one thing to another, and it changes form. Every week asks you to follow it. And every test changes one thing at a time, so you know what caused what.

WEEK	TITLE	TOPIC	STANDARD
PART 1 · WEEKS 1–7 · SPEED, COLLISIONS AND ENERGY			
1	**Faster Means More**	Energy	4-PS3-1
2	**Speed You Can Measure**	Energy	4-PS3-1
3	**When Things Collide**	Energy	4-PS3-3
4	**Where the Energy Went**	Energy	4-PS3-3
5	**Protect the Egg**	Design	3-5-ETS1-3
6	**Test, Change, Test Again**	Design	3-5-ETS1-3
7	**Energy Moves**	Review	4-PS3-1
PART 2 · WEEKS 8–15 · ENERGY ON THE MOVE, AND WHERE IT COMES FROM			
8	**Energy Travels**	Transfer	4-PS3-2
9	**Light, Sound, Heat, Current**	Transfer	4-PS3-2
10	**A Closed Loop**	Transfer	4-PS3-2
11	**Changing the Form**	Converting	4-PS3-4
12	**Build a Converter**	Converting	4-PS3-4
13	**Where Fuel Comes From**	Sources	4-ESS3-1
14	**Every Source Costs Something**	Sources	4-ESS3-1
15	**Follow the Energy**	Review	4-PS3-2
PART 3 · WEEKS 16–22 · SCULPTING LANDSCAPES			
16	**Rock in Layers**	Landscapes	4-ESS1-1
17	**Fossils in the Layers**	Landscapes	4-ESS1-1
18	**Breaking Rock**	Landscapes	4-ESS2-1

WEEK	TITLE	TOPIC	STANDARD
19	**How Fast It Wears Away**	Landscapes	4-ESS2-1
20	**Patterns on a Map**	Landscapes	4-ESS2-2
21	**Where Mountains Are**	Landscapes	4-ESS2-2
22	**Reading a Landscape**	Review	4-ESS1-1
PART 4 · WEEKS 23–29 · WAVES AND EARTHQUAKES			
23	**A Wave Moves Energy**	Waves	4-PS4-1
24	**Tall and Long**	Waves	4-PS4-1
25	**Waves Move Things**	Waves	4-PS4-1
26	**When the Ground Shakes**	Earthquakes	4-ESS3-2
27	**Build It to Stand**	Earthquakes	4-ESS3-2
28	**Compare the Designs**	Earthquakes	3-5-ETS1-2
29	**Shaking, Measured**	Review	4-PS4-1
PART 5 · WEEKS 30–36 · SENSES, LIGHT AND SIGNALS			
30	**Inside and Outside**	Senses	4-LS1-1
31	**Parts With Jobs**	Senses	4-LS1-1
32	**Sense, Decide, Respond**	Senses	4-LS1-2
33	**How You See**	Senses	4-PS4-2
34	**A Pattern Carries a Message**	Senses	4-PS4-3
35	**Two Codes Compared**	Senses	4-PS4-3
36	**Where Did It Go?**	Review	4-PS3-2

WEEK 1 ENERGY

Faster Means More

A ball rolling fast can do more than a ball rolling slowly. That difference is energy.

SITS BESIDE
Speed and energy (4-PS3-1)

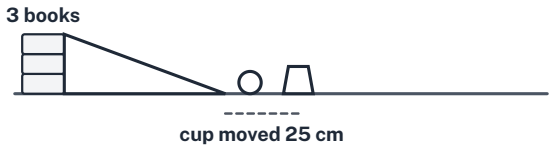
NOTICE FIRST · 2 MINUTES
Roll a ball gently into a wall, then roll it fast. Which time does it bounce back harder?

TRY IT · YOU WILL NEED

- a ball
- books to stack
- stiff cardboard for a ramp
- a paper cup
- a tape measure

WORDS TO KEEP

energy — What something has when it can make a change happen: move something, warm it, light it or make a sound.



Speed and energy

Set a paper cup upside down at the bottom of a ramp. Roll a ball down the ramp into it and measure how far the cup slides.

Now stack another book under the ramp. The ball reaches the bottom faster, hits the cup, and the cup slides farther. The faster ball had more **energy**, so it could make a bigger change happen.

Keep the same ball and the same cup, and change only the height, so the speed is the only thing that changes.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Ramp height and the cup

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class rolled the same ball into the same cup from four ramp heights.

Ramp height	How far the cup moved
1 book	8 cm
2 books	17 cm
3 books	25 cm
4 books	34 cm

Which ramp height moved the cup farthest? _____

How much farther did the cup move from 4 books than from 1 book? _____

Finish the sentence: the higher the ramp, the faster the ball, so the cup _____

▶ ADD TO YOUR ENERGY LOG

Start your Energy Log. Write down one thing you saw moving today, and one change its motion made happen.

💬 TALK ABOUT IT

Name something that moves fast and something that moves slowly. Which could do more damage if it hit you?

Why are there lower speed limits near schools?



STUCK? TRY THIS

Read down the second column. Each extra book adds about the same amount.

★ CHALLENGE ZONE

Would a heavier ball moving at the same speed move the cup farther? Plan a fair test: what would you change, and what would you keep the same?

WEEK 2 ENERGY

Speed You Can Measure

Fast and slow are words. Centimeters per second is a measurement.

SITS BESIDE
Speed and energy (4-PS3-1)

NOTICE FIRST · 2 MINUTES
Cross the room slowly, then quickly, walking or rolling. What is different, if you only count seconds?

TRY IT · YOU WILL NEED

- a tape measure
- a timer with seconds
- a partner

WORDS TO KEEP

speed How far something goes in a set amount of time.

Distance divided by time

Speed is how far something goes in a set amount of time.

To measure it, you need two numbers: the distance and the time. A car that goes 100 centimeters in 5 seconds goes 20 centimeters every second, because 100 divided by 5 is 20. That is its speed: 20 centimeters per second.

Mark a start line and a finish line 5 meters apart. Time a partner going slowly, then quickly, walking or rolling. Work out each speed. Last week said a faster object has more energy, and now you can say how much faster.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Five toy cars

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

All five cars are the same size and weight. A class measured how far each one went and how long it took.

Car	Distance	Time	Speed (cm each second)
A	100 cm	5 seconds	
B	150 cm	5 seconds	
C	75 cm	5 seconds	
D	200 cm	5 seconds	
E	120 cm	4 seconds	

Which car was fastest? _____

Which TWO cars went at the same speed? _____

Which car had the most energy? How do you know? _____

▶ ADD TO YOUR ENERGY LOG

Add a page called My Speed: your slow crossing and your quick crossing, each with its distance, its time, and its speed.

💬 TALK ABOUT IT

Where do you see speed written as a number? Look for a sign or a screen.

Is the fastest person always the one who gets there first? What else matters?



STUCK? TRY THIS

Divide the distance by the time for every car first. Then compare the speeds, not the distances.

★ CHALLENGE ZONE

Car E went less far than car B but took less time. Explain how they can have the same speed.

WEEK 3 ENERGY

When Things Collide

When one moving thing hits another, the energy moves across.

SITS BESIDE
Energy in collisions (4-PS3-3)

NOTICE FIRST · 2 MINUTES
Watch a game of marbles or pool, or picture one. When one ball hits another, what happens to each?

TRY IT · YOU WILL NEED

- two marbles of the same size
- a ruler with a groove down the middle
- books
- a tape measure

Safely: Roll marbles on a table, and pick every one up after so nobody slips on one.

WORDS TO KEEP

collide To bump into something. In a collision, energy moves from one object to another.



Energy moves in a collision

Lay one marble at the bottom of a grooved ruler used as a ramp. Roll a second marble down the groove into it.

When the marbles **collide**, the rolling one nearly stops and the still one rolls away. The energy did not disappear. It moved from the first marble to the second.

Now raise the ramp, so the first marble arrives faster. The second marble rolls farther. More speed going in means more energy to pass across.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Marbles from three heights

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class rolled one marble into another from three ramp heights and measured how far the second marble rolled.

Ramp height	How far the second marble rolled	What the first marble did
1 book	22 cm	nearly stopped
2 books	45 cm	nearly stopped
3 books	66 cm	nearly stopped

About how many times farther did the second marble roll from 2 books than from 1 book? _____

How much farther from 3 books than from 2 books? _____

The first marble nearly stopped every time. Where did its energy go?

_____

💬 **TALK ABOUT IT**

Why do cars have seat belts? Think about what happens to the people when the car suddenly stops.

In a game of pool, how can a player make a ball they never touched move?



STUCK? TRY THIS

Compare each row with the one above it. Does the distance about double, or about add the same amount each time?

