THE STANDARD

Molecules & Extended Structures

Develop models to describe the atomic composition of simple molecules and extended structures.

ANCHORING PHENOMENON

The Diamond and Pencil Lead Mystery

A pencil's "lead" is graphite. Soft, slick, dark gray, leaves a mark when you press it. A diamond is the hardest natural substance on Earth. Clear, sharp, glittery. Total opposites. But they're made of the exact same atom: carbon. Same building block, different stuff. Students will keep circling back to this all week.

DRIVING QUESTION

"How can two substances made of identical atoms turn out so different?"

INVESTIGATIVE 1

Water and Hydrogen Peroxide. Same Atoms, Different Story.

Two clear liquids. Water (H_2O) and hydrogen peroxide (H_2O_2). Same atoms, just one extra oxygen in the peroxide. Water is safe to drink. Hydrogen peroxide bleaches hair and disinfects cuts. One atom of difference, totally different behavior. Use this to sharpen the lens the anchor is pushing on: arrangement and count of atoms matter.

DRIVING QUESTION

"If you can change a substance's behavior by adding one atom, how strict is the rule that 'matter is made of atoms'?"

INVESTIGATIVE 2

A Salt Grain Up Close

A few grains of table salt under a hand lens. Most grains are cubic, even at the smallest visible scale. Zoom out to a salt formation underground. Still cubic. The crystal shape outside mirrors how the atoms are arranged inside. The cube you can see is the pattern repeating up to a scale you can hold.

DRIVING QUESTION

"Why does salt always grow in cubes, and what does that tell us about how its atoms are arranged?"

THE STANDARD

Chemical Reaction Data

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

ANCHORING PHENOMENON

Burning Steel Wool on a Balance

A piece of steel wool on a digital scale. Touch a flame to it. It glows red, sparks fly, the metal turns dark and crumbly. The number on the scale *goes up*. Fifteen seconds of demo, but the result breaks every intuition students have about what happens when something burns. They'll be circling back to it all week.

> DRIVING QUESTION
> *"Where did the new mass come from when the steel wool burned?"*

INVESTIGATIVE 1

Baking Soda + Vinegar: Temperature Goes Down

Vinegar in a beaker, room temperature. Sprinkle in baking soda. It fizzes violently. Temperature drops several degrees. The smell changed, the solid disappeared, a gas escaped. Use this to sharpen the "is it really a reaction, or just mixing?" lens.

> DRIVING QUESTION
> *"Is this a real chemical reaction, or just three things getting mixed together?"*

INVESTIGATIVE 2

Iron Nail Rusting in Saltwater

A shiny iron nail in a cup of saltwater on the windowsill. Photograph and weigh on day one, then weekly. By week two, it's covered in orange rust and the mass has shifted. Same change as the anchor, running in slow motion.

> DRIVING QUESTION
> *"What is the orange flaky stuff on the nail, and where did it come from?"*

THE STANDARD

Synthetic Materials

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

ANCHORING PHENOMENON

The Pill That Came From a Tree

Hold up an aspirin tablet next to a piece of willow bark. The pill is small, white, identical to every other one in the bottle. The bark is rough, brown, full of fibers, smells like wood. The pill works the same every time. The bark works sometimes, sort of, depending on which piece you chew. People used the bark for thousands of years before chemists figured out how to make the pill.

> DRIVING QUESTION
>
> *"How did people turn a tree into a reliable medicine, and what did that change about how the world works?"*

INVESTIGATIVE 1

A Plastic Bottle's Backstory

A clear plastic water bottle on the desk. Then a photo of an oil pump in West Texas. The bottle and the oil look nothing alike. But every plastic bottle in the room started as crude oil somewhere underground. The chemical process in the middle is what changed everything. Use this to sharpen the "natural resource to synthetic product" lens the anchor is pushing on.

> DRIVING QUESTION
>
> *"How does black goopy oil become a clear, lightweight, leak-proof water bottle, and what does that transformation cost us?"*

INVESTIGATIVE 2

The Fertilizer That Fed the World

A bag of synthetic lawn fertilizer next to a picture of clear blue sky. Most of the nitrogen in that bag came from the air. About a hundred years ago, chemists figured out how to pull nitrogen out of the atmosphere and turn it into fertilizer. That single invention changed how much food the planet could grow. It also changed what runs off into rivers. Same kind of source-to-product chain as the anchor, with bigger stakes.

> DRIVING QUESTION
>
> *"If fertilizer comes from the air, why does it sometimes cause so much damage to lakes and rivers?"*

THE STANDARD

Changes by Thermal Energy

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

ANCHORING PHENOMENON

The Ice Bath That Won't Warm Up

A beaker of crushed ice and water sits on a hot plate. The thermometer reads 0°C. Five minutes later, the ice is mostly gone, the water level is the same, and the thermometer still reads 0°C. The hot plate has been pumping heat in the whole time. Something is absorbing that energy without showing up as temperature. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"Where is the heat going if the temperature isn't changing?"*

INVESTIGATIVE 1

Dry Ice on the Counter

A chunk of dry ice (solid carbon dioxide) sitting in a tray. No puddle forms underneath. Instead, the solid shrinks and a thick white fog pours over the edge of the tray. It skipped the liquid stage entirely. Use this to sharpen the lens the anchor is pushing on: phase changes are about particles breaking free of each other, not just heating up.

> DRIVING QUESTION
> *"Why does dry ice turn straight into a gas without ever becoming a liquid?"*

INVESTIGATIVE 2

The Boiling-Point Plateau

A pot of water on a stove with a thermometer in it. As it heats up, the temperature climbs steadily until it hits 100°C. Then it parks there. Even with the burner cranked all the way up, the thermometer doesn't budge above 100°C, no matter how long you wait. The water just keeps boiling away. Same kind of flat line as the anchor, only at the top of the curve instead of the bottom.

> DRIVING QUESTION
> *"Why can't you make boiling water any hotter than 100°C, no matter how high the heat is?"*

THE STANDARD

Mass & Chemical Reactions

Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

ANCHORING PHENOMENON

The Sealed-Bag Reaction That Doesn't Change the Balance

A zip-top bag with baking soda in one corner and vinegar in the other. Weigh the whole thing on a balance. Tip the bag and let them mix. It fizzes. The bag swells like a pillow. Read the balance again. Same number. Then run it open in a beaker. Same reactants, same fizzing, but now the balance drops as gas escapes. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"Why does the same reaction lose mass in one container and not in another?"*

INVESTIGATIVE 1

Iron Nail Turns Copper, Blue Water Turns Pale

A clean iron nail dropped into a cup of bright blue copper sulfate solution. Within minutes the nail darkens with a copper-colored coating. Over the next hour the blue fades toward pale green. Weigh the nail by itself and it gained mass. Weigh the solution by itself and it lost some. Weigh the whole cup before and after and the number doesn't move. Atoms shifted from one substance to another, but none left the system.

> DRIVING QUESTION
> *"If the nail gained mass and the solution lost color, where exactly did each atom end up?"*

INVESTIGATIVE 2

Burning a Log: Where Does All the Wood Go?

A video clip or fireplace photo. A heavy log before burning, a small pile of ash afterward. Most of the log is "missing." Same change as the anchor, only running in slow motion and in an open system the size of a room. Use this to push the atoms-leave-as-gas reasoning out into the world students actually see.

> DRIVING QUESTION
> *"If atoms can't be destroyed, where did the log go?"*

THE STANDARD

Endothermic & Exothermic

Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

ANCHORING PHENOMENON

The Squeeze-and-It-Gets-Cold Pack

A sealed plastic pouch from a first-aid kit. Room temperature. Squeeze it once. The inside breaks. Within thirty seconds, the whole pouch is cold enough to use on an injury. No batteries. No freezer. No external power. It got cold all by itself just from being squeezed. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"Where did the cold come from inside a sealed bag sitting at room temperature?"*

INVESTIGATIVE 1

Calcium Chloride Hitting Water

A few spoonfuls of calcium chloride (the white pellets sold as ice-melt or moisture absorber) dropped into a beaker of room-temperature water. Stir for 30 seconds. The water is now noticeably warm to the touch. The thermometer climbs 15 to 20 degrees Celsius. Use this to sharpen the energy-flow lens: the reactant gave energy to the water.

> DRIVING QUESTION
> *"Where did the warmth come from when nothing was heated?"*

INVESTIGATIVE 2

Baking Soda + Citric Acid: The Pantry Cold Pack

Same setup, opposite result. Stir a spoonful of citric acid into room-temperature water in a beaker. Drop in a spoonful of baking soda. It fizzes hard. Within 30 seconds the beaker is cool to the touch and the thermometer has dropped 4 to 8 degrees Celsius. Same kind of energy story as the calcium chloride, only running in reverse. Use this to push the lens further: energy moves both directions, and the chemistry decides which way.

