THE STANDARD

Speed & Energy

Use evidence to construct an explanation relating the speed of an object to the energy of that object.

ANCHORING PHENOMENON

The Higher Ramp Sends the Cup Flying

A marble rolls down a ramp and slams into a plastic cup at the bottom. Raise the top of the ramp higher and the same marble reaches the bottom moving faster. Each time it's faster, the cup skids farther across the floor. Same marble, same cup, but the distance keeps growing. 4th graders will want to know why.

DRIVING QUESTION

"Why does letting the marble start from higher up make it push the cup farther?"

INVESTIGATIVE 1

Same Marble, Different Push

No ramp this time. Flick the same marble across a smooth table, once gently and once hard, into a paper cup. The hard flick sends the cup farther every time. Use this one to sharpen the anchor's big question: it's the speed that changes the energy, not the ramp or the height.

DRIVING QUESTION

"If we use the very same marble, what makes it move the cup farther some times than others?"

INVESTIGATIVE 2

Fast Marble Down the Domino Line

Stand up a row of dominoes and roll a marble into the front one, first slowly, then quickly. The slow marble knocks down a few. The fast marble runs the energy farther down the line. Same setup as the anchor, but now you can watch the energy travel from object to object.

DRIVING QUESTION

"How far down the line does the marble's energy travel, and what decides that?"

THE STANDARD

Evidence of Energy Transfer

"Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents."

ANCHORING PHENOMENON

The Lamp Across the Room

Flip a switch on the wall and a lamp clear across the room lights up and gets warm. A wire runs hidden inside the wall, so you cannot see what connects the switch to the lamp. The energy started far away and showed up here as light and heat.

DRIVING QUESTION

"How does flipping a switch over here make a lamp light up and warm up way over there?"

INVESTIGATIVE 1

The Spoon That Steals Your Warmth

Put a metal spoon and a plastic spoon in a cup of warm water. After a minute, the metal spoon handle feels warm but the plastic one stays cool. The heat traveled up the metal from the water to your fingers, so some paths carry it better than others.

DRIVING QUESTION

"Why does the metal spoon handle get warm while the plastic one stays cool in the same cup?"

INVESTIGATIVE 2

You Can Feel the Speaker Buzz

Turn up a speaker and hold a hand a few inches in front of it. On a low, loud note you feel a buzz on your skin and a balloon nearby trembles. The sound left the speaker, crossed the air, and pushed on your hand. You feel the energy travel.

DRIVING QUESTION

"How does sound from the speaker reach across the air and make a balloon shake?"

THE STANDARD

Energy & Collisions

"Ask questions and predict outcomes about the changes in energy that occur when objects collide."

ANCHORING PHENOMENON

One Marble Stops, the Other Takes Off

Roll a marble into a line of still marbles sitting tight against each other. The rolling marble nearly stops. But the marble at the far end takes off, all by itself. Nothing touched it directly. Roll the first marble faster and the far one flies away faster. Same marbles every time, but the energy keeps showing up at the other end.

> DRIVING QUESTION
> *"How does the marble at the far end take off when the marble that hit the line stopped?"*

INVESTIGATIVE 1

Crash the Carts

Send one toy car rolling into a parked car, first slow, then fast. The parked car gets knocked forward every time, and the harder crash sends it farther. Use this to sharpen the anchor's big question: the energy of the moving car transfers into the still car, and a faster crash hands off more energy.

> DRIVING QUESTION
> *"What happens to the parked car when a faster car crashes into it, and why?"*

INVESTIGATIVE 2

Listen for the Energy

Drop a ball onto a hard floor from low, then high. The higher drop hits faster, bounces higher, AND makes a louder bang. Same setup as the anchor, but now 4th graders hear something. Some of the crash energy turns into sound, which is a clue that energy spreads into more than just the bounce.

> DRIVING QUESTION
> *"Why does the ball make a louder sound when it hits the floor faster?"*

THE STANDARD

Changes in Forms of Energy

"Apply scientific ideas to design, test, and refine a device that converts energy from one form to another."