★ **CHALLENGE ZONE**

Line up three marbles touching in the groove and roll a fourth into the end. Predict which marble moves, then try it. Where did the energy travel?

WEEK 4 ENERGY

Where the Energy Went

A ball bounces lower every time. Its energy did not vanish. It went somewhere.

SITS BESIDE
Energy in collisions (4-PS3-3)

NOTICE FIRST · 2 MINUTES
Drop a ball and listen. What do you hear each time it hits the floor?

TRY IT · YOU WILL NEED

- a bouncy ball
- a meter stick or tape measure taped to a wall
- a partner



Every bounce, a little goes elsewhere

Drop a ball from 100 centimeters and watch how high it bounces. It never comes all the way back up.

Each time it hits the floor, the ball squashes, and squashing stores energy that springs back and lifts it up again. But a little of the energy becomes sound (the bounce you hear) and a little warms the ball and the floor, and that part does not spring back.

So the energy is not used up. It is spread out, and only part of it goes back into the bounce. Your partner watches the meter stick while you drop.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Five bounces

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class dropped a ball from 100 cm and measured how high each bounce went.

Bounce	1	2	3	4	5
Height	72 cm	52 cm	37 cm	27 cm	19 cm

How much lower was bounce 2 than bounce 1? _____

Between which two of the five bounces did the height drop the most?

_____

Name two places the ball's energy went that were not the bounce.

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Where It Went: one collision you saw or heard this week, and every place its energy went.

💬 TALK ABOUT IT

Clap your hands hard ten times. What do you feel and hear? Where did the energy of your moving hands go?

Why does a ball bounce lower on carpet than on a hard floor?



STUCK? TRY THIS

Subtract bounce 2 from bounce 1, bounce 3 from bounce 2, and so on. The biggest difference is the biggest drop.

★ CHALLENGE ZONE

Each bounce here is about seven tenths of the one before. Use that to predict bounce 6, then explain why the ball eventually stops.

WEEK 5 DESIGN

Protect the Egg

A soft ball of clay shows how hard it landed. Design something that keeps it round.

SITS BESIDE
Testing and improving a design (3-5-ETS1-3)

NOTICE FIRST · 2 MINUTES
Drop a soft ball of clay onto the floor. What does the flat spot tell you?

TRY IT · YOU WILL NEED

- modeling clay
- paper
- drinking straws
- tape
- a ruler marked in millimeters

Safely: Drop from table height. Never drop anything from a stairway, a balcony or a window.

WORDS TO KEEP

prototype A first model of a design, built to be tested and then improved.

The problem: a soft landing

A ball of clay is the “egg.” When it lands, it flattens, and the flat spot shows how much energy it took in. A deeper dent means a harder landing.

Your job is to build a lander that protects it when it drops from a table. The **criteria**: the dent must be 2 millimeters or less. The **constraints**: paper, straws and tape only, and no more than 10 straws.

Your first lander is a **prototype**. Its job is not to be perfect. Its job is to be tested, so you learn what to change.

DRAW IT

Draw your first lander. Label the part you think will soak up the landing.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four landers

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Lander	Dent depth	Straws used	Materials
no protection	6 mm	0	paper, straws and tape only
paper cone	4 mm	0	paper, straws and tape only
straw cage	2 mm	8	paper, straws and tape only
cotton balls	1 mm	0	cotton

Which lander meets the criterion AND every constraint? _____

Which lander protected best, but broke a constraint? _____

How many millimeters less dent did the straw cage get than no protection? _____

TALK ABOUT IT

What does a bike helmet do with the energy when someone falls?

Why do you think shipping boxes have soft padding inside?



STUCK? TRY THIS

Check every lander against every rule. A lander has to pass all of them.

★ CHALLENGE ZONE

Sketch a lander you think could get the dent to 1 mm with paper, straws and tape only. What will it do with the clay's energy?

WEEK 6 DESIGN

Test, Change, Test Again

Engineers do not get it right the first time. They change one thing and test again.

SITS BESIDE
Testing and improving a design (3-5-ETS1-3)

NOTICE FIRST · 2 MINUTES
Think of something you got better at by trying again. What did you change each time?

TRY IT · YOU WILL NEED

- your lander from last week
- modeling clay
- paper
- straws
- tape
- a ruler marked in millimeters

Safely: Drop from table height only.

One change at a time

Test your lander. Change ONE thing. Test it again.

If you change two things at once and the dent gets smaller, you cannot tell which change helped. If you change one thing, the test tells you whether that thing mattered. Sometimes the answer is that it did not, and that is worth knowing too.

Engineers call this iterating: build, test, learn, change, and test again. Write down each version and its result, so you can see which change made the biggest difference.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Four versions of one lander

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Version	What changed	Dent depth
1	the first try	5 mm
2	added a straw base	4 mm
3	painted it red	4 mm
4	added a paper spring	1 mm

Which change made no difference at all? _____

Which change helped the most? _____

Why was changing only one thing each time useful here?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Version by Version: each version of your lander, the one thing you changed, and the dent.

💬 TALK ABOUT IT

Ask someone at home or at school about something they improved by trying again.

Is a test that shows a change did nothing a failed test?



STUCK? TRY THIS

Subtract each version's dent from the one before. The biggest difference is the most helpful change.

★ CHALLENGE ZONE

Version 4 got the dent to 1 mm. Design version 5. What would you change, and how would you know if it helped?

WEEK 7 REVIEW

Energy Moves

Six weeks in one idea: faster means more energy, and in a collision it moves on.

SITS BESIDE
Speed and energy (4-PS3-1)

NOTICE FIRST · 2 MINUTES
Watch something get knocked over today. What was moving before it fell?



Part 1 on one card

Something moving has **energy**, and the faster it moves, the more energy it has.

Speed is distance divided by time.

When objects **collide**, energy moves from one to the other, and a little of it becomes sound and warmth.

A **prototype** is tested, changed one thing at a time, and tested again.

NOTES AND DRAWINGS

Four balls, ten pins

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Four balls of the same size and weight were rolled at ten pins.

Ball	Speed (cm each second)	Pins knocked down
A	50	1
B	120	7
C	80	4
D	30	0

Did the fastest ball knock down the most pins? _____

How many more pins did the fastest ball knock down than the slowest? _____

Put the balls in order from least energy to most. _____

TALK ABOUT IT

Explain to someone at home why a faster ball knocks down more pins.

What is one thing you would like to measure the speed of?



STUCK? TRY THIS

More speed, more energy. Order the speeds first.

★ CHALLENGE ZONE

Ball D knocked down no pins. Did it have no energy? Explain.

WEEK 8 TRANSFER

Energy Travels

Energy can cross a room without anything solid carrying it.

SITS BESIDE
Energy moving from place to place (4-PS3-2)

NOTICE FIRST · 2 MINUTES
Hum with your hand flat on your throat. What do you feel?

TRY IT · YOU WILL NEED

- a bowl
- plastic wrap
- a few grains of dry rice
- a metal pan and a spoon
- a tape measure

Safely: Tap gently. Loud sounds close to your ears can hurt your hearing.

WORDS TO KEEP

transfer — To move from one place or object to another. Energy can transfer by motion, sound, light, heat or electric current.

Rice that jumps

Stretch plastic wrap tight over a bowl and sprinkle a few grains of rice on top. Hold a metal pan nearby and tap it with a spoon.

The rice jumps, and nothing solid touched it. The energy of the tap traveled through the air as sound, made the plastic wrap shake, and the shaking moved the rice.

Energy can **transfer** in five ways you will meet this year: by something moving, by sound, by light, by heat, and by electric current. This week is sound.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

How far does the sound reach?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class tapped the pan the same way every time, from five distances, and counted the grains of rice that jumped.

Distance from the bowl	Grains that jumped
20 cm	14
40 cm	9
60 cm	5
80 cm	2
100 cm	0

What is the farthest distance that still made the rice jump? _____

How many more grains jumped at 20 cm than at 60 cm? _____

Finish the sentence: the farther the pan, _____

▶ ADD TO YOUR ENERGY LOG

Add a page called Energy Travels: three times this week energy moved from one place to another, and which of the five ways it traveled.

💬 TALK ABOUT IT

Name a sound you can feel as well as hear.

Why might a window rattle when a big truck goes by?



STUCK? TRY THIS

Look for the last row where the number of grains is not zero.

★ CHALLENGE ZONE

Predict what happens if you tap the pan twice as hard at 100 cm. Then explain what “harder” changes about the energy.

WEEK 9 TRANSFER

Light, Sound, Heat, Current

Light, sound, heat and current: four of the five ways energy travels.

SITS BESIDE
Energy moving from place to place (4-PS3-2)

NOTICE FIRST · 2 MINUTES
Stand in the sun, then step into the shade. What changed, and how did it reach you?