> DRIVING QUESTION
> *"If everything started at room temperature, where did the missing thermal energy go?"*

THE STANDARD

Newton's Third Law & Collisions

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

ANCHORING PHENOMENON

The Egg That Survives a Wall

A raw egg taped to a small toy car. The car rolls down a ramp at the same speed in two trials. In trial one, the car hits a bare wall and the egg cracks. In trial two, the car hits the same wall, but with a pile of crumpled paper towels stacked in front. The egg survives. Same ramp. Same car. Same wall. Different outcome. Students will keep circling back to this all week.

DRIVING QUESTION

"What did the crumpled paper towels actually change about the crash?"

INVESTIGATIVE 1

The Skater and the Wall

A short video clip of an ice skater pushing off a smooth wall with both hands. The wall doesn't move. The skater glides backward. Almost nothing was touching her except the wall, so where did her motion come from? Use this to sharpen the force-pair lens the anchor is pushing on: every push is two pushes, on two different things.

DRIVING QUESTION

"If the wall didn't push her, what made her move?"

INVESTIGATIVE 2

Balloon Car Across the Floor

A small car with a balloon taped to the top, the balloon's neck pointing out the back. Inflate the balloon, let it go, and the car shoots forward. The air rushes backward out of the balloon. The car goes the other way. Same kind of push-pair as the skater on the wall, only here both objects are free to move. Use this to extend the lens further: when nothing is holding either object in place, both move in opposite directions from a single force pair.

DRIVING QUESTION

"If the air is what's moving, how is the car moving too?"

THE STANDARD

Changes in an Object's Motion

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

ANCHORING PHENOMENON

The Loaded Shopping Cart

A shopping cart on a smooth tile floor. Empty, a gentle push sends it gliding across the aisle. Now load it up: gallons of milk, a watermelon, a couple of bags of dog food. The same gentle push barely moves it. Same arms, same shove, same floor, different cart. Students will keep circling back to this all week.

DRIVING QUESTION

"Why does the same push move an empty cart so much further than a loaded one?"

INVESTIGATIVE 1

The Stuck Tug-of-War

Two teams pulling on a rope, neither side gaining ground. The flag in the middle doesn't move an inch, even though everyone is pulling hard. Then one team adds a player. The flag jerks toward them and the rope goes flying. Use this to sharpen the lens the anchor is pushing on: motion changes when the forces stop cancelling out.

DRIVING QUESTION

"Why didn't the flag move at all when both teams were pulling hard, but jumped right away when one team added a person?"

INVESTIGATIVE 2

Two Carts, Same Ramp

Two toy cars at the top of the same ramp, released at the same time. One is empty, one has a stack of pennies taped to the roof. They both roll down, but the loaded car keeps going much further past the bottom of the ramp before friction stops it. Same ramp, same release, different load, different finish. Same kind of change as the anchor, only this time the heavier object goes further instead of less far.

DRIVING QUESTION

"Why does the heavier cart roll further past the ramp, even though both started in the same spot?"

THE STANDARD

Electric & Magnetic Force Strength

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

ANCHORING PHENOMENON

The Junkyard Crane

A junkyard crane uses a giant flat disc to lift a stack of car parts. No hook, no chain wrapped around anything. Just the disc, hovering over the metal, and the metal jumps up to meet it. The operator drives the load across the yard, hits a switch, and the whole pile drops. Same disc, totally different behavior depending on whether the switch is on or off. Students will keep circling back to this all week.

DRIVING QUESTION

"What is that disc actually doing, and what would change the size of the pile it can lift?"

INVESTIGATIVE 1

The Balloon That Won't Fall

A balloon rubbed on hair pressed against a wall. It sticks. No tape, no glue, no hook. Just two surfaces and an invisible pull. Walk away, come back in ten minutes, and the balloon is usually still there. Same kind of cause-and-effect logic as the crane, only in slow motion with charge instead of current. Use this one to sharpen the distance-and-magnitude lens the anchor is pushing on.

DRIVING QUESTION

"What's pulling the balloon to the wall, and why does it eventually let go?"

INVESTIGATIVE 2

Magnetism Through a Book

Lay a paperclip on top of a closed textbook. Slide a strong magnet underneath the cover. The paperclip slides across the top of the book, following the magnet you can't see. Add a second textbook on the stack and try again. Sometimes it still works. Add a third, and the paperclip usually stops moving. The force passes through the materials until distance shuts it down.

DRIVING QUESTION

"Why does the magnet still pull the paperclip through a book, and what stops it from working through three?"

THE STANDARD

Gravitational Interactions

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

ANCHORING PHENOMENON

The Moon Has Been Up There the Whole Time

Show a time-lapse of the Moon crossing the night sky, or a series of photos from the same window at the same time of night across a month. The Moon keeps showing up. It hasn't drifted off into space, and it hasn't crashed into Earth. Something invisible is keeping it on the same path for billions of years. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"What's holding the Moon in place if there's nothing physical connecting it to Earth?"*

INVESTIGATIVE 1

High Tide, Low Tide, Same Beach

Two photos of the same coastline six hours apart. Water level dramatically different. Ask students what could move that much water across a whole ocean twice a day, every day, on a perfect schedule. Then drop the hint: the Moon. Use this to sharpen the "gravity works at a distance" lens the anchor is pushing on. The Moon is hundreds of thousands of miles away and still moving oceans.

> DRIVING QUESTION
> *"How can the Moon move that much water from that far away?"*

INVESTIGATIVE 2

Drop Two Different Objects At Once

Drop a textbook and a small rubber ball from the same height at the same time. They hit the ground at the same moment. Then watch a clip of the famous hammer-and-feather drop from the Apollo 15 mission on the Moon. No air, same result. Use this to sharpen the "mass and acceleration" facet. Heavier doesn't mean faster falling. Mass matters for gravitational pull, but acceleration near a planet is the same for everything.

> DRIVING QUESTION
> *"If gravity depends on mass, why don't heavier objects fall faster?"*

THE STANDARD

Noncontact Forces

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

ANCHORING PHENOMENON

The Paperclip That Jumps

Hold a strong neodymium magnet near a paperclip resting on a table. Lower the magnet slowly. At some distance the paperclip suddenly hops off the table and snaps to the magnet. Nothing touched it before it moved. Students will keep circling back to this all week. What reached across that gap and pulled the paperclip up?

> DRIVING QUESTION
>
> *"What's happening in the space between the magnet and the paperclip that makes the paperclip move?"*

INVESTIGATIVE 1

Iron Filings Reveal the Pattern

Sprinkle iron filings on a piece of paper laid flat over a bar magnet. Tap the paper. The filings shift and line up in arcs flowing from one end of the magnet to the other. The pattern was there the whole time, just invisible. Use this one to sharpen the lens the anchor is pushing on: the space between objects isn't empty, it's filled with a field.

> DRIVING QUESTION
>
> *"Why do the iron filings form a pattern, and what is that pattern showing us about the space around the magnet?"*

INVESTIGATIVE 2

The Balloon and the Water Stream

Turn on a thin stream of water from a faucet. Rub a balloon on a sweater or hair, then hold it close to the stream without touching. The water bends toward the balloon. The stream is moving, the balloon is still, and something is reaching across the air to pull the water sideways. Use this one to sharpen the same lens, only with electric force instead of magnetic.

> DRIVING QUESTION
>
> *"How can a balloon pull on water it isn't touching?"*

THE STANDARD

Kinetic Energy of an Object

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

ANCHORING PHENOMENON

The Slow Truck vs. the Fast Bicycle

A video of a delivery truck rolling into a parked car at 5 mph. A scratch and a dent. Then a video of a cyclist hitting a parked car at 25 mph. The bike is destroyed, the rider goes flying, and the parked car has serious damage. The truck weighs 50 times more than the bike, but the bike did way more damage. That contradiction is what students will keep circling back to all week.

> DRIVING QUESTION
> *"How can a small fast thing do more damage than a huge slow thing?"*

INVESTIGATIVE 1

Wiffle Ball or Tennis Ball

Two balls of about the same size. A hollow wiffle ball weighs around 23 grams. A tennis ball weighs about 58 grams. Toss each one at a foam block on a table at roughly the same speed. The tennis ball knocks the block further every time. Same speed, different mass, different damage. Use this one to sharpen the mass-side of what the anchor is asking. Speed is held constant. Mass is doing the work.

> DRIVING QUESTION
> *"If you keep the throwing speed the same, how much does the ball's weight change what happens when it hits something?"*

INVESTIGATIVE 2

Same Ball, Different Speeds

One tennis ball. Roll it at a stack of cups at a slow walking pace. A few cups topple. Now throw it at the same stack at a hard throwing speed. The whole stack explodes. Same ball, same mass, two very different results. Use this to sharpen the speed-side of what the anchor is asking. Mass is held constant. Speed is doing the work, and it's doing a lot of it.