ANCHORING PHENOMENON

The Flashlight That Wouldn't Turn On

A teacher holds up a flashlight with everything it needs: a battery, a bulb, and wires. But it stays dark. One small fix later, a loose wire pushed back into place, and it glows. Same parts, same battery, but now energy is flowing all the way through and coming out as light.

DRIVING QUESTION

"The battery was full of stored energy the whole time, so why did the light only turn on after we fixed the wire?"

INVESTIGATIVE 1

One Battery, Three Different Jobs

Take one battery and hook it to three different things, one at a time: a small bulb, a tiny motor with a paper flag, and a buzzer. The bulb makes light, the motor makes motion, the buzzer makes sound. Same stored energy, three different forms coming out. The energy that powers the device can become more than one thing.

DRIVING QUESTION

"How can the very same battery make light one time, motion the next, and sound the third time?"

INVESTIGATIVE 2

The Solar Cup of Warm Water

Set a small cup of water in sunlight inside a black-lined box and put a matching cup in the shade. After a while, the sunny one is clearly warmer. No battery, no wires. Light energy from the sun turned into heat energy in the water. Use this to show energy converting in a totally different device than the circuit.

DRIVING QUESTION

"There's no battery here, so where did the warmth in the water come from?"

THE STANDARD

Modeling Waves

"Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move."

ANCHORING PHENOMENON

The Rope That Won't Travel

Tie one end of a long rope to a chair. Shake the other end up and down, and a wave races to the chair. But here is the puzzle: the rope never goes anywhere. Each part bounces in place, yet the wave clearly moves. 4th graders want to know how that works.

DRIVING QUESTION

"How can a wave move all the way down the rope when the rope itself never moves to the other side?"

INVESTIGATIVE 1

Ripples in the Water Tray

Tap one finger on a shallow tray of water and watch the ripples spread in rings. Drop a small cork on the water first. When the ripple reaches it, the cork bobs up and down but stays put. The wave moves, the water does not travel with it.

DRIVING QUESTION

"When the ripple passes the floating cork, why does the cork bob in place instead of riding the wave away?"

INVESTIGATIVE 2

Big Shake, Little Shake

Stretch a coiled spring toy or a jump rope flat on the floor between two people. Shake your end gently, then shake it big. The gentle shake makes short bumps, the big shake makes tall bumps. Now shake slow versus fast and watch the spacing change. This one zeroes in on two words: amplitude and wavelength.

DRIVING QUESTION

"What do I have to change about my shaking to make the wave taller, and what makes the bumps crowd closer together?"

THE STANDARD

Reflecting Light & Vision

"Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen."

ANCHORING PHENOMENON

The Pitch-Black Room

You walk into a room with the lights off and the shades pulled tight. You know your backpack is on the chair, but you cannot see it at all. Then you click on a flashlight and there it is. The backpack didn't move and it didn't change. So why could you suddenly see it the instant the light came on? 4th graders will want to figure out what the light is actually doing.

> DRIVING QUESTION
> *"The backpack was there the whole time, so why couldn't we see it until the light turned on?"*

INVESTIGATIVE 1

Catching Light in a Mirror

Shine a flashlight at a small mirror and aim the bright spot it makes onto the wall or ceiling. Tilt the mirror and the spot jumps to a new place. The light clearly bounced off the mirror and traveled somewhere new. Use this to sharpen the anchor: light doesn't stop at an object, it bounces off and keeps going, and it can travel right into your eye.

> DRIVING QUESTION
> *"Where does the flashlight beam go after it hits the mirror, and how do we know it bounced?"*

INVESTIGATIVE 2

The Box With One Peephole

Put a small toy inside a sealed cardboard box with one peephole to look through. With the box closed up tight, you see only black. Cut a flap to let light in and suddenly the toy appears. Same toy, same eye, same peephole. The only thing that changed was letting light reach the toy. This zeroes in on whether light is the missing piece.