TRY IT · YOU WILL NEED

- squares of black, white and green paper
- foil
- a sunny window or sidewalk
- a thermometer if you have one

Safely: Never look straight at the sun, or at sunlight reflected off the foil.

Which way did it travel?

	What happens	Light, sound, heat or current?
a	sunlight reaching a sidewalk	
b	hearing a dog bark across the yard	
c	a wire carrying energy to a lamp	
d	a hot mug warming your hands	
e	a flashlight beam reaching a wall	
f	hot soup warming the bowl it is in	

Which row is the only one where energy travels as sound? _____

How many rows are light? _____

Sunlight becomes warmth

Light from the sun travels all the way here, and when it hits something, some of its energy warms that thing. Lay different papers in the sun for 20 minutes and feel them, or measure them. Dark colors take in more of the light and warm up more.

NOTES AND DRAWINGS

Twenty minutes in the sun

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class laid four materials in the same sunny spot for 20 minutes, then measured each one's temperature.

Material	Temperature
black paper	104°F
white paper	88°F
foil	82°F
green paper	97°F

Which material warmed the most? _____

How many degrees warmer was black paper than white paper? _____

Why might people in hot places paint roofs white?

_____

TALK ABOUT IT

Why do you think dark car seats get so hot in summer?

Name something in your school that uses electric current to make light.



STUCK? TRY THIS

For the sorting table, ask how the energy reached the thing, not what it does when it gets there.

★ CHALLENGE ZONE

Row a arrives as light and then warms the sidewalk. Pick one more row and say what form the energy is in when it arrives, and what it becomes after.

WEEK 10 TRANSFER

A Closed Loop

Electric current only flows when the path goes all the way around.

SITS BESIDE
Energy moving from place to place (4-PS3-2)

NOTICE FIRST · 2 MINUTES
Flip a light switch on and off. What do you think the switch does inside the wall?

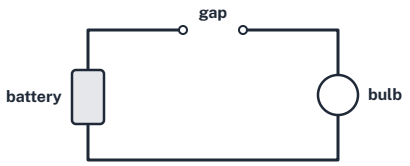
TRY IT · YOU WILL NEED

- one AA battery
- a small 1.5-volt flashlight bulb
- two short wires
- tape
- a paper clip, a coin, foil, a wooden craft stick, a plastic spoon, a rubber band

Safely: Use only a small AA or AAA battery. Never connect a wire straight from one end of a battery to the other, because it gets hot. Never use a wall outlet.

WORDS TO KEEP

circuit A closed loop that electric current can flow all the way around.



open loop: the bulb stays dark



closed loop: the bulb lights

Make the bulb light

Tape one wire to each end of the battery. Touch the other two ends to the bulb: one to its tip, one to its metal side.

The bulb lights only when the path is a **circuit**, a closed loop from the battery, through the bulb, and back. Open the loop anywhere and the bulb goes dark. A light switch is a gap you can open and close.

Now leave a gap between one wire and the bulb, and bridge it with each object. If the bulb lights, current flows through that material.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

What closes the gap?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class bridged the gap in a circuit with six objects.

Object in the gap	Did the bulb light?
paper clip	yes
coin	yes
wooden craft stick	no
foil	yes
plastic spoon	no
rubber band	no

How many objects let the current through? _____

What do all of those objects have in common? _____

Why are wires covered in plastic?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Closed Loop: your circuit drawn, with an arrow showing the way around it.

💬 TALK ABOUT IT

Find three switches at school or at home. What does each one open and close?

Why should nobody ever poke anything into a wall outlet?



STUCK? TRY THIS

Count the yes answers first. Then look at what those objects are made of.

★ CHALLENGE ZONE

Draw a circuit with two bulbs that both light. Then draw one where taking out one bulb would make the other go dark too.

WEEK 11 CONVERTING

Changing the Form

Energy does not only move. It changes from one form into another.

SITS BESIDE
Converting energy (4-PS3-4)

NOTICE FIRST · 2 MINUTES
Think of a bulb that has been on for a while. What two things does it give off?

TRY IT · YOU WILL NEED

- a rubber band
- an empty thread spool or a toilet paper tube
- a pencil
- tape

Safely: Never stretch a rubber band toward anybody's face.

WORDS TO KEEP

convert To change energy from one form to another, like electric energy into light.



From one form to another

A lamp **converts** electric energy into light. It also turns some of it into warmth, which is why a bulb can feel warm.

Converting is everywhere. A wind-up toy turns the energy stored in a twisted spring into motion. A solar panel turns light into electric current. Your body turns the energy in food into motion and warmth.

Thread a rubber band through a spool, put a pencil through the loop, and twist it. Let go. The energy you stored by twisting becomes motion.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

A sun-charged toy

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class charged a small solar-powered toy in sunlight for different amounts of time, then timed how long it ran.

Minutes in the sun	Seconds the toy ran
5	20
10	41
15	60
20	79

About how many seconds of running did each extra minute in the sun give? _____

Predict how long the toy would run after 25 minutes in the sun. _____

Name every form the energy took, from the sun to the moving toy.

_____

TALK ABOUT IT

Name three machines at school or at home and what form of energy each one changes into what.

When you rub your hands together, what are you converting?



STUCK? TRY THIS

Divide the seconds by the minutes in each row. The answers should be close to each other.

★ CHALLENGE ZONE

Does the pattern keep going forever? What might happen after 3 hours in the sun?

WEEK 12 CONVERTING

Build a Converter

Design something that turns moving air into a lift you can measure.

SITS BESIDE
Designing a device that converts energy (4-PS3-4)

NOTICE FIRST · 2 MINUTES
Blow on a pinwheel. What is moving before it spins, and what is moving after?

TRY IT · YOU WILL NEED

- paper
- a pencil with an eraser
- a pushpin
- an empty toilet paper tube
- thread
- a paper clip
- scissors

Safely: An adult pushes the pin in. Blow on the pinwheel; never hold it near a fan without its guard.

The problem: lift a paper clip with wind

Pin a paper pinwheel tight to a pencil's eraser, so the pencil turns with it. Poke the pencil through both sides of a tube so it can spin. Tie a thread to the pencil and a paper clip to the thread. When you blow, the thread winds up and the clip rises.

Your breath is moving air. Its motion becomes the pinwheel's spinning, and the spinning lifts the clip higher, which stores energy in it: let go and it falls. A real wind turbine goes one step further. Its spinning turns a generator, which converts the motion into electric current.

The criterion: lift the clip 30 cm in 10 seconds or less. The constraint: one sheet of paper. Change one thing at a time, like the number of blades.

DRAW IT
Draw your pinwheel converter. Label where the energy comes in and where it goes out.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

How many blades?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class built pinwheels from one sheet each, changing only the number of blades, and timed the lift with the same steady breath.

Blades	Seconds to lift the clip 30 cm
2	18
4	9
6	7
8	8

Which number of blades lifted the clip fastest? _____

How many of the four pinwheels met the criterion? _____

More blades helped, until it did not. Where did it stop helping? _____

▶ ADD TO YOUR ENERGY LOG

Add a page called My Converter: your pinwheel drawn, the energy it started with, and the energy it ended with.

💬 TALK ABOUT IT

Have you ever seen wind turbines? What were they connected to?

Where else could moving air or moving water be put to work?



STUCK? TRY THIS

Fewer seconds is faster. Cross out every pinwheel that took more than 10 seconds.

★ CHALLENGE ZONE

Change something else, not the blades: their size, their shape, the thread. Predict which change helps, then test it.

WEEK 13 SOURCES

Where Fuel Comes From

Every light switch is connected, eventually, to a source in the natural world.

SITS BESIDE
Energy from natural resources (4-ESS3-1)

NOTICE FIRST · 2 MINUTES
Follow a lamp's cord to the wall. Where do you think the energy comes from before that?

WORDS TO KEEP

fuel	A material that stores energy people can release, like coal, oil, gas or wood.
renewable	A source that is replaced naturally and quickly, like sunlight, wind or flowing water.

Sources, renewable and not

Coal, oil and natural gas are called fossil **fuels**. They formed underground over millions of years from the remains of plants and tiny living things.

Burning them releases energy that people use to make electricity and run cars. Once it is burned the fuel is gone. Its energy went out as heat and light, but nobody can gather that back into fuel, and the Earth takes millions of years to make more, so it is not renewable.

Sunlight, wind and flowing water are **renewable**: they are replaced naturally and quickly. A solar panel converts light, a wind turbine converts moving air, and a dam converts flowing water.

NOTES AND DRAWINGS

A made-up town's electricity

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Out of every 10 parts of this town's electricity, here is how many come from each source.