> DRIVING QUESTION
> *"When you throw the same object faster, how much more energy does it carry?"*

THE STANDARD

Distance & Potential Energy

Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

ANCHORING PHENOMENON

The Paused Roller Coaster

Video of a roller coaster cart clicking its way up the first hill, then pausing right at the top. No movement. No motor. Just a cart sitting still, ninety feet in the air. A second later it drops, and the rest of the ride happens without any motor at all. Every loop, every hill, all of it powered by something that was set up while the cart sat still at the top. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"Where is the energy when the cart is paused, and why is it enough to power the whole rest of the ride?"*

INVESTIGATIVE 1

Two Magnets That Won't Touch

Two ring magnets on a vertical pencil, both with the same pole facing up. The top magnet floats above the bottom one with a visible gap. Press the top magnet down toward the bottom and it pushes back harder the closer it gets. Let go and it jumps back up. Use this one to sharpen the lens the anchor is pushing on: stored energy lives in the arrangement, and changing the arrangement changes how much is stored.

> DRIVING QUESTION
>
> *"Why does it get harder to push the magnets together, and where does that effort go?"*

INVESTIGATIVE 2

The Balloon and the Hair

A balloon rubbed on a head of hair, held near someone's arm. As the balloon gets closer to the arm hairs, the hairs start to lift toward it. No contact yet. The closer the balloon, the more the hairs rise. Same kind of arrangement-changes-stored-energy idea as the anchor, only now the interaction is electric and the system is balloon-and-hair.

> DRIVING QUESTION
>
> *"Why does the hair start moving before the balloon touches it, and what changes about the system as the balloon gets closer?"*

THE STANDARD

Thermal Energy Transfer

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

ANCHORING PHENOMENON

The Two Spoons on the Counter

A metal spoon and a wooden spoon sit side by side on the kitchen counter overnight. Same room. Same air. Touch them both in the morning. The metal feels noticeably colder than the wood. But a thermometer pressed against each one reads exactly the same temperature. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"If both spoons are the same temperature, why does one feel colder than the other?"*

INVESTIGATIVE 1

The Foil Ice Cube vs. the Wool Sock Ice Cube

Two identical ice cubes. One gets wrapped in a tight layer of aluminum foil. The other gets wrapped in a thick wool sock. Both sit on the counter at room temperature. The foil-wrapped cube turns into a puddle in about 20 minutes. The wool-wrapped cube is still mostly solid after an hour. Use this to sharpen the conductor-vs-insulator lens the anchor is pushing on.

> DRIVING QUESTION
>
> *"Which is better at protecting an ice cube, shiny foil or thick wool, and why does each one work the way it does?"*

INVESTIGATIVE 2

Three Cups of Coffee, Three Hours Later

Three cups, all filled with coffee at 70 degrees Celsius at the same moment. One is a paper to-go cup, lid on. One is a ceramic mug, no lid. One is a stainless-steel thermos, sealed. Three hours later the paper cup is room temperature, the ceramic mug is barely warm, and the thermos is still hot enough to drink. Same starting point, three completely different endings. Use this to push the lens further: design choices change the rate of energy flow, not the rule.

> DRIVING QUESTION
>
> *"If heat always moves from hot to cold, why are the three cups in such wildly different places after three hours?"*

THE STANDARD

Temperature & Energy

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

ANCHORING PHENOMENON

The Beach Where the Sand Burns and the Ocean Stays Cool

A summer day at the beach. The sun has been shining on both the sand and the ocean for hours. The sand is so hot it burns your feet. The ocean, only steps away, is cool enough to swim in. Same sun. Same time. Same beach. Two wildly different temperatures. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"Why does the same amount of sunlight heat the sand and the ocean so differently?"*

INVESTIGATIVE 1

A Metal Can and a Plastic Cup Race to Cool

Pour the same volume of hot water into a metal can and a plastic cup. Drop a thermometer into each. Within minutes, the water in the metal can has cooled noticeably while the water in the plastic cup has barely moved. Same starting temperature, same volume, same room. Use this to sharpen the lens the anchor is pushing on: the type of matter around the energy controls how fast the temperature changes.

> DRIVING QUESTION
>
> *"Why does the metal cup lose its heat faster than the plastic one when everything else is the same?"*

INVESTIGATIVE 2

Two Cups of Water on the Same Burner

Put 100 mL of water in one beaker and 500 mL in another. Same hot plate, same starting temperature, same lid. Start the timer. The small beaker hits boiling in a few minutes. The big one takes much longer to get there, even though the burner hasn't changed. Same energy going in. Different mass on the receiving end.

> DRIVING QUESTION
>
> *"If the burner is putting out the same energy, why does more water take so much longer to boil?"*

THE STANDARD

Kinetic Energy Transfer

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

ANCHORING PHENOMENON

The Bike That Won't Stay Moving

A cyclist on a flat, paved road stops pedaling. No brakes. No hill. No wind. The bike slows down anyway and eventually stops. Nothing pushed back on it that students can easily see. The kinetic energy clearly went somewhere, but where? Students will keep returning to this one because it feels like it should keep rolling forever.

> DRIVING QUESTION
>
> *"If nothing is pushing back on the bike, why does it slow down at all?"*

INVESTIGATIVE 1

Brake Discs Get Hot Fast

A car coming to a hard stop produces brake discs hot enough to glow on race cars and warm enough to feel on a regular car after a long downhill. Same kind of energy transfer as the bike, but concentrated and visible. Use this one to sharpen the "energy goes somewhere measurable" lens the anchor is pushing on.

> DRIVING QUESTION
>
> *"If brakes get hot enough to glow, how much of the car's kinetic energy is becoming thermal energy?"*

INVESTIGATIVE 2

The Pendulum That Slowly Dies

A pendulum released from one side swings high, then a little less high, then a little less high. Over many swings, the arc shrinks until the bob barely moves. The energy isn't disappearing in one dramatic moment. It's leaking out swing by swing. Same kind of change as the anchor, only in slow motion.

> DRIVING QUESTION
>
> *"Where does the energy go on each swing, and what would the pendulum do without air or pivot friction?"*

THE STANDARD

Waves & Energy

Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

ANCHORING PHENOMENON

The Tsunami That Hid in the Open Ocean

On December 26, 2004, a massive earthquake near Sumatra sent a tsunami across the Indian Ocean. In the deep open ocean, ships barely felt it. The wave was less than a meter tall and stretched for hundreds of kilometers. By the time it reached shore, the waves were up to 30 meters tall in some places, killing hundreds of thousands of people. Same wave. Same energy. The amplitude exploded as the water got shallow.

> DRIVING QUESTION
>
> *"How can a wave look harmless in deep water and devastating in shallow water if the energy didn't change?"*

INVESTIGATIVE 1

The Tuning Fork and the Water Cup

A tuning fork tapped softly and dipped into a cup of water makes small ripples and a quiet hum. Tapped harder and dipped in again, it splashes water out of the cup and the hum is much louder. Same fork. Same water. Two different amplitudes. Use this one to sharpen the amplitude-and-energy lens the anchor is pushing on: when a wave carries more energy, the amplitude is bigger.

> DRIVING QUESTION
>
> *"What changed about the wave when you hit the fork harder, and why did the sound get louder at the same time?"*

INVESTIGATIVE 2

The Slinky on the Floor

A slinky stretched across the floor between two students. One end gets a single up-and-down flick. A wave pulse travels down the slinky, hits the other end, and reflects back. Students can change the flick height and the flick speed independently. Big flick, small flick. Slow flick, fast flick. Same slinky, four different waves. The pattern they see is the same shape every time. Just different numbers.

> DRIVING QUESTION
>
> *"Can you change the amplitude without changing the frequency, or are they tied together?"*

THE STANDARD

Wave Transmission

Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

ANCHORING PHENOMENON

The Cafeteria vs. The Library

Two rooms in the same school. One is loud enough that you have to lean in to hear your friend. The other is so quiet a whisper carries. Same kid, same voice, same school. The rooms aren't different sizes or different temperatures in any way that matters. What's different is the stuff on the walls, the floor, the ceiling. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"Why does the exact same voice sound completely different depending on what's around you?"*

INVESTIGATIVE 1

A Window You Can See Through AND See Yourself In

Stand outside a lit room at night and look at the window. You see the room inside. Stand inside the same lit room at night and look at the window. You see yourself reflected. Same glass, same window, two different jobs at the same time. Use this one to sharpen the lens the anchor is pushing on: a single material can split a wave into more than one outcome at the same surface.

> DRIVING QUESTION
> *"How can one piece of glass let light through one way and bounce it back the other?"*

INVESTIGATIVE 2

Stained Glass in Afternoon Sun

A stained-glass window with the sun behind it. The floor inside catches colored patches of light. Red panes throw red light, blue panes throw blue, but the dark panes don't throw anything (no patch on the floor under them). Same sunlight hitting every part of the window. Different colors of glass do different things to it. Same kind of split as the anchor, only now color decides what gets through.