> DRIVING QUESTION
> *"What has to happen inside the box before our eye can see the toy through the peephole?"*

THE STANDARD

Transferring Information

"Generate and compare multiple solutions that use patterns to transfer information."

ANCHORING PHENOMENON

Sending a Secret Message Across the Room

You can't talk, you can't walk over, and you can't pass a note. Your partner is on the other side of the room. You have to get them a message using only a flashlight, a drum, or your hands. Teams try it and notice something: some codes get through perfectly, some turn into a mess. 4th graders will want to know why.

> DRIVING QUESTION
>
> *"How can you send a message all the way across the room without talking, and which way works best?"*

INVESTIGATIVE 1

Drumbeat Code

Two teams agree on a drum code: one beat means "yes," two beats means "no," three beats means "come here." Then they sit back to back and send messages. When the beats are clear and spaced out, it works. When they rush, the partner can't tell two beats from three. This sharpens the anchor: the pattern has to be easy to tell apart.

> DRIVING QUESTION
>
> *"What makes a drum code easy to read, and what makes it get mixed up?"*

INVESTIGATIVE 2

Picture on a Grid

Give partners a small grid, like 5 squares by 5 squares. One partner colors a simple shape, then reads it out square by square: "filled, empty, filled." The other partner colors what they hear and tries to copy the picture without ever seeing it. This shows how a picture can travel as a pattern of "on" and "off" squares.

> DRIVING QUESTION
>
> *"How can you send a picture to a partner using only the words "filled" and "empty"?"*

THE STANDARD

Internal & External Structures

"Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction."

ANCHORING PHENOMENON

The Cactus That Won't Let Anyone Take a Bite

A cactus lives where almost nothing else grows. It has sharp spines all over, a thick waxy skin, and roots that spread out wide and shallow. Hungry animals walk right past it. Other plants nearby wilt and die, but the cactus stays full and green. 4th graders will want to know how one plant has the exact parts it needs to survive a place this harsh.

> DRIVING QUESTION
>
> *"How do the cactus's parts work together to help it survive in a place where other plants can't?"*

INVESTIGATIVE 1

Watch the Stem Move Water (Color Climb)

Stand a white flower or a stalk of celery in a cup of water dyed bright red. These are cuttings with no roots. Leave them overnight. The next day the color has climbed up the stem and into the petals or leaves. You can actually watch the stem do its job of moving water, even with no roots in the cup.

> DRIVING QUESTION
>
> *"How does water get from the bottom of the cutting all the way up to the leaves and flowers?"*

INVESTIGATIVE 2

Bird Beaks Built for the Job

Give 4th graders different tools: tweezers, a clothespin, a spoon, an eyedropper. Add a pile of 'foods' like seeds, water, and gummy worms. Each tool grabs some foods easily and fails at others. Use this to show the same idea in animals: a body part is shaped for the job it does, and the right part helps the animal eat and survive.

> DRIVING QUESTION
>
> *"Why is each bird's beak a different shape, and how does that shape help it get food?"*

THE STANDARD

Animal Senses

"Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways."

ANCHORING PHENOMENON

The Cat That Freezes Before the Doorbell Rings

A house cat is asleep on the couch. A second before the doorbell rings, the cat's ears swivel, its head lifts, and it bolts under the bed. Something tiny, a faint sound or a vibration, reached the cat first. 4th graders will want to know what the cat noticed that they didn't, and why its body reacted so fast.

DRIVING QUESTION

"What information did the cat pick up, and how did that turn into the cat running away?"

INVESTIGATIVE 1

The Earthworm That Hates the Light

Put an earthworm on a damp paper towel and shine a flashlight on one end. The worm crawls away from the light toward the dark, every single time. It has no real eyes, but it still senses the light and responds. Even a simple animal catches information and reacts, sense to brain to action.