Source	Parts out of 10	Renewable?
natural gas	4	no
sunlight	3	yes
wind	2	yes
flowing water	1	yes

What fraction of the town's electricity is renewable? _____

Which single source gives the most? _____

The town wants 8 out of 10 parts to be renewable. How many more parts does it need?

_____

TALK ABOUT IT

What energy sources can you see from your school or home: panels, turbines, gas pipes, power lines?

Why might a town want more renewable sources?



STUCK? TRY THIS

Add the parts for every row marked yes. Write the total over 10.

★ CHALLENGE ZONE

Sunlight is renewable, but a solar panel gives no electricity at night. How could a town that uses a lot of solar power keep the lights on after dark?

WEEK 14 SOURCES

Every Source Costs Something

No way of making electricity is free. The costs are just in different places.

SITS BESIDE
Energy from natural resources (4-ESS3-1)

NOTICE FIRST · 2 MINUTES
Think of anything you use that needs energy. Who or what pays for it, besides money?

Nothing is free

Every energy source affects the environment somehow.

Burning fossil fuels puts gases into the air, including carbon dioxide, which traps heat and warms the Earth. Dams change rivers and the fish that live in them. Wind turbines need open land and can harm birds. Solar panels need land and materials that are dug out of the ground.

So choosing an energy source means choosing which costs to accept. That is a design problem, with criteria and constraints like any other.

Weigh it up

Pick one source from last week. Write one thing it gives and one thing it costs.

_____

_____

NOTES AND DRAWINGS

Four plans for a made-up town

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Each plan got two scores from 1 to 10. Lower is better for both.

Plan	Air pollution score	Land used score
Plan A: more gas	9	2
Plan B: more solar	2	6
Plan C: more wind	1	8
Plan D: half gas, half solar	5	4

Which plan has the lowest air pollution score? _____

Which plan uses the least land? _____

The town will only accept a plan with both scores at 5 or less. Which plan is that?

_____

💬 TALK ABOUT IT

Ask someone at home: what would they choose for the town, and why?

Is there a choice with no costs at all?



STUCK? TRY THIS

Check every plan against both numbers. A plan must pass both.

★ CHALLENGE ZONE

Plan C has the cleanest air but uses the most land. Write two sentences arguing for it, and two arguing against it.

WEEK 15 REVIEW

Follow the Energy

Every action you saw this part was one link in a chain of energy moving and changing.

SITS BESIDE
Energy moving from place to place (4-PS3-2)

NOTICE FIRST · 2 MINUTES
Think of a time you ate something and then ran or played. Where did the energy for running come from?



Part 2 on one card

Energy **transfers** by motion, sound, light, heat and electric current.

A **circuit** must be a closed loop for current to flow.

Devices **convert** energy from one form to another, and you can design one.

Energy comes from natural sources, some **renewable** and some not, and every source costs something.

NOTES AND DRAWINGS

Four energy chains

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Chain	The links, in order	Number of names in the chain
A	sun → plant → you → running	
B	battery → wire → bulb → light	
C	wind → turbine → wire → lamp → light	
D	rolling ball → cup	

Which chain has the most names in it? _____

Which TWO chains begin with a renewable source? _____

Add one link to the start of chain B. Where did the battery's energy come from?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Back to the Sun: one chain from your own day, traced back as far as you can.

💬 TALK ABOUT IT

Trace one chain from your day back to the sun.

Is there any energy you used today that did not start with the sun?



STUCK? TRY THIS

Count every name in the chain, the first and the last included. Then look at the first name of each chain.

★ CHALLENGE ZONE

Chain A and chain C both start, if you go back far enough, with the sun. Explain how wind comes from the sun.

WEEK 16 LANDSCAPES

Rock in Layers

A cliff is a stack of pages. The bottom page was written first.

SITS BESIDE
Rock layers as evidence (4-ESS1-1)

NOTICE FIRST · 2 MINUTES
Look at a road cut, a cliff or a picture of a canyon. Do you see stripes?

TRY IT · YOU WILL NEED

- a clear plastic jar with a lid
- a handful each of gravel, sand and soil
- water

Safely: Keep the lid on tight while shaking.

WORDS TO KEEP

layer A flat band of rock or soil laid down on top of the one below it.



Layers settle in order

Put gravel, sand, soil and water in a jar, shake it, and let it sit overnight.

It settles in **layers**: the heavy gravel first, then sand, then the finest soil on top. Over very long times, layers of mud and sand on the bottom of seas and lakes are pressed into rock.

Because each layer is laid on top of the last, the lowest layer in a cliff is usually the oldest. Fossils in a layer show what lived there when it formed.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

A canyon wall, top to bottom

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

The drawing on page 1 shows the layers in order. Here is how thick each one is.

Layer	Rock	Fossils	Thickness
A	sandstone	none	12 m
B	shale	sea shells	8 m
C	limestone	coral, a sea animal	20 m
D	siltstone	fern leaves	5 m

Which layer is most likely the oldest? _____

Which TWO layers have fossils of sea animals? _____

How tall is the canyon wall from top to bottom? _____

▶ ADD TO YOUR ENERGY LOG

Add a page called Layers: your settled jar drawn to scale, with the thickness of each layer.

💬 TALK ABOUT IT

Where near you can you see layers in rock or soil?

Why is the bottom layer usually older than the one on top of it?



STUCK? TRY THIS

Read the table from the bottom row up. That is the order the layers formed.

★ CHALLENGE ZONE

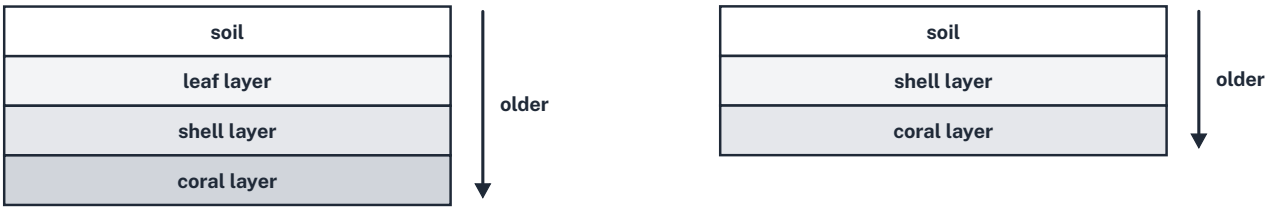
Draw your jar after it settled. Label each layer and say why the gravel ended up at the bottom.

Fossils in the Layers

The same layer in two cliffs, miles apart, means the land between them has a story.

SITS BESIDE
Rock layers as evidence (4-ESS1-1)

NOTICE FIRST · 2 MINUTES
If you found the same striped pattern in two cliffs across a valley, what would you think?



Matching layers

Scientists match layers by their fossils and their rock. A layer full of the same shells, at both sides of a valley, was once one layer that stretched all the way across.

Then a river cut the valley through it. The river did not make the layers; it uncovered them. That is how a canyon lets you read a long history, from the bottom up.

Sometimes a layer is in one cliff and missing from the other. It may have been worn away there, or it may never have formed. Both are possible, and a good scientist says so.

NOTES AND DRAWINGS

Two cliffs across a valley

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

The left drawing on page 1 is cliff 1 and the right drawing is cliff 2. Each lists its layers from top to bottom.

Which layer is in cliff 1 but missing from cliff 2? _____

How many fossil layers do the two cliffs share? _____

Give two reasons the missing layer might not be in cliff 2.

_____

_____

TALK ABOUT IT

Have you ever seen a river or stream cut into the ground? What did the banks look like?

Why do you think scientists trust a match of fossils more than a match of colors?



STUCK? TRY THIS

Line the two lists up side by side, starting from the bottom.

★ CHALLENGE ZONE

Draw a third cliff that shares two layers with cliff 1 and has one layer neither of the others has. Where would it fit in the story?

WEEK 18 LANDSCAPES

Breaking Rock

Rock seems permanent. Water, ice, roots and rubbing break it down anyway.

SITS BESIDE
Weathering and erosion (4-ESS2-1)

NOTICE FIRST · 2 MINUTES
Look at an old sidewalk or step. Find a crack, a rounded edge, or a plant growing through.

TRY IT · YOU WILL NEED

- sugar cubes
- a plastic jar with a lid
- a kitchen scale if you have one

Safely: The sugar is for the experiment, not for eating.

WORDS TO KEEP

weathering Rock breaking into smaller pieces where it is, by water, ice, wind, roots, rubbing or temperature changes.

Weathering, slowly

Weathering breaks rock into smaller pieces where it is.

Water seeps into cracks and freezes; ice takes up more room than water, so it pushes the crack wider. Roots grow into cracks and split them. Loose rocks at the foot of a cliff grind against each other every time more rock falls on them.