> DRIVING QUESTION
> *"Why does a red pane of glass make a red patch on the floor, and what happens to the rest of the light?"*

THE STANDARD

Digital vs Analog Signals

Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

ANCHORING PHENOMENON

The Same Song, Two Ways

Play the same song twice in a row. First through a static-filled AM radio station, the kind you have to hold the antenna just right to hear. Then through a digital streaming service on a phone speaker. The song is identical. The signal carrying it is not. One is full of pops and fuzz. The other is crystal clear. Both traveled a similar distance to get to the room. Something in how each signal was built made all the difference.

DRIVING QUESTION

"Why does the same information sound completely different depending on which kind of signal carries it?"

INVESTIGATIVE 1

Photocopy of a Photocopy

Show a clear printed photograph. Make a photocopy of it. Then a photocopy of that copy. Keep going for five generations. By copy five, the photo is muddy and unreadable. Then show the same image as a digital file, copied five times. Bit-for-bit identical to the original. Use this to sharpen the "analog noise builds up, digital noise gets cleaned out" lens the anchor is pushing on. Same kind of degradation, but in a way students can see, not just hear.

DRIVING QUESTION

"Why does information fall apart when you copy it as a picture, but stay perfect when you copy it as a file?"

INVESTIGATIVE 2

The Whisper Chain

Line up six volunteers. Whisper a one-sentence message to the first. They whisper to the next, who whispers to the next, all the way down. The message at the end almost always comes out garbled. Then run it again, but each student passes a card labeled either "0" or "1" instead. Each card gets passed down the line, copied if needed, and read at the end. The pattern arrives intact. Same kind of "noise piling up" the anchor is showing, but built from students instead of speakers.

DRIVING QUESTION

"Why does a whispered message scramble down a line, but a pattern of 0s and 1s makes it through clean?"

THE STANDARD

Evidence of Living Things

Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

ANCHORING PHENOMENON

A Drop of Pond Water Under the Microscope

One drop of pond water from a stagnant puddle, on a slide, at 100x. What looked like clear water is suddenly full of moving things. Some shaped like slippers, some like rotating green spheres, some shape-shifting blobs. Each one is a complete living thing in a single cell. The water wasn't empty. It was teeming, just at a scale you couldn't reach with your eyes. Students will keep circling back to this all week.

DRIVING QUESTION

"If a drop of pond water is full of living things you can't see, what else is alive at a scale we can't see?"

INVESTIGATIVE 1

Onion Skin Looks Solid. It Isn't.

A thin layer peeled off the inside of an onion, mounted on a slide, stained with a drop of iodine. To the eye, it's a smooth film. Under the microscope it's a brick wall of identical units, every one a cell. Use this one to sharpen the scale lens the anchor is pushing on: what looks like one continuous piece of tissue is actually a grid of repeating building blocks.

DRIVING QUESTION

"If a flat sheet of onion is really made of thousands of tiny boxes, what does that say about every other 'solid' piece of a living thing?"

INVESTIGATIVE 2

Cheek Cells Don't Look Like Onion Cells

A toothpick gently scraped on the inside of a cheek, smeared on a slide, stained with methylene blue. Round, soft-edged blobs with a dark dot in the middle. Nothing like the brick wall of the onion. Same kind of building block, completely different shape. Use this one to sharpen the same-building-block-different-shape idea the anchor is pushing on: a cell's shape follows its job.

DRIVING QUESTION

"If plant cells and animal cells are both cells, why don't they look anything alike?"

THE STANDARD

Cell Parts & Functions

Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.

ANCHORING PHENOMENON

The Red Onion Skin Under a Microscope

A thin layer of red onion skin under the lens. The cells line up like bricks, perfectly rectangular, with a clear boundary around each one and a bright purple blob filling most of the middle. The purple is the central vacuole. The brick-like shape is the cell wall. Students will keep coming back to this image because nothing about it looks like the round, blobby cells in their textbook.

DRIVING QUESTION

"Why are plant cells shaped like bricks, and what's the giant purple thing inside?"

INVESTIGATIVE 1

Cheek Cells vs. Elodea Leaf Cells Side by Side

Two slides on two microscopes. On one, a cheek cell scrape: round-ish, soft-edged, a single dark dot (the nucleus) in the middle of a mostly empty-looking space. On the other, an elodea leaf cell: rectangular, sharp-edged, packed with green chloroplasts moving in a slow circle (a real effect called cytoplasmic streaming). Same building block, totally different look. Use this one to sharpen the structure-tells-function lens the anchor is pushing on.

DRIVING QUESTION

"If both are cells, why do they look so different, and what does that tell us about what each one does?"

INVESTIGATIVE 2

A Plant Cell Shrinking in Salt Water

A drop of saltwater added to the edge of an elodea slide. Over a few minutes, the green chloroplasts and cytoplasm pull inward, away from the cell wall, leaving a visible gap. The cell wall stays put. The membrane and everything inside shrinks. This is plasmolysis, and it makes the membrane-vs-wall distinction impossible to ignore. Use this one to sharpen the boundary-control lens the anchor exposes.

DRIVING QUESTION

"What's pulling away from the cell wall, and why does the wall stay where it is?"

THE STANDARD

Interacting Body Systems

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

ANCHORING PHENOMENON

The Stair Sprint

A student sprints up two flights of stairs and stops at the top. Heart pounding. Breathing fast. Legs burning a little. Sweat starting on the forehead. Watch it on video, then go do it. Inside that 30-second event, at least five subsystems are talking to each other. The body that walked away from the stairs is the same body, but every system is in a different state than 30 seconds earlier.

DRIVING QUESTION

"Which body systems are talking to each other when you sprint up stairs, and how do you know?"

INVESTIGATIVE 1

The Sandwich Trip

A student takes one bite of a sandwich and chews. The food disappears into the body and the student keeps going about their day. Inside the next several hours, that bite is going to get broken down, sorted, and delivered to cells all over the body. Use this one to sharpen the hierarchy lens the anchor is pushing on: groups of cells, tissues, organs, systems, all working in sequence.

DRIVING QUESTION

"How does one bite of food turn into energy for cells all over your body, and how many systems does it take?"

INVESTIGATIVE 2

The Stubbed Toe

A student walks past a coffee table and slams their pinky toe into the leg. They yank the foot back before they even think about it. A second later, they say "ow." The reflex happened before the conscious thought. Two different systems doing two different things, both triggered by the same event. Same body, two different system responses, almost on top of each other.

DRIVING QUESTION

"Why does your foot move before you feel the pain, and what systems are doing the work?"

THE STANDARD

Plant & Animal Reproduction

Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

ANCHORING PHENOMENON

The Peacock's Ridiculous Tail

A male peacock spreads its tail. Brilliant blue and green, hundreds of eyespots, taller than the bird itself. It's heavy. It slows the bird down. It catches the eye of every predator in the field. Every survival rule says this should not exist. But peacocks have been carrying these tails for thousands of generations. Something about this tail must be working, even though it looks like a bad idea.

DRIVING QUESTION

"Why does a trait that hurts survival still keep showing up generation after generation?"

INVESTIGATIVE 1

The Dandelion Parachute

A single dandelion makes around 150 to 200 seeds. Each one has a tiny umbrella of bristles. A breath of wind launches the whole crop, and the seeds float a few feet or a few miles. Most land on driveways, lawns, or get eaten. A few hit dirt and sprout. Use this one to sharpen the probability lens the anchor is pushing on: low odds per seed, high seed count, strategy wins.

DRIVING QUESTION

"Why does a plant invest energy in making hundreds of seeds when almost none of them will become new plants?"

INVESTIGATIVE 2

The Coconut on the Beach

A coconut washes up on a beach with no palm trees in sight. Tough fibrous husk. Hollow inside, with a layer of food for the seedling. Light enough to float. It rode an ocean current from somewhere far away, possibly another island. When the tide leaves it on warm sand above the water line, the seedling inside can sprout. Same probability play as the dandelion. Different transport.

DRIVING QUESTION

"How can a plant 'travel' across an ocean without being able to move?"

THE STANDARD

Influencing Organism Growth

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

ANCHORING PHENOMENON

The Great Dane and the Chihuahua

Two dogs in a photo. One is a Great Dane, head almost level with the kitchen counter. The other is a Chihuahua, small enough to fit in a coat pocket. Both are descended from the same ancestor (the wolf). Both eat dog food, drink water, and live in houses. Same species, same basic needs, wildly different sizes. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can two animals of the same species end up so different in size, and what would happen if you raised them in opposite conditions?"*

INVESTIGATIVE 1

Same Seed Packet, Two Very Different Plants

Two radish plants, both grown from seeds out of the same packet. One is tall and dark green. One is short, pale, and leaning sideways. The only difference: where they grew. The tall one sat on a sunny windowsill. The short one sat on a desk in a back corner. Use this to sharpen the environment-as-cause lens the anchor is pushing on, with the genetic factor held constant.