DRIVING QUESTION

"How does an earthworm with no eyes know which way to crawl away from the light?"

INVESTIGATIVE 2

The Dog That Comes Running at the Can Opener

A dog in another room can't see the kitchen. The second a can opener clicks, the dog comes sprinting in. The sound reached its ears, its brain matched that sound to food, and it ran. Focus on the middle step: the brain reads the information and picks the response. The same sound means nothing to a dog never fed from a can.

DRIVING QUESTION

"Why does one sound make the dog come running while another sound is ignored?"

THE STANDARD

Landscape Changes

"Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time."

ANCHORING PHENOMENON

Seashells on Top of a Mountain

Show 4th graders a photo of a tall, dry mountain far from any ocean. Then show a close-up: the rock near the top is packed with fossil seashells. How did ocean animals end up frozen in the rock at the very top of a mountain? Let the rock layers start telling that story.

DRIVING QUESTION

"How did seashell fossils end up in the rock at the top of a mountain with no ocean anywhere near it?"

INVESTIGATIVE 1

The Canyon and the River

Show a photo of a deep canyon with many colored rock layers in its walls and a small river at the very bottom. The river looks too tiny to have made such a giant canyon. Use this one to sharpen the anchor's big idea: the layers stacked first, then slow change (a river cutting down) carved through them over a very long time.

DRIVING QUESTION

"How could a small river at the bottom cut all the way through that many rock layers?"

INVESTIGATIVE 2

Two Layers, Two Kinds of Fossils

Give students a simple drawing of a road cut with two stacked layers. The bottom layer has leaf and plant fossils and no shells. The layer above it is full of shell fossils. This one zooms in on the exact pattern in the clarification statement, so students practice reading fossils as evidence.

DRIVING QUESTION

"If the bottom layer has plants and the top layer has shells, what changed about this place over time?"

THE STANDARD

Weathering & Rate of Erosion

"Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation."

ANCHORING PHENOMENON

The Hill That Washed Away

Build a hill of sand and soil in a tray. Pour a cup of water down the top. The water cuts a groove and carries sand to the bottom. Pour faster or tilt the tray steeper, and a lot more sand washes away. 4th graders will want to know why.

DRIVING QUESTION

"What makes the water wash away way more of the hill some times than others?"

INVESTIGATIVE 1

Roots That Hold the Hill

Build two hills, one bare sand and one with grass, moss, or craft-stick roots pushed in. Pour the same water on both. The bare hill washes away fast, the rooted one mostly stays put. Plants are a cause too, and they slow erosion down.

DRIVING QUESTION

"Why does the hill with roots lose so much less than the bare hill?"

INVESTIGATIVE 2

Ice That Cracks the Rock

Fill a sealable zip bag or flexible balloon with water and freeze it overnight. The bag or balloon bulges and stretches as the ice pushes outward. Water freezing in a crack does the same to rock, breaking it apart a little at a time. This is weathering by ice.

DRIVING QUESTION

"How can frozen water be strong enough to break a rock?"

THE STANDARD

Earth's Features

"Analyze and interpret data from maps to describe patterns of Earth's features."

ANCHORING PHENOMENON

The Ring of Fire

Show 4th graders a world map with every volcano marked, then a second map with every big earthquake marked. At first it looks messy. But the volcano dots curve in a giant ring all the way around the Pacific Ocean, and a lot of the earthquake dots trace that same ring. Same shape, two different maps. They'll want to know why so many dots keep landing in the same places.

> DRIVING QUESTION
>
> *"Why do so many volcanoes and earthquakes show up in the same long lines instead of being spread out everywhere?"*

INVESTIGATIVE 1

Where the Mountains Stand

Give groups a topographic or relief map and ask them to find the tallest mountain ranges. They'll notice the big ranges don't sprinkle randomly. They run in long chains, often near the edges of continents or right where two land areas meet. Use this to sharpen the anchor: mountains follow lines too, just like the volcanoes did.