Model the grinding with sugar cubes. Shake some in a closed jar. They rub against each other, the corners wear off first, and crumbs collect at the bottom.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Sugar cubes, shaken

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class shook the same number of sugar cubes in a jar and weighed the crumbs that broke off.

Times shaken	Crumbs broken off
0	0 g
50	4 g
100	7 g
150	9 g
200	10 g

Between which two rows did the most crumbs break off? _____

How many grams broke off from 50 shakes to 200 shakes? _____

Why do you think fewer crumbs broke off near the end?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Breaking Rock: one place near you where rock or concrete is weathering, drawn, and what you think is breaking it.

💬 TALK ABOUT IT

Find a crack in a sidewalk or a wall. What might be making it wider?

Why do roads crack more in places with cold winters?



STUCK? TRY THIS

Subtract each row from the one below it. The biggest difference is where the most broke off.

★ CHALLENGE ZONE

Sugar dissolves in water and rock mostly does not. Is that a problem for this model? What part of real weathering does the model show well?

WEEK 19 LANDSCAPES

How Fast It Wears Away

Water carries land away. How fast depends on the slope, and on what is growing there.

SITS BESIDE
Weathering and erosion (4-ESS2-1)

NOTICE FIRST · 2 MINUTES
After a heavy rain, look at a slope with bare dirt and one with grass. Which one lost soil?

TRY IT · YOU WILL NEED

- a baking pan or tray
- sand or soil
- a cup of water
- books
- a spoon for measuring
- a second pan of damp sand with grass seed planted a week ahead

Safely: Do this outside or over a sink: it gets muddy.

WORDS TO KEEP

erosion	Broken rock and soil being carried away, by water, wind, ice or gravity.

A slope in a pan

Pack damp sand into one end of a pan and prop that end up on a book. Pour one cup of water slowly onto the top.

The water carries sand down the slope and leaves a channel. That carrying away is **erosion**. Rivers do it with rocks too: stones carried along knock against each other on the way, which is why river stones are round. Count the spoonfuls of sand that end up at the bottom.

Now prop the pan higher and try again with the same amount of water. Then try a pan where grass seed has sprouted. Change one thing each time, so you know which change made the difference.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Five trays

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class poured the same cup of water down five trays and measured the sand carried to the bottom.

Tray	Slope	Surface	Sand carried down
R1	1 book	bare	3 spoonfuls
R2	2 books	bare	7 spoonfuls
R3	3 books	bare	12 spoonfuls
R4	4 books	bare	18 spoonfuls
R5	3 books	sprouts	4 spoonfuls

Which two trays are a fair test of what grows on the surface? _____

In that fair test, how many fewer spoonfuls did the sprouts let wash away? _____

Among the bare trays, does a steeper slope erode more or less?

_____

TALK ABOUT IT

Why do you think people plant grass or bushes on hillsides beside roads?

Find a rounded stone and a sharp one. Which do you think was carried by a river?



STUCK? TRY THIS

For the fair test, find two trays that are the same in every column except the surface.

★ CHALLENGE ZONE

Design a way to slow erosion on the steepest tray without plants. Then say how you would test whether it worked.

Patterns on a Map

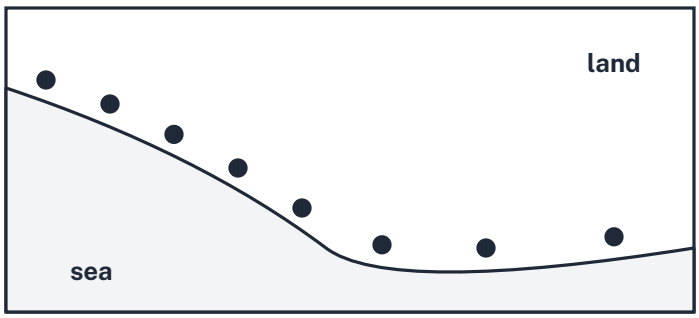
Plot where things happen, and a pattern can jump out that nobody could see from the ground.

SITS BESIDE
Patterns in Earth's features (4-ESS2-2)

NOTICE FIRST · 2 MINUTES
Look at a map of California. Where are the mountains? Is there a pattern?

WORDS TO KEEP

pattern Something that repeats in a way you can see, like a line of volcanoes along a coast.



practice map: each dot is one earthquake

The pattern is the clue

Earthquakes, volcanoes and tall mountains are not scattered evenly over the Earth.

On a world map they line up in long bands. Many of them follow the edges of oceans, including the coast of California. Scientists noticed that **pattern** on maps long before they could explain it.

The map on this page is a practice map of a made-up place. Each dot is one earthquake. Look at where the dots are before you read any further.

NOTES AND DRAWINGS

Reading the practice map

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Use the practice map on page 1.

How many earthquakes does the map show? _____

Describe where the dots are, compared with the coast, in one sentence.

_____

If one more earthquake happened, where on the map would you predict it? Why there?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Patterns: one pattern you noticed on a real map, drawn, and what you think might cause it.

💬 TALK ABOUT IT

Look at a map of where you live. What patterns do you notice in the roads, the rivers or the hills?

Why might scientists keep careful maps of where earthquakes happen?



STUCK? TRY THIS

Trace the coastline with your finger. How far from it is each dot?

★ CHALLENGE ZONE

Draw your own practice map of a made-up place with a line of volcanoes. Write one question a classmate could answer from it.

WEEK 21 LANDSCAPES

Where Mountains Are

The tallest mountains, the volcanoes and the earthquakes often turn up in the same places.

SITS BESIDE
Patterns in Earth's features (4-ESS2-2)

NOTICE FIRST · 2 MINUTES
Find the tallest mountain you can see or have seen. Is it near the coast or far from it?

Edges of the Earth's plates

The outside of the Earth is broken into huge pieces called plates. They move very slowly, a few centimeters a year.

Where plates push together, grind past each other or pull apart, you often find mountains, volcanoes and earthquakes. California sits where two plates meet, which is why it has so many earthquakes.

So a map of mountains, a map of volcanoes and a map of earthquakes often look alike. They are three clues to the same pattern. A clue is not proof: some tall mountains stand far from any plate edge.

Make a model

Lay two stacks of paper on a table, edge to edge. Push them slowly together. Where do the sheets bend up? Draw what you see.

NOTES AND DRAWINGS

Five peaks in a made-up land

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Peak	Height	Distance from the coast
A	2,500 m	30 km
B	2,900 m	40 km
C	950 m	190 km
D	2,400 m	50 km
E	730 m	240 km

Which peak is tallest? _____

How many peaks are taller than 2,000 meters? _____

How much taller is the tallest peak than the shortest? _____

Where are the tall peaks: near the coast or far from it? _____

TALK ABOUT IT

Ask someone at home if they know the name of a mountain range in California.

Why might it matter to people where the plate edges are?



STUCK? TRY THIS

Sort the peaks by height first. Then look at the distance column for the tall ones.

★ CHALLENGE ZONE

Peaks C and E are far from the coast and short. Make a claim about this made-up land's plate edge, and say what evidence supports it.

WEEK 22 REVIEW

Reading a Landscape

A canyon is a history book. Weathering and erosion turned its pages.

SITS BESIDE
Rock layers as evidence (4-ESS1-1)

NOTICE FIRST · 2 MINUTES
Look at any hill or cliff. What do you think it looked like a very long time ago?



Part 3 on one card

Rock forms in **layers**, and the lower layers are usually older. Fossils show what lived there.

Weathering breaks rock where it is. **Erosion** carries the pieces away, faster on steep slopes and slower where plants hold the soil.

Mountains, volcanoes and earthquakes make a **pattern** on a map, often along the edges of the Earth's plates.

NOTES AND DRAWINGS

A canyon's story, out of order

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Use the drawing on page 1: it shows the layers from top to bottom. Number the events in the order they happened.

	What happened	Order (1 = first)
a	a layer full of sea shells formed	
b	a river cut a canyon through all the layers	
c	a layer with fern leaves formed at the bottom	
d	a layer of sandstone formed on top	

Which event happened first? _____

Which event happened last? _____

How do you know the river came last?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Reading a Landscape: the story of one landscape you know, oldest event first.

💬 TALK ABOUT IT

Tell someone at home the story of the canyon, from the oldest event to the newest.

What could you learn from the rocks under your school?



STUCK? TRY THIS

A layer has to exist before a river can cut through it. Start with the bottom layer.

★ CHALLENGE ZONE

Add one more event to the story that happened after the river: weathering, a flood, a town. Where does it go, and why?

WEEK 23 WAVES

A Wave Moves Energy

A wave travels across the water. The water itself mostly stays where it was.

SITS BESIDE
Waves carry energy (4-PS4-1)

NOTICE FIRST · 2 MINUTES
Watch a leaf floating on a pond when a wave passes. Does the leaf ride away with the wave?