> DRIVING QUESTION
>
> *"If two seeds had identical starting instructions, why did they end up so different, and what does that say about which factor mattered more here?"*

INVESTIGATIVE 2

The Pond Fish Size Mystery

Two ponds, both stocked with the same species of fish at the same time. Five years later, the fish in the big pond are nearly twice the size of the fish in the small pond. Same species. Same starting genetics. Different space, different available food. Use this one to extend the environmental-factor reasoning to a non-plant organism so students see the pattern holds across living things.

> DRIVING QUESTION
>
> *"Why do the same kind of fish grow to different sizes in different ponds, and what does that tell us about the limits of genetics?"*

THE STANDARD

Role of Photosynthesis

Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

ANCHORING PHENOMENON

The Willow Tree That Didn't Eat the Soil

In the 1600s, a scientist named Jan van Helmont planted a young willow tree in a pot. He weighed the tree (5 pounds) and weighed the soil (200 pounds). For 5 years he only added rainwater. At the end he weighed everything again. The tree was 169 pounds. The soil was still 199 pounds, 14 ounces. The tree had gained 164 pounds while the soil had barely lost 2 ounces. Where did all that tree come from? Students will keep circling back to this all week.

DRIVING QUESTION

"If the soil barely changed, where did 164 pounds of tree come from?"

INVESTIGATIVE 1

Bubbles on a Water Plant in Sunlight

A sprig of elodea sits in a beaker of water under a bright lamp. Within minutes, tiny bubbles start streaming off the cut end of the stem and from the leaves. Move the beaker into the dark. The bubbles stop. Put it back under the light. The bubbles come back. Same plant, same water. The only thing changing is the light. Use this one to sharpen the energy-input lens the anchor is pushing on.

DRIVING QUESTION

"What gas is in those bubbles, and why does the plant only make them in the light?"

INVESTIGATIVE 2

The Variegated Leaf and the Iodine Test

A variegated leaf (one with both green and white patches) gets covered for a day, then sits in bright sunlight for several hours. The teacher boils it briefly, soaks it in alcohol to pull the green out, and drops it in iodine. The leaf comes out with dark blue-black patches only where the green chlorophyll used to be. The white sections stay pale. The blue-black is starch, made from glucose, made by photosynthesis. Same kind of cycling the anchor exposes, only frozen in place on a leaf.

DRIVING QUESTION

"Why did only the green parts of the leaf make starch?"

THE STANDARD

Food & Chemical Reactions

Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

ANCHORING PHENOMENON

The Sprinter and the Sandwich

A track athlete eats a turkey sandwich two hours before a race. During the race, she sprints all-out for 12 seconds. The sandwich is gone. The race is over. Somewhere in between, the molecules in that bread and turkey turned into the energy that moved her legs. But the atoms didn't vanish. They went somewhere. Students will keep circling back to this all week: where did the sandwich end up?

> DRIVING QUESTION
> *"How does a sandwich become a sprint?"*

INVESTIGATIVE 1

The Cracker That Turns Sweet

Have students chew a saltine cracker and hold it on their tongue for a full 60 seconds without swallowing. It starts to taste sweet. The starch in the cracker is being broken down into glucose by an enzyme in their saliva (amylase). Digestion is starting in their mouth, and they can taste the chemistry happening. Use this one to sharpen the breakdown lens the anchor is pushing on.

> DRIVING QUESTION
> *"If digestion is invisible, how did the cracker change in my mouth?"*

INVESTIGATIVE 2

The Bodybuilder and the Chicken

A bodybuilder eats six chicken breasts a day and gains visible muscle over a few months. The chicken protein didn't just give him energy. Some of the amino acids from that chicken got rearranged into his muscle protein. The chicken, atom by atom, became part of him. Same kind of matter-tracking the sprint phenomenon hints at, but in slow motion and aimed at growth instead of energy release.

> DRIVING QUESTION
> *"How does eating chicken make a person bigger?"*

THE STANDARD

Stimuli & Sensory Receptors

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

ANCHORING PHENOMENON

The Hot Pan Yank

You reach for what you think is a cool pan handle. It is not. Before you have any conscious thought, your hand is already across the kitchen. A full second later, the pain shows up and you say a word you should not say. The order is what gets students. The movement happened before the feeling. That cannot be right, and yet it is. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"How can your hand move away from danger before your brain even tells you it hurts?"*

INVESTIGATIVE 1

Apple, Potato, Pear, Nose Plugged

Three small white cubes. Apple, potato, pear. Eyes closed, nose pinched. Most students cannot tell which is which. Some guess all three wrong. Open the nose back up and the flavors snap into place. Use this one to sharpen the lens the anchor is pushing on: receptors are specialized, and what feels like one sense (taste) is actually two senses (taste and smell) working together.

> DRIVING QUESTION
> *"If taste is mostly smell, what is the tongue actually doing?"*

INVESTIGATIVE 2

The Song That Pulls a Whole Memory With It

Play a song from five years ago that the class will know. Ask students what they see in their head. Most can name a specific moment, place, or person. Not a general feeling. A specific scene. The song is the trigger. The memory it pulls is detailed, multi-sensory, and was sitting there the whole time. Same kind of receptor-to-brain chain as the anchor, only ending in a stored memory instead of an instant behavior.

> DRIVING QUESTION
> *"How can one sound pull back a whole moment with sights, smells, and feelings attached?"*

THE STANDARD

Resource Availability

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

ANCHORING PHENOMENON

The Deer Explosion After the Wolves Were Gone

A forest region loses its wolves to hunting and trapping by the 1920s. Deer numbers climb for decades. Then the deer start starving. Plants are stripped bare. Newborn fawns don't survive winter. By the time wolves are reintroduced in the 1990s, the forest is a mess. One missing predator changed the entire system. Students will keep circling back to this all week.

DRIVING QUESTION

"How can one missing species turn a whole ecosystem upside down?"

INVESTIGATIVE 1

Wildflowers and the Spring Rain

A Texas hillside in March 2015. Bluebonnets and Indian paintbrush in waves, edge to edge. Same hillside in March 2011. Almost bare. The seeds are the same. The soil is the same. The difference is a few inches of spring rain. Use this one to sharpen the resource lens the anchor is pushing on: when one specific resource shifts, the population shifts with it.

DRIVING QUESTION

"Why does the same field grow waves of wildflowers in some years and almost nothing in others?"

INVESTIGATIVE 2

The Aquarium That Got Too Crowded

A 10-gallon tank with six small fish. Healthy for months. The owner adds four more fish. Within a week, two are dead. Within two weeks, half the tank is gone. The water looked clean. The food was the same brand. Nothing visible changed except the number of fish. Use this one to sharpen the carrying-capacity lens at a scale students can see.

DRIVING QUESTION

"Why did adding more fish to a working tank kill the ones already living there?"

THE STANDARD

Interactions in Ecosystems

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

ANCHORING PHENOMENON

The Shark and the Cleaner Fish

A shark, the apex predator of the reef, holds completely still while a tiny cleaner fish swims into its open mouth and picks parasites off its teeth and gills. The shark could eat the cleaner fish in a single snap. It never does. Students will keep circling back to this all week: why doesn't the shark just eat the helper?

> DRIVING QUESTION
> *"Why do two organisms that should be predator and prey work together instead?"*

INVESTIGATIVE 1

Lions and Hyenas Over a Kill

A pride of lions has taken down a wildebeest. Within minutes, a pack of hyenas shows up, hoping to steal the kill. The two groups face off, snarl, sometimes fight, and one side eventually walks away. Both species hunt, both eat the same animals, both want the same food. Use this one to sharpen the competition lens the anchor is pushing on: not every cross-species relationship is cooperative.

> DRIVING QUESTION
> *"When two predators want the same meal, what determines who wins and who walks?"*

INVESTIGATIVE 2

The Tick on the Deer

A deer walks through tall grass and picks up a tick. The tick burrows in, drinks blood for several days, and falls off bloated. The deer scratches but mostly carries on. Same kind of "one organism using another" the anchor showed, only this time one of them gets hurt. Use this to push the parasitism vs. mutualism distinction the anchor opens up.

> DRIVING QUESTION
> *"Why is this relationship different from the shark and cleaner fish, even though both involve one organism feeding off another?"*

THE STANDARD

Matter & Energy in Ecosystems

Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

ANCHORING PHENOMENON

The Sealed Jar That Won't Die

In 1960, a man named David Latimer planted a spiderwort seedling inside a 10-gallon glass bottle with some compost and water, then sealed it shut. He opened it once in 1972 to add a bit of water. He hasn't opened it since. As of recent years the plant is still alive inside, taller than the bottle, leaning against the glass. No new food, no new water, no new air. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"How is anything still alive inside that bottle after 60-plus years with no inputs?"*

INVESTIGATIVE 1

The Fallen Log Disappearing into the Forest Floor

A photo series shows the same fallen log in a forest over 10 years. Year 1, it's a solid log. Year 5, it's soft and covered in fungi. Year 10, it's barely a dark line in the soil, with new plants growing out of where it used to be. The log didn't go anywhere magical. Its atoms got broken down by fungi and bacteria and pulled into the soil, where new plants picked them back up. Use this one to sharpen the cycling lens the anchor is pushing on.