> DRIVING QUESTION
>
> *"Where on the map do the biggest mountain ranges line up, and what do those spots have in common?"*

INVESTIGATIVE 2

Mountains Under the Ocean

Flip the map to the ocean floor. A topographic map of the seafloor shows deep trenches and long underwater mountain ridges. 4th graders are usually shocked the ocean floor has mountains and deep canyons at all. Look closely at where each one sits. The deep trenches tend to sit near the edges of continents, while the long underwater ridges usually run through the middle of the ocean.

> DRIVING QUESTION
>
> *"What patterns show up on the bottom of the ocean, and do they match the patterns we saw on land?"*

THE STANDARD

Energy & Fossil Fuels

"Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment."

ANCHORING PHENOMENON

The Light Switch That Reaches All the Way to a Mountain

Flip a switch and the lights come on. Easy. But trace that energy backward and the trail leaves the building. It might lead to a mountain scraped open for coal, or a valley flooded behind a giant dam. The light is simple. What it took to make it is not.

DRIVING QUESTION

"Where does the energy for our lights actually come from, and what did it change out in the world to get here?"

INVESTIGATIVE 1

Wind and Sun That Never Run Out

Set a pinwheel in front of a fan and it spins as long as the air moves. Point a solar yard light at a sunny window and it charges every day. Use this to sharpen the anchor's question: some sources keep refilling. The wind blows again, the sun rises again.

DRIVING QUESTION

"Why can we use the wind and the sun over and over without ever running out of them?"

INVESTIGATIVE 2

The Fuel You Can Only Burn Once

Fill a small jar with sand to stand for fuel pumped from the ground, then scoop some out each "day." The jar empties and never refills on its own. That is the other side: fossil fuels are non-renewable. Once we burn what we dug up, that batch is gone.

DRIVING QUESTION

"What happens when we keep using up a fuel that doesn't fill back up?"

THE STANDARD

Solutions to Natural Hazards

"Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans."

ANCHORING PHENOMENON

The Two Towns and the Same Earthquake

Two towns sit right next to each other on the same shaky ground. One day an earthquake hits both of them with the exact same force. In one town, buildings crack and fall. In the other town, the buildings shake hard but stay standing. Same earthquake, same ground, but completely different outcomes. 4th graders will want to know what the second town did differently.

> DRIVING QUESTION
>
> *"If the earthquake was the same in both towns, why did one town's buildings fall while the other's stayed up?"*

INVESTIGATIVE 1

Stop the Wave Before It Hits the Houses

Pour a tub of water and tip it to send a tsunami wave rolling toward a row of toy houses. The wave knocks them flat. Now let your 4th graders add a barrier in front, like a wall of clay or a row of blocks. The wave can't be stopped, but the damage can. Test two walls and see which protects more houses.

> DRIVING QUESTION
>
> *"We can't stop the wave, so what can we build in front of the houses to keep them dry and standing?"*

INVESTIGATIVE 2

Two Ways to Survive the Flood

Set toy houses in a low tray and slowly pour in water to flood the town. Then let your 4th graders try two different solutions on different houses: one team raises a house up on stilts (blocks), another team builds a levee wall around theirs. Pour the flood again. Now they have two solutions to compare instead of one, which is exactly what the standard asks for.

> DRIVING QUESTION
>
> *"When the flood comes, which house stays drier, the one up on stilts or the one behind the wall?"*

THE STANDARD

Defining Design Problems

"Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost."

ANCHORING PHENOMENON

The Backpack That's Breaking Your Back

Every elementary student knows the struggle: a backpack so stuffed it pulls your shoulders down and digs into your straps. It is a real, daily, annoying need. But "my backpack stinks" is not a problem you can solve yet. The challenge is to take that complaint and sharpen it into a design problem with clear rules. 3rd to 5th graders will argue about what "better" even means, and that argument IS the work.