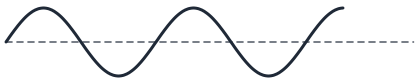
TRY IT · YOU WILL NEED

- a baking pan or tub of water
- a cork or a small piece of foam
- a ruler
- a spoon

Safely: Wipe up spills so nobody slips.

WORDS TO KEEP

wave — A repeating up-and-down or back-and-forth motion that carries energy from place to place.



The wave moves on. The cork does not.

Float a cork in the middle of a tub of water. Tap the water at one end with a spoon, again and again.

Ripples spread to the far end, but the cork mostly bobs up and down in the same place. The **wave** carries energy across the tub. It does not carry the water, or the cork, along with it.

Out in open water, ocean waves mostly do the same: the water bobs and the wave moves on. Where waves reach a beach, the water rushes forward and back.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Where was the cork?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class measured the cork's distance from the left side of the tub after each of five waves passed.

	Start	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Distance from the left	30 cm	30 cm	31 cm	30 cm	29 cm	30 cm

What is the farthest the cork ever was from where it started? _____

The waves traveled about 60 cm across the tub. Did the cork travel with them?

_____

TALK ABOUT IT

Have you seen a stadium wave, where people stand and sit in turn? What moves around the stadium, and what stays in its seat?

Where else have you seen a wave?



STUCK? TRY THIS

Compare every number in the row with the start, 30 cm.

★ CHALLENGE ZONE

A rope tied to a fence carries a wave when you flick it. Describe what each part of the rope does, and what travels along it.

WEEK 24 WAVES

Tall and Long

Every wave has a height and a length, and you can measure both.

SITS BESIDE
Waves carry energy (4-PS4-1)

NOTICE FIRST · 2 MINUTES
Make waves on a jump rope lying on the floor. Can you make them taller? Closer together?

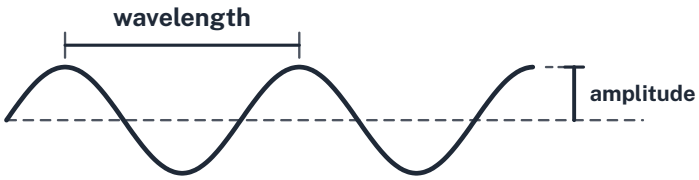
TRY IT · YOU WILL NEED

- a jump rope or a long scarf
- a partner
- a meter stick

Safely: Keep the rope low along the floor and away from everyone's face.

WORDS TO KEEP

amplitude	How tall a wave is: the distance from the resting line to the top of a crest.
wavelength	The distance from one crest to the next.



Measuring a wave

The **amplitude** is how tall a wave is, from the resting line to the top. The **wavelength** is the distance from one crest to the next.

Shake a rope harder and the amplitude grows. A wave with more amplitude carries more energy: a tall ocean wave can knock you over, and a ripple cannot.

Shake the rope faster and the crests come closer together, so the wavelength gets shorter.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four rope waves

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Wave	Amplitude	Wavelength
A	3 cm	20 cm
B	6 cm	20 cm
C	3 cm	40 cm
D	8 cm	40 cm

Which wave has the greatest amplitude? _____

Which TWO waves have the longest wavelength? _____

Waves A and B have the same wavelength. Which one carries more energy, and why?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Tall and Long: a wave you made with a rope, drawn, with its amplitude and wavelength measured.

💬 TALK ABOUT IT

Why do surfers care about the height of a wave?

When someone speaks louder, what do you think happens to the sound wave?



STUCK? TRY THIS

Amplitude is the first number column. Wavelength is the second.

★ CHALLENGE ZONE

Draw two waves of your own: one with twice the amplitude of the other but the same wavelength. Label both measurements.

WEEK 25 WAVES

Waves Move Things

A wave carries energy, and when it reaches something, it can push it.

SITS BESIDE
Waves carry energy (4-PS4-1)

NOTICE FIRST · 2 MINUTES
Picture the edge of a lake or a pool. What do the waves do to the sand or the toys?

TRY IT · YOU WILL NEED

- a baking pan of water
- a small pile of sand at one end
- a ruler or flat lid to make waves

Safely: Wipe up spills so nobody slips.

Waves at the beach

Ocean waves move sand along a beach, pile it into sandbars, and pull it away in storms.

The energy a wave carries reaches the shore and pushes the sand around. Bigger waves carry more energy, so they move more sand.

Pile sand at one end of a pan of water. Push the water gently with a flat lid to make small waves, then stronger ones. Watch the sand.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Wave height and sand

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class made waves of four heights in a pan for one minute each and weighed the sand that moved.

Wave height	Sand moved
1 cm	2 g
2 cm	7 g
3 cm	15 g
4 cm	26 g

How much more sand did the 4 cm waves move than the 2 cm waves? _____

Each time the wave height goes up 1 cm, does the extra sand moved stay the same, grow, or shrink? _____

TALK ABOUT IT

Why might a town build a wall of rocks along a beach?

Have you ever felt a wave push you? What did it feel like?



STUCK? TRY THIS

Subtract each row from the next. Then look at whether those differences get bigger.

★ CHALLENGE ZONE

A storm makes waves twice as tall as usual. Use the table to explain why storms change beaches so much faster than calm days.

WEEK 26 EARTHQUAKES

When the Ground Shakes

An earthquake sends waves through the ground. Knowing what to do is the first design.

SITS BESIDE
Reducing the impact of natural hazards (4-ESS3-2)

NOTICE FIRST · 2 MINUTES
Has your school practiced an earthquake drill? What were you told to do?

WORDS TO KEEP

earthquake A sudden shaking of the ground when rock deep underground slips.

Waves in the ground

Deep underground, rock can be pushed for years until it suddenly slips. That slip sends waves through the ground in every direction. That is an **earthquake**.

The waves get weaker as they spread out, so places far away shake less than places close by. Scientists measure the shaking with instruments that record the ground moving.

Nobody can stop an earthquake. People can reduce the harm it does. The first thing everyone learns is what to do: **Drop** to your hands and knees, **Cover** your head and neck under a sturdy table, and **Hold On** until the shaking stops. No table nearby? Get down next to an inside wall and cover your head and neck with your arms. In a wheelchair or with a walker: **Lock** your wheels, **Cover** your head and neck with your arms, and **Hold On**.

Practice it

Find the sturdiest table near where you sit. Practice Drop, Cover and Hold On with your class.

NOTES AND DRAWINGS

One earthquake, four places

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Shaking was measured at four places at different distances from where an earthquake started. A higher number means stronger shaking.

Distance away	Shaking strength
10 km	8
20 km	4
40 km	2
80 km	1

Where was the shaking weakest? _____

Which place felt shaking half as strong as the place 10 km away? _____

Finish the sentence: the farther from where it started, _____

💬 **TALK ABOUT IT**

What does your school do to get ready for an earthquake?

Why do you think a heavy bookshelf should be fastened to the wall?



STUCK? TRY THIS

Half of 8 is 4. Find the row where the shaking strength is 4.

★ **CHALLENGE ZONE**

Make a short checklist a classroom could use to get ready for an earthquake. Choose three things that would reduce harm.

WEEK 27 EARTHQUAKES

Build It to Stand

Buildings in earthquake country are designed to shake without falling. You can test why.

SITS BESIDE
Reducing the impact of natural hazards (4-ESS3-2)

NOTICE FIRST · 2 MINUTES
Stack blocks into a tall thin tower and a short wide one. Bump the table. Which falls first?

TRY IT · YOU WILL NEED

- drinking straws
- tape
- index cards
- a baking pan set on a few pencils, to make a shake table

Safely: Keep the shake table on the floor or in the middle of a table, and slide it gently so nothing rolls off.

The problem: a tower that stands

Set a baking pan on four pencils so it rolls when pushed. That is a shake table. Build a straw tower on it, and slide the pan back and forth 20 times.

The criteria: the tower must be at least 30 cm tall and stand through at least 15 of the 20 shakes. The constraint: no more than 20 straws.

Engineers in earthquake country use wide bases, diagonal braces that make triangles, and connections that can bend without breaking. Try one idea at a time.

DRAW IT

Draw your tower. Label the part you think will keep it standing.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Four towers on the shake table

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Tower	Design	Height	Shakes it stood through	Straws used
A	wide base	30 cm	18 of 20	16
B	tall and thin	45 cm	6 of 20	12
C	cross-braced	35 cm	20 of 20	24
D	short and squat	20 cm	20 of 20	10

Which tower meets every criterion and the constraint? _____

Which tower stood through every shake but broke the constraint? _____

Tower D stood through every shake too. Why does it still not meet the criteria?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Build It to Stand: your tower drawn, its height, its straw count, and how many shakes it stood through.