> DRIVING QUESTION
> *"Where did the log go, and what is growing out of it now?"*

INVESTIGATIVE 2

A Forest Fire Releasing Centuries of Stored Carbon

A time-lapse of a forest fire shows a stand of 200-year-old trees burning down in a few hours. All the carbon those trees pulled out of the air over two centuries gets released back into the atmosphere as CO in one afternoon. Same atoms, different address, different speed. The slow cycle the anchor exposes runs in the opposite direction here, only on fast-forward.

> DRIVING QUESTION
> *"Where did the carbon in those trees go after they burned, and how long had it been stored?"*

THE STANDARD

Effects of Ecosystem Change

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

ANCHORING PHENOMENON

The Wolves That Brought Back the Aspens

In 1995 and 1996, 31 gray wolves were reintroduced to Yellowstone after a 70-year absence (14 in 1995, 17 more in 1996). Within a decade, aspen trees were taller, beavers were building dams again, and songbirds were returning. The wolves didn't plant trees or build dams. But they changed elk behavior and elk numbers, and that change moved through the whole ecosystem. One predator. A reshaped landscape. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can adding one species change an entire ecosystem?"*

INVESTIGATIVE 1

A Lake Where One New Fish Crashed the Others

Lake Davis in northern California had a healthy mix of trout and other native species. In the 1990s, northern pike showed up (likely introduced illegally). Pike are aggressive predators with no natural enemies in that lake. Within a few years, trout populations crashed and the recreational fishery nearly collapsed. Use this one to sharpen the lens the anchor is pushing on: how a new biological component shifts populations even when the physical environment doesn't change.

> DRIVING QUESTION
>
> *"What makes a new species so disruptive when other species have always lived in that lake together?"*

INVESTIGATIVE 2

A Forest a Year After the Fire

Aerial photos of a section of the British Columbia interior, 2017 (before the wildfire) and 2018 (one year after). The 2017 image shows a dense conifer forest. The 2018 image shows blackened ground, surviving trees, and patches of new green growth where fireweed and other early plants have already moved in. The forest isn't gone. It's being rebuilt by a different set of species first. Same kind of disturbance-and-response as the anchor, only in slow motion.

> DRIVING QUESTION
>
> *"How does an ecosystem 'come back' after fire wipes out most of what was living there?"*

THE STANDARD

Designs for Biodiversity

Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

ANCHORING PHENOMENON

The Vanishing Monarchs

Monarch butterfly populations migrating to Mexico have dropped more than 80% over 30 years. The reasons aren't simple: pesticide use, loss of milkweed (the only plant monarch caterpillars eat), climate shifts along the migration route, and habitat loss in overwintering forests. No single cause, no single fix. Students keep coming back to this all week because every solution they propose hits one piece of the problem and misses another.

> DRIVING QUESTION
>
> *"Which solution actually saves the monarchs, and how would we know if it's working?"*

INVESTIGATIVE 1

The Beavers Came Back

When beavers were reintroduced to certain western watersheds, the change was bigger than anyone expected. Their dams slowed water down, which let groundwater recharge, which kept streams cool and flowing in summer. Native fish came back. Wildfires in beaver-dammed areas burned cooler. One species engineered an entire system shift. Use this one to sharpen the cascade lens the anchor is pushing on: small change, big system effect.

> DRIVING QUESTION
>
> *"How can adding one species change a whole watershed, and could the same trick work somewhere else?"*

INVESTIGATIVE 2

Bleached Coral, Warm Water

Coral reefs across the world are bleaching, turning ghostly white when ocean temperatures spike. The corals expel the algae that feed them, and if temperatures don't drop, they starve. Reefs support roughly a quarter of all marine species and protect coasts from storm surges. Use this one to sharpen the services lens: when the reef goes, the fishing goes, the tourism goes, and the storm wall goes.

> DRIVING QUESTION
>
> *"What's a design solution for an ecosystem we can't directly cool down?"*

THE STANDARD

Mutations

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

ANCHORING PHENOMENON

Sickle Cell Trait: Same Mutation, Two Different Outcomes

A single change in one gene affects a protein called hemoglobin, which carries oxygen in red blood cells. People with two copies of the changed gene can develop sickle cell disease, where red blood cells bend into a sickle shape and cause serious problems. People with just one copy of the changed gene usually feel fine, and in regions where malaria is common, that single copy actually offers some protection against the malaria parasite. One mutation. Harmful in one situation. Beneficial in another. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can the exact same gene change be harmful for one person and beneficial for another?"*

INVESTIGATIVE 1

Lactase Persistence: A Change That Lets Adults Digest Milk

Most mammals stop making the enzyme lactase after they're weaned. In some human populations, a mutation in a regulatory region near the lactase gene keeps the enzyme switched on into adulthood. Those adults can drink milk without trouble. Adults without the mutation often can't. Use this one to sharpen the "beneficial depends on context" lens the anchor is pushing on: the mutation is helpful in populations that raise dairy animals, neutral in populations that don't.

> DRIVING QUESTION
>
> *"Why does the same gene change count as beneficial in one population and not really other?"*

INVESTIGATIVE 2

Albinism in Animals

Most animals make a pigment called melanin that colors skin, fur, feathers, and eyes. A mutation in one of the genes for melanin production can stop the pigment from being made. The result is an animal with white fur or feathers and pink or pale eyes. Same species, same general body plan, very different appearance. Use this one to make protein function visible: the mutation disrupts a pigment-making protein, and the trait change is immediate and obvious.

> DRIVING QUESTION
>
> *"How can one broken protein change something as visible as an entire animal's color?"*

THE STANDARD

Models for Genetic Variation

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

ANCHORING PHENOMENON

The Strawberry Patch Puzzle

A single strawberry plant sends out a runner that grows into a new strawberry plant. The new plant is identical to the parent. Same fruit, same leaves, same everything. But if you plant the seeds from a strawberry, the new plants are slightly different. Different size, different flavor, different yield. Same parent plant, two ways of making offspring, two completely different outcomes. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"Why does the same plant produce identical offspring one way and varied offspring another way?"*

INVESTIGATIVE 1

Identical Twins vs. Fraternal Twins

Two pairs of twins. One pair looks exactly alike, same face, same hair, same everything. The other pair looks no more alike than any siblings, different height, different features. Both came from the same two parents in the same pregnancy. Use this one to sharpen the cause-effect lens the anchor is pushing on. The reproductive event was the same. The starting cell was different.

> DRIVING QUESTION
>
> *"How can two pairs of twins from the same parents look so different from each other?"*

INVESTIGATIVE 2

The Banana Crisis

Every banana sold in a grocery store is a Cavendish. Every Cavendish plant on Earth is a genetic clone of every other one, grown from cuttings instead of seeds. A fungus called Panama disease is sweeping through banana plantations and the plants have no genetic variation to fight back. The same thing happened to the previous variety, the Gros Michel, in the 1950s. Use this one to push on the survival side of variation: what happens when a whole population has no genetic differences.

> DRIVING QUESTION
>
> *"Why is a crop with no genetic variation so vulnerable to a single disease?"*

THE STANDARD

Patterns in the Fossil Record

Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

ANCHORING PHENOMENON

The Tiktaalik Fossil. A Fish With a Neck.

A fossil dug out of arctic rock layers in Canada. From one angle it looks like a fish: scales, fins, gills. From another angle it looks like something that could push up on land: a flat head, a neck (fish don't have necks), wrist bones inside the fins, room for lungs. It sits in layers right between fully aquatic fish below and four-legged land animals above. Exactly where the record says an in-between organism should be. The team that found it predicted the layer first, then went looking. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"What does it mean when a fossil shows up exactly where the rock layers predict it should?"*

INVESTIGATIVE 1

The Horse Lineage. Small to Large, Many Toes to One.

A set of horse fossils laid out from oldest to youngest. The earliest one is dog-sized, with four toes on each front foot and three on the back, padded for walking on soft forest ground. Moving up the layers, the body gets bigger, the toes reduce, and the foot structure stretches into the single-hoof shape modern horses have. Use this to sharpen the lens the anchor is pushing on: the record doesn't just contain one in-between fossil. It contains whole sequences of them.

> DRIVING QUESTION
>
> *"If you only had these horse fossils and nothing else, what story would the body changes tell you?"*

INVESTIGATIVE 2

Whale Fossils With Leg Bones

Modern whales have no back legs. They live entirely in the ocean. But fossil whales in older rock layers have small back legs, hip bones, and even foot bones. The further back in the layers you look, the bigger the legs get, until you reach whale ancestors that walked on land. Modern whales still have tiny leftover hip bones buried inside their bodies. Same kind of change as the horse lineage, only the body plan shifted in the other direction: from land back to water.