> DRIVING QUESTION
>
> *"How do we turn "my backpack is too heavy and uncomfortable" into a clear problem an engineer could actually solve?"*

INVESTIGATIVE 1

The Lunchbox That Won't Keep Anything Cold

A student opens their lunch at noon and the yogurt is warm and the juice is room temperature. Gross. This sharpens the anchor's big idea around CRITERIA: before anyone designs a better lunchbox, the class has to agree on what "success" actually means. Cold by lunchtime? For how long? Fits in a backpack? Students discover that a need is useless until you decide what would count as solving it.

> DRIVING QUESTION
>
> *"What would a lunchbox have to DO for us to say the cold-food problem is solved?"*

INVESTIGATIVE 2

The Class Pet Cage on a Tiny Budget

The class wants a better hideout for the class hamster, but there is a catch: you can only use the bin of recycled cardboard, three pieces of tape, and one class period. This sharpens the anchor's big idea around CONSTRAINTS. Suddenly the dream design crashes into real limits on materials, time, and cost. Students learn that a good problem statement names the limits up front, so nobody designs something they could never actually build.

> DRIVING QUESTION
>
> *"How do the limits on our materials, time, and cost change what problem we should even try to solve?"*

THE STANDARD

Comparing Solutions

"Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem."

ANCHORING PHENOMENON

Two Bridges, One Backpack to Hold

Two groups each build a paper bridge that has to span a gap and hold a stack of pennies. Both bridges look totally different. One is folded into a deep V, the other is flat with rolled paper columns. They both get pennies stacked on top until one sags. The class wants to know which design is actually better, and that turns out to be a trickier question than it sounds.

> DRIVING QUESTION
> *"When two designs solve the same problem in different ways, how do we decide in a fair way which one is better?"*

INVESTIGATIVE 1

Same Rules for Both: The Criteria List

Before testing anything, the class writes down what a good bridge has to do (span the gap, hold pennies, stay under a paper limit). Those are the criteria and constraints. Now both bridges get judged by the exact same list. This sharpens the anchor's big question: a comparison is only fair when both designs face the same rules.

> DRIVING QUESTION
> *"What rules does every design have to follow so the contest between them is actually fair?"*

INVESTIGATIVE 2

Borrow the Best Parts

After comparing, groups talk to each other about what worked. The V-fold group sees that columns added height, the column group sees that folding added strength. They each build a second bridge that borrows the other team's best idea. This sharpens the anchor: comparing isn't just to crown a winner, it's to make the next design better.

> DRIVING QUESTION
> *"After we compare two designs, how do the best parts of each one help us build an even better third design?"*

THE STANDARD

Improving Designs

"Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved."

ANCHORING PHENOMENON

The Tower That Keeps Falling on the Third Floor

Each group builds a paper-and-tape tower as tall as they can, then a fan or a gentle table shake tests it. Almost every tower fails the same way: it folds right where the second section meets the third. Same materials, same wobble, same weak spot. Elementary students will want to know why it always breaks in that one place, and how to stop it.

> DRIVING QUESTION
>
> *"Why does the tower keep failing in the same spot, and what one change would fix it?"*

INVESTIGATIVE 1

One Change at a Time: The Fair-Test Showdown

Two groups both want a stronger tower base, but one widens the base AND adds tape while the other only widens the base. When the wide-and-taped tower wins, nobody can say why. Use this challenge to sharpen the anchor's question: if you change two things at once, you never learn which one actually helped.

> DRIVING QUESTION
>
> *"If we want to know what really made the tower stronger, how do we set up a test that gives us a clear answer?"*

INVESTIGATIVE 2

Find the Failure Point Before You Fix It

Before changing anything, groups run the same wind test three times and watch closely for exactly where and when the tower gives out. They mark the weak spot with a sticky dot. This challenge zooms in on the anchor: you can't improve a design until you've found the precise place it fails.

> DRIVING QUESTION
>
> *"Where exactly does our prototype fail, and how do we pinpoint it before we start changing things?"*