💬 TALK ABOUT IT

Look at a tall building, a bridge or a playground climber. Can you find triangles?

Why might a tower that is short and wide be steadier than a tall thin one?



STUCK? TRY THIS

Check each tower against all three rules: height, shakes, straws.

★ CHALLENGE ZONE

Design a tower that keeps tower C's cross braces but uses 20 straws or fewer. Draw it and predict how many shakes it would stand through.

WEEK 28 EARTHQUAKES

Compare the Designs

Three ways to make a library safer in an earthquake, and the evidence to choose one.

SITS BESIDE
Comparing design solutions (3-5-ETS1-2)

NOTICE FIRST · 2 MINUTES
Look around your classroom. What could fall if the room shook hard?

The problem: books and shelves

In a strong earthquake, tall shelves can tip over and books can fly off. A library wants to make itself safer.

It tested three ideas on a model shelf on a shake table and counted how many of 20 books fell. The criterion: no more than 3 books fall. The constraint: the fix must cost $100 or less.

Comparing solutions fairly means the same test, the same books, and the same rules for all of them. The best-looking idea is not always the one that wins.

Your own idea

Describe one more way to keep the books on the shelves.

DRAW IT
Draw a shelf with your best fix. Label how it stops the books.

Three fixes, tested

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Fix	Cost	Books that fell (of 20)
strap the shelves to the wall	$40	2
use only low shelves	$300	0
add a lip to every shelf	$25	6

Which fix meets the criterion and the constraint? _____

Which fix kept the most books on the shelves but broke the constraint?

_____

How many more books fell with the shelf lip than with the straps? _____

TALK ABOUT IT

What is one thing in a room at school that could be fastened down?

Why do you think the cheapest fix was not the best one here?



STUCK? TRY THIS

Cross out any fix where more than 3 books fell. Then cross out any that cost more than $100.

★ CHALLENGE ZONE

Combine two of the fixes into one design. Predict how many books would fall and what it would cost.

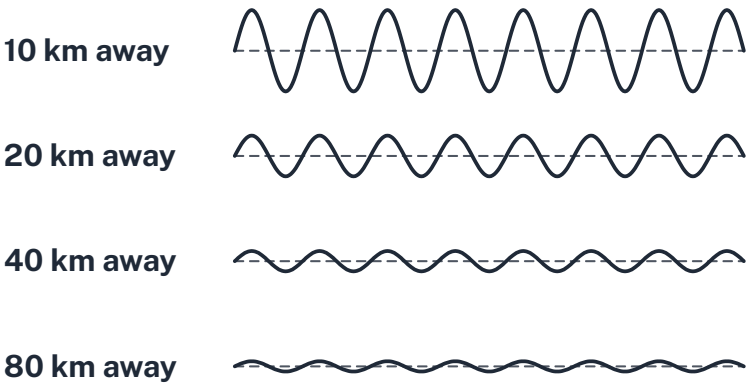
WEEK 29 REVIEW

Shaking, Measured

An earthquake's waves can be recorded on paper. The wiggles get smaller with distance.

SITS BESIDE
Waves carry energy (4-PS4-1)

NOTICE FIRST · 2 MINUTES
Tap a table gently, then hard, with a cup of water on it. How do the ripples change?



Part 4 on one card

A **wave** carries energy without carrying the water, the rope, or the ground along with it.

Its **amplitude** is how tall it is, and a taller wave carries more energy. Its **wavelength** is crest to crest.

An **earthquake** sends waves through the ground, and they get weaker as they spread out.

Engineers compare designs with the same test and the same rules.

NOTES AND DRAWINGS

Four recording stations

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Four stations recorded the same earthquake. Each measured the tallest wiggle on its paper record.

Distance from the start	Tallest wiggle
10 km	24 mm
20 km	12 mm
40 km	6 mm
80 km	3 mm

Each time the distance doubles, what happens to the wiggle? _____

Predict the tallest wiggle at a station 160 km away. _____

💬 TALK ABOUT IT

Explain to someone at home how a wave can carry energy without carrying water.

Which do you think carries more energy, a ripple or an ocean wave? Why?



STUCK? TRY THIS

Compare each wiggle with the one above it. What do you do to 24 to get 12?

★ CHALLENGE ZONE

A station 5 km from the start shook so hard that its pen went off the edge of the paper. Use the pattern to predict how tall its wiggle should have been, and explain your reasoning.

WEEK 30 SENSES

Inside and Outside

Every part of a living thing is there because it does a job.

SITS BESIDE
Structures that help living things survive (4-LS1-1)

NOTICE FIRST · 2 MINUTES
Look closely at a flower or a picture of one. How many different parts can you find?

TRY IT · YOU WILL NEED

- a flower, a leaf and a seed
- a magnifying glass if you have one

Safely: Do not eat any part of a plant you find. Never look at the sun through a magnifying glass, and never use one to make a hot spot.

WORDS TO KEEP

structure	A part of a living thing, inside or outside, that does a job, like a root, a heart or a feather.

A part for every job

A **structure** is a part of a living thing that does a job. Some are on the outside, some are inside.

A flower's bright petals attract bees, which carry pollen from flower to flower so the plant can make seeds. A rose's thorns protect it from animals that would eat it. A bird's feathers keep it warm and let it fly.

Every structure helps the living thing survive, grow, behave or reproduce. Look at your flower closely and find a part for each job you can.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

What is each part for?

	The structure	Its job
a	a porcupine's quills	
b	a duck's webbed feet	
c	a flower's bright petals	
d	an eagle's sharp beak	
e	a turtle's shell	
f	a plant's roots	

Use these jobs: protection, moving, getting food or water, reproduction.

How many structures are for protection? _____

Which structure helps with reproduction? _____

▶ ADD TO YOUR ENERGY LOG

Add a page called Structures: a plant or animal you looked at closely, three structures, and the job of each.

💬 TALK ABOUT IT

Name one of your own structures and the job it does.

Why do you think some plants have thorns and others do not?



STUCK? TRY THIS

Ask: what would go wrong for this living thing if it did not have this part?

★ CHALLENGE ZONE

Invent an animal for a very cold, icy place. Draw it with three structures and label the job each one does.

WEEK 31 SENSES

Parts With Jobs

Inside a plant, tiny tubes carry water up from the roots. You can watch them work.

SITS BESIDE
Structures that help living things survive (4-LS1-1)

NOTICE FIRST · 2 MINUTES
Look at the cut end of a celery stalk. Do you see small dots in a curve?

TRY IT · YOU WILL NEED

- a celery stalk with leaves
- a clear cup of water
- food coloring
- a ruler

Safely: An adult cuts the celery. Never taste anything in an investigation. Food coloring stains skin and clothes.

Tubes inside a stalk

Put a celery stalk in water with a few drops of food coloring. Check it every few hours.

The color climbs up the stalk through tiny tubes. Those tubes carry water from the roots to the leaves. They are a structure inside the plant, the way your heart and blood vessels are structures inside you.

Your heart pumps blood, your lungs take in air, your stomach breaks down food, and your brain takes in information and decides. Each one is an inside structure with a job.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

How high did the color climb?

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class measured how far the color had climbed up a celery stalk.

Hours in colored water	How high the color climbed
0	0 cm
1	2 cm
2	4 cm
4	7 cm
8	11 cm
24	18 cm

How far did the color climb in the first 4 hours? _____

Between which two checks did the color climb the most centimeters?

_____

Why do the leaves need the water to reach them?

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Inside: your celery stalk drawn at the start and at the end, with how high the color climbed.

💬 TALK ABOUT IT

Name three structures inside your body and the job each one does.

Why do you think flowers in a vase need fresh water?



STUCK? TRY THIS

Subtract each row from the next to find how many centimeters the color climbed between those two checks.

★ CHALLENGE ZONE

Plan a fair test of whether celery with leaves pulls water up faster than celery without leaves. What would you keep the same?

WEEK 32 SENSES

Sense, Decide, Respond

Your eyes see the ruler drop, your brain decides, your hand closes. It all takes time.

SITS BESIDE
How animals use their senses (4-LS1-2)

NOTICE FIRST · 2 MINUTES
Clap when a friend says go. Is there a tiny pause before your hands move?

TRY IT · YOU WILL NEED

- a 30 cm ruler
- a partner

WORDS TO KEEP

sense	A way of taking in information: seeing, hearing, touching, tasting or smelling.
respond	To act because of information your senses took in.



The ruler drop

Your partner holds a ruler by the top end, with the 0 end at the bottom. You hold your thumb and finger open around the 0 mark, not touching it. Without warning, they let go. Catch it as fast as you can.

Read the number where you caught it. A smaller number means you caught it sooner. Your **sense** of sight took in the information, your brain processed it, and your hand **responded**.