> DRIVING QUESTION
>
> *"Why would a whale have leg bones buried inside its body, and what does that tell us about its ancestors?"*

THE STANDARD

Comparative Anatomy

Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

ANCHORING PHENOMENON

Four Limbs, One Blueprint

Four labeled skeleton diagrams side by side: a human arm, a bat wing, a whale flipper, and a cat front leg. They look nothing alike from the outside. One throws a baseball, one flies, one swims, one walks. But the bones inside follow the exact same order: one upper bone, two lower bones, a cluster of wrist bones, then long fingers. Different sizes, different proportions, same blueprint. Once students notice it, they can't stop noticing it. Why would four animals that look this different have the same hidden skeleton?

> DRIVING QUESTION
>
> *"Why do four animals that look completely different on the outside have the exact same bone structure on the inside?"*

INVESTIGATIVE 1

Whales With Leg Bones

Modern whales live entirely in the ocean and have no back legs. But buried inside the body of every whale are small hip bones, leftover from ancestors that walked on land. Fossil whales in older rock layers have bigger back legs, and the further back you look, the more complete the legs get, until you reach whale ancestors that walked. Use this one to sharpen the lens the anchor is pushing on: shared anatomy connects modern bodies to ancestral ones, even across millions of years.

> DRIVING QUESTION
>
> *"Why would a whale carry leg bones inside its body when it never walks?"*

INVESTIGATIVE 2

Bat Wings and Butterfly Wings

Two flying animals, side by side. A bat wing and a butterfly wing. Both fly. Both have a wide flat surface. But the bat wing has finger bones inside (the same finger bones as a human hand, stretched out and connected by skin), and the butterfly wing has no bones at all. Same job. Completely different blueprint. Same kind of comparison as the anchor, but with a twist: this time the shared feature is what they DO, not what they're made of.

> DRIVING QUESTION
>
> *"If a bat wing and a butterfly wing both fly, why aren't they built the same way?"*

THE STANDARD

Comparative Embryology

Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

ANCHORING PHENOMENON

Four Embryos. One Looks Human. Can You Tell Which?

Four early-stage vertebrate embryos side by side at the same developmental point. Fish, chicken, lizard, human. All curled in a C-shape. All with a tail. All with pharyngeal arches in the neck region. Students try to pick the human one and almost always get it wrong. The adults of these four species could not look more different. The embryos look almost identical. That gap is the whole lesson.

> DRIVING QUESTION
>
> *"If these four species have nearly identical embryos but completely different adult bodies, what does that pattern tell us about how they're related?"*

INVESTIGATIVE 1

The Human Embryo's Disappearing Tail

Around weeks 4 to 8 of human development, the embryo has a clear tail-like structure made of about 10 to 12 vertebrae. Then most of those vertebrae are absorbed back into the body. By birth, only 3 to 5 fused vertebrae remain as the coccyx (tailbone). Use this one to sharpen the question the anchor is pushing on: why would a body build a structure during development that it then takes apart?

> DRIVING QUESTION
>
> *"Why does a human embryo build a tail it doesn't keep, and what does that tell us about our ancestors?"*

INVESTIGATIVE 2

Webbed Fingers, Then Not

Around week 6 to 8 of human development, the hand looks like a paddle. The fingers exist, but they're connected by webbing. Then cells in the webbing die off in a programmed process (apoptosis), and the fingers separate. Ducks and other webbed-footed animals skip this final step. Same starting hand, different ending. Use this one to sharpen the lens the anchor is pushing on: shared start, different end.

> DRIVING QUESTION
>
> *"If a human embryo and a duck embryo both start with webbed digits, what does that tell us about how their development is connected?"*

THE STANDARD

Genetic Variation for Survival

Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

ANCHORING PHENOMENON

The Peppered Moth Color Shift

Before England's Industrial Revolution, peppered moths were mostly light with speckled wings, blending into lichen-covered tree bark. As factories blackened the trees with soot, the population shifted hard. By the late 1800s, dark moths made up over 95% of the population in industrial areas. After clean-air laws in the 1950s cleaned up the bark, light moths bounced back. Same species, same forest, two opposite shifts driven by what the environment rewarded.

> DRIVING QUESTION
>
> *"How can the same species end up looking completely different in two different decades?"*

INVESTIGATIVE 1

Galapagos Finch Beaks After a Drought

On the small island of Daphne Major, researchers measured every medium ground finch they could catch. After a severe drought in 1977, soft seeds disappeared and only big tough seeds were left. The next year's surviving finches had measurably bigger, stronger beaks. The average beak depth in the population jumped in a single generation. Use this to sharpen the proportional-reasoning lens the moth anchor is pushing on: selection isn't a story, it's a measurable shift in numbers.

> DRIVING QUESTION
>
> *"How much can a population change in one generation when the environment changes fast?"*

INVESTIGATIVE 2

MRSA in Hospitals

Staphylococcus aureus is a common bacterium. Decades ago, penicillin wiped it out almost every time. Today, a strain called MRSA (methicillin-resistant Staphylococcus aureus) survives most common antibiotics. Hospitals fight outbreaks of it every year. The same selection logic from the moth anchor, only on a clock that runs in hours instead of decades. Bacteria reproduce so fast that resistance spreads through a population in a matter of days under drug pressure.

> DRIVING QUESTION
>
> *"How can a hospital's most-used drug stop working in just a few decades?"*

THE STANDARD

Inheritance of Desired Traits

Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.

ANCHORING PHENOMENON

From Wolf to Chihuahua

A photo lineup: a gray wolf, a Great Dane, a Chihuahua, a Border Collie, a Pug. All the same species. All descended from a common wolf ancestor. The differences in size, shape, coat, and behavior came from thousands of generations of humans choosing which dogs reproduced. Students keep coming back to this all week, because every other technology in the standard is a faster version of what produced these dogs.

> DRIVING QUESTION
>
> *"How did people turn one wolf species into hundreds of dog breeds, and what tools do we have to do that kind of work faster today?"*

INVESTIGATIVE 1

Teosinte and Modern Corn

A photo of teosinte, the wild grass that corn came from, next to a modern corn cob. Teosinte has a few hard kernels in a thin spike. Modern corn has hundreds of soft kernels on a thick cob. Same plant lineage, 10,000 years apart, shaped almost entirely by farmers saving seeds from the biggest cobs each season. Use this one to sharpen the lens the anchor is pushing on: cause (human choice) and effect (trait change over generations) in a plant instead of an animal.

> DRIVING QUESTION
>
> *"What did farmers actually do, year after year, that turned a skinny grass into modern corn?"*

INVESTIGATIVE 2

Golden Rice

Standard white rice next to golden rice. They look almost identical except for color. Golden rice was engineered to produce beta-carotene, which the human body converts to vitamin A. It was developed to address vitamin A deficiency in regions where rice is a staple food. Same plant species, a targeted genetic change involving two added genes, a trait that doesn't exist in standard rice. Use this one to show what genetic engineering can do that selective breeding alone couldn't, and to give students a real case study with documented trade-offs they can research.

> DRIVING QUESTION
>
> *"What can a gene editing or genetic engineering approach do that selective breeding can't, and what trade-offs come with each path?"*

THE STANDARD

Natural Selection & Traits

Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

ANCHORING PHENOMENON

Peppered Moths in Industrial England

Before 1850, almost every peppered moth in England was light-colored, dusted to blend with pale lichen on tree bark. By 1895, dark-colored moths made up 98% of the population in some industrial cities. Forty-five years. Same species. The trees had turned black with coal soot, and birds could now spot light moths easily. After clean-air laws in the 1950s, the proportions flipped back. Students will keep circling back to this all week.

> DRIVING QUESTION
> *"How does the color of trees in a forest change the color of moths over time?"*

INVESTIGATIVE 1

Bacteria Beating Antibiotics

When penicillin first came into wide use in the 1940s, it cured almost every staph infection. Resistance showed up almost immediately. By 1960, most hospital staph strains were already resistant to penicillin, which is why doctors switched to a new antibiotic called methicillin. Within a year, methicillin-resistant strains (MRSA) appeared. Over the next several decades MRSA spread widely in hospitals, peaking around 2005. Bacteria reproduce every 20 minutes, so the selection clock runs fast. Use this one to sharpen the math lens the anchor is pushing on. Students see the same proportion shift as the moths, just on a faster timeline.

> DRIVING QUESTION
> *"Why are antibiotics that worked in our grandparents' time barely working now?"*

INVESTIGATIVE 2

Galapagos Finches in a Drought

In 1977 a drought hit the Galapagos Islands. Small seeds disappeared. Only big, hard seeds were left. Finches with bigger, stronger beaks could crack them; finches with smaller beaks starved. Within one year, the average beak depth in the surviving population was measurably larger. The Grant lab measured this in real time across 30+ years. Use this one to sharpen the proportions-shift-fast lens the anchor exposes more slowly.