Animals do this all day: a rabbit hears a sound, its brain decides it means danger, and it runs. Five tries with each hand, or ten with one. If you cannot see the ruler, catch it when your partner says go.

MY INVESTIGATION

I predict: _____

What happened: _____

What I think caused it: _____

Five catches with each hand

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Try	1	2	3	4	5
Left hand	18 cm	16 cm	15 cm	15 cm	14 cm
Right hand	14 cm	13 cm	12 cm	12 cm	11 cm

Which hand caught the ruler sooner on every try? _____

What was the best catch of all? _____

Did practice help? Use the numbers to explain.

_____

▶ ADD TO YOUR ENERGY LOG

Add a page called Sense and Respond: your five catches with each hand, and which sense started each one.

💬 TALK ABOUT IT

Ask a classmate or someone at home to try the ruler drop. Who caught it sooner?

Why do you think goalkeepers and drummers practice so much?



STUCK? TRY THIS

A smaller number is a faster catch. Compare the hands one try at a time.

★ CHALLENGE ZONE

Try catching the ruler when your partner says go instead of watching it. Is that sooner or later? Which sense did you use?

WEEK 33 SENSES

How You See

You do not see a thing by looking at it. You see it because light bounces off it into your eyes.

SITS BESIDE
Light, reflection and seeing (4-PS4-2)

NOTICE FIRST · 2 MINUTES
In a completely dark room, can you see your own hand? What has to change before you can?

TRY IT · YOU WILL NEED

- a shoebox with a lid
- a pencil to poke small holes
- five small objects

Safely: An adult pokes the holes. Never look straight at the sun.

WORDS TO KEEP

reflect — To bounce off a surface. You see most things because light reflects off them into your eyes.

Light in, light out

Put five small objects in a shoebox and close the lid. Make one small peephole in the end and look in.

You see nothing, because no light gets in to bounce off the objects. Poke a second hole in the lid to let light in. Light enters, **reflects** off the objects, and some of it comes out through the peephole into your eye.

That is how you see almost everything: light from the sun or a lamp bounces off it and travels to your eyes.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Holes for light

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

A class added light holes to the lid one at a time and counted how many of the five objects someone could name through the peephole.

Light holes in the lid	Objects named (of 5)
0	0
1	2
2	4
3	5

With no light holes, how many objects could be named? _____

How many light holes did it take to name all five? _____

Why did more holes help? Use the word reflect.

_____

TALK ABOUT IT

How do you see the moon at night? Where does its light come from?

Why do bikes have reflectors?



STUCK? TRY THIS

Light has to get in before it can bounce out. Count the light holes first.

★ CHALLENGE ZONE

Draw arrows showing the path of light from a lamp, to a book, to your eye. Then draw what changes when the lamp is switched off.

WEEK 34 SENSES

A Pattern Carries a Message

Flashes of light can carry words across a dark room, if both people know the pattern.

SITS BESIDE
Patterns that carry information (4-PS4-3)

NOTICE FIRST · 2 MINUTES
Have you ever blinked a flashlight or tapped a pencil to send a signal? What did it mean?

TRY IT · YOU WILL NEED

- a flashlight
- a partner
- paper and a pencil

Safely: Never shine a flashlight into anyone's eyes. Point it at a wall.

WORDS TO KEEP

code A pattern that stands for a message, like dots and dashes or flashes of light.

A class flash code

In this **code**, every letter is a pattern of short flashes (S) and long flashes (L). A pause comes between letters.

Letter	A	B	C	D	E	O
Flashes	SL	LS	LL	SS	S	L

Flash a letter on the wall for your partner. Then flash a whole word. People have sent messages this way across the sea, between ships at night, for more than a hundred years.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Read and write the code

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

This message was flashed, letter by letter, with a pause at each slash:

SS / S / LL / L / SS / S

What word is it? _____

Write the word BED in the code. _____

How many flashes in all does it take to send CAB? _____

▶ ADD TO YOUR ENERGY LOG

Add a page called My Code: a code you invented, a message in it, and how the energy carried it: light, sound or motion.

💬 TALK ABOUT IT

Where do you see codes every day? Think of traffic lights and the dots on dice.

Why do both people need to know the code before it works?



STUCK? TRY THIS

Take one letter at a time, between the slashes, and find it in the code table.

★ CHALLENGE ZONE

Make up a code for the letters of your first name. Write it down, then flash it for a partner and see if they can read it.

WEEK 35 SENSES

Two Codes Compared

Two codes can carry the same message. One may be faster, the other easier to read.

SITS BESIDE
Patterns that carry information (4-PS4-3)

NOTICE FIRST · 2 MINUTES
Is a short message always easier to read than a long one?

TRY IT · YOU WILL NEED

- a flashlight
- a partner
- a timer

Safely: Never shine a flashlight into anyone's eyes.

Code X and code Y

Code X is last week's code: each letter takes 1 or 2 flashes. **Code Y** is a new code where every letter takes exactly 3 flashes:

Code Y	A	B	C	D	E	O
Flashes	SSL	SLS	SLL	LSS	SSS	LLL

Send the same word in both codes, and time each one.

Code X is shorter, so it is faster to send. But because its letters are different lengths, a pause that is a little too short can make two letters run together. Code Y is longer, and every letter is the same length, so it is harder to misread.

Choosing between them is a design decision. It depends on what matters more: speed or getting every letter right.

MY INVESTIGATION

I predict:

What happened:

What I think caused it:

Testing the two codes

PRACTICE DATA · MADE UP FOR THIS PAGE, NOT MEASURED

Count every flash, short or long, as 1 second, and do not count the pauses. A class also sent 20 letters in each code and counted the letters read wrong.

Code	Flashes per letter	Letters read wrong (of 20)
X	1 or 2	5
Y	always 3	1

How many seconds of flashing to send DECODE in code X? _____ In code Y? _____

The rule is fewer than 3 letters read wrong out of 20. Which code meets it? _____

Which code would you choose for an emergency message, and why?

_____

TALK ABOUT IT

When is it more important to be fast, and when is it more important to be right?

How do you make sure a message you send is understood?



STUCK? TRY THIS

For code X, count the S's and L's in each letter of the word and add them. For code Y, multiply the number of letters by 3.

★ CHALLENGE ZONE

Design a code Z that is faster than code Y but harder to misread than code X. Explain your idea.

WEEK 36 REVIEW

Where Did It Go?

Thirty-six weeks, one question. Energy was never used up. It moved, and it changed form.

SITS BESIDE
Energy moving from place to place (4-PS3-2)

NOTICE FIRST · 2 MINUTES
Find one thing that changed in the room today. Where did the energy for it come from, and where did it go?



The year in one question

A ball hit a cup. A pan made rice jump. A pinwheel lifted a clip. A wave rolled sand up a beach. Each time you asked: where did the energy go?

It moved: by motion, sound, light, heat and electric current. It changed form: from light to warmth, from motion to sound, from current to light. And it carried information: a flash of light, a ruler seen falling, a code across a dark room.

It was never used up. That is the most useful sentence in this book.

NOTES AND DRAWINGS

How did the energy travel?

Choose from: **motion**, **sound**, **light**, **heat**, **electric current**.

	What happens	How the energy traveled
a	hearing a clap from across the room	
b	a lamp lighting up a dark room	
c	a rolling ball hitting a cup	
d	a wire carrying energy from a battery to a bulb	
e	a hot water bottle warming your cold feet	
f	a flashlight sending a code	

How many rows are light? _____

Which row is the only one where energy travels as heat? _____

▶ ADD TO YOUR ENERGY LOG

Finish your Energy Log with a page called Never Used Up: the longest energy chain you found this year, from start to end.

💬 TALK ABOUT IT

Tell someone at home the investigation you liked best this year and what you found out.

What question about energy do you still want to answer?



STUCK? TRY THIS

Ask what reached you, or reached the next thing: was it something moving, a sound, light, warmth or current?

★ CHALLENGE ZONE

Write the longest energy chain you can that ends with you reading this page.

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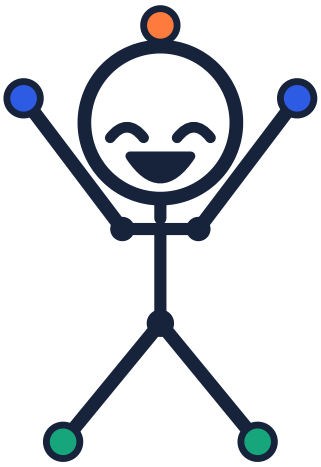
Grade 4 · Where Did It Go?

Certificate of Completion

This is to certify that

_____

practiced following energy for thirty-six weeks.



_____ _____

Teacher Date

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