> DRIVING QUESTION
> *"How does a year of bad weather change the shape of a bird's beak across a whole population?"*

THE STANDARD

Earth-Sun-Moon System

Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

ANCHORING PHENOMENON

The Summer Heat Paradox

It's 100°F in Texas in July. It's 95°F in Argentina in January. Both are hot summer months in their own hemisphere. But here's the puzzle: Earth is actually closer to the sun in January than in July. If "closer = hotter" were the rule, summer in Texas should be in January, not July. Something else has to be driving the seasons. Students will keep circling back to this until they get tilt.

> DRIVING QUESTION
>
> *"Why is it summer in Texas in July when Earth is actually farther from the sun than it is in January?"*

INVESTIGATIVE 1

A Full Moon and a New Moon, Side by Side

Two photos taken two weeks apart. Same moon, same camera, same sky. One is fully lit and round. The other is invisible (you can only tell where it is because of the stars around it). Same object, totally different look. Use this one to sharpen the geometry the anchor is pointing at: the moon's position relative to Earth and the sun changes what we see, not the moon itself.

> DRIVING QUESTION
>
> *"If it's the same moon, why does it look completely different from one week to the next?"*

INVESTIGATIVE 2

A Solar Eclipse in the Middle of the Day

Footage of a total solar eclipse. The sky darkens in the middle of the afternoon. Birds get confused. Streetlights flicker on. Then a few minutes later, it's back to a normal day. Use this one to sharpen the alignment idea the anchor doesn't reach directly: eclipses happen when the geometry lines up exactly, which is rare and dramatic.

> DRIVING QUESTION
>
> *"What has to be lined up for the sky to go dark in the middle of the day?"*

THE STANDARD

Gravity & Our Solar System

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

ANCHORING PHENOMENON

Jupiter's Moons Moving Night After Night

Through a small telescope (or even good binoculars), Jupiter looks like a tiny pale disk with four bright dots in a line near it. Sketch them tonight. Sketch them tomorrow. The dots are in different positions. Sketch them all week. The dots loop around Jupiter on a schedule. Those are Jupiter's four largest moons, and you're watching gravity do its job in real time. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"What's making those moons swing around Jupiter like that, instead of flying off in a straight line?"*

INVESTIGATIVE 1

Planets That Wander Across the Sky

Most "stars" in the night sky stay in the same pattern night after night. A few don't. Mark Venus or Jupiter on a star map this week, then check back in two weeks. They've moved relative to the background stars. That's because they aren't stars at all. They're planets orbiting the sun, and we're watching from another planet doing the same thing. Use this to sharpen the orbital-motion lens the anchor is pushing on.

> DRIVING QUESTION
>
> *"If everything is orbiting the sun, why do some planets seem to wander while the stars stay put?"*

INVESTIGATIVE 2

The Milky Way Stretched Across a Dark Sky

On a really dark night, far from city lights, a hazy band of light stretches across the sky from one horizon to the other. That haze is billions of stars too far to see one at a time. You're looking edge-on into the disk of our own galaxy. The sun is in the disk too, partway out from the center. Same kind of gravity holding all those stars together, only the system is way bigger than the solar system.

> DRIVING QUESTION
>
> *"If we're inside the galaxy, how do astronomers know what it looks like from the outside?"*

THE STANDARD

Scale Model of the Solar System

Analyze and interpret data to determine scale properties of objects in the solar system.

ANCHORING PHENOMENON

The Solar System You've Never Actually Seen

Every solar system diagram ever printed shows planets in a tidy row, all visible at once. None of them are to scale. If you shrunk the Sun to a basketball, Earth would be a pea about 26 yards away. Jupiter would be a softball at the far end of the football field. Neptune would be a marble a mile down the road. Almost every "picture" of the solar system in their life has been a lie of convenience. The real thing is mostly empty.

> DRIVING QUESTION
>
> *"What does our solar system actually look like, and why does every picture make it look like something else?"*

INVESTIGATIVE 1

Cassini's Photos of Saturn's Rings

The Cassini spacecraft orbited Saturn from 2004 to 2017. It sent back close-up photos of the rings, which from Earth look like solid bands. Up close, the rings turn out to be billions of separate icy chunks, ranging from grain-size to house-size, spread thin across hundreds of thousands of kilometers. From far away: a solid disk. Up close: scattered ice. Same object, different story depending on the scale. Use this to sharpen the scale lens the anchor is pushing on.

> DRIVING QUESTION
>
> *"How can the same object look completely different depending on how close you are to it?"*

INVESTIGATIVE 2

New Horizons' First Real Photos of Pluto

Until 2015, the best image we had of Pluto was a fuzzy smudge a few pixels wide. Then the New Horizons spacecraft did a flyby and sent back high-resolution photos. They showed mountains of water ice, a giant heart-shaped plain of frozen nitrogen, and possible signs of an underground ocean. The "ninth planet" turned into a real place overnight. Same logic as the anchor: a system too far away to see clearly until we sent something there to look.

> DRIVING QUESTION
>
> *"How does the data we have about a solar system object change what we think it is?"*

THE STANDARD

Time Scale of Earth

Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

ANCHORING PHENOMENON

The Grand Canyon's Stack of Time

A side-view photo of the Grand Canyon, with layer after layer of different-colored rock running down its walls. The deepest rock at the bottom is about 1.8 billion years old. The top is around 270 million. Two billion years of Earth's history are visible in one view. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can two billion years of Earth's history sit in plain sight, and what does each layer tell us?"*

INVESTIGATIVE 1

The K-Pg Iridium Layer

A thin, dark band in rock formations on every continent. Inside, it's loaded with iridium, an element rare in Earth's crust but common in asteroids. The same band sits at the exact rock layer that marks the end of the dinosaurs, 66 million years ago. Use this one to sharpen the evidence lens the anchor is pushing on: a single thin layer can tell a global story.

> DRIVING QUESTION
>
> *"How can one thin layer of rock, found all over the world, point to a single event 66 million years in the past?"*

INVESTIGATIVE 2

Burgess Shale Fossils

A set of fossils from a rock layer in Canada, 508 million years old. The fossils show soft-bodied creatures that don't exist today, including animals with five eyes, claws on stalks, and bodies built unlike anything in the modern oceans. They lived during the Cambrian explosion, when most major animal groups first appear in the fossil record. Use this to sharpen the timeline lens: life wasn't always like this, and the rocks prove it.

> DRIVING QUESTION
>
> *"If creatures this strange once lived on Earth, what does the rock record tell us about how life has changed?"*

THE STANDARD

Cycling of Earth's Materials

Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

ANCHORING PHENOMENON

The Layered Highway Road Cut

A photo (or a field trip if you can swing it) of a highway road cut showing 20 distinct horizontal layers of rock, each a different color. The bottom layers are gray limestone full of tiny shell fragments. The middle layers are red sandstone. The top is dark shale. Students notice immediately that the layers look like a stack of pancakes and that each one used to be something at the surface. The question that sticks: how did all of this used to be loose stuff, and what's holding it together now?

> DRIVING QUESTION
>
> *"How did 30 meters of solid rock get built up in layers, and how long did it take?"*

INVESTIGATIVE 1

Marble Countertops, Limestone Floors

A piece of polished marble next to a piece of polished limestone. Same atoms (calcium carbonate). Almost identical chemistry. But marble has swirly veins and a crystalline shine. Limestone has fossils and a duller surface. Use this one to sharpen the heat-and-pressure lens the anchor is pushing on. The marble used to be limestone before it got cooked and squeezed deep underground.

> DRIVING QUESTION
>
> *"If marble and limestone are basically the same chemical, why do they look and feel so different?"*

INVESTIGATIVE 2

Yellowstone Hot Springs and the Grand Canyon

Two photos side by side. Yellowstone hot springs steaming and bubbling, fed by magma a few kilometers underground. The Grand Canyon, a mile deep, carved by the Colorado River over six million years. Same planet, two completely different energy sources making the landscape. Yellowstone is internal heat doing visible work. The Grand Canyon is solar energy (driving the water cycle, driving the river) doing visible work over deep time.

> DRIVING QUESTION
>
> *"These two places are reshaping themselves right now. Where is the energy coming from in each one, and how does it connect to the rock cycle?"*

THE STANDARD

Geoscience Processes

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

ANCHORING PHENOMENON

Mt. St. Helens, Before and After

May 17, 1980: Mt. St. Helens is a classic cone-shaped volcano in Washington. Snow-capped. Symmetrical. May 18, 1980, around 8:32 a.m.: the north face of the mountain collapses in the largest landslide in recorded history, and a lateral blast tears through the failing flank. The mountain loses 1,300 feet of summit in the first few minutes. The full eruption sequence continues for about nine hours, burying the landscape for miles around in ash and debris. Visible from space. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can a mountain that took hundreds of thousands of years to build change so much in a single day?"*

INVESTIGATIVE 1

The Grand Canyon vs. the Mississippi Delta

Two photos. The Grand Canyon: a mile deep, layers of rock exposed, carved by the Colorado River over about 6 million years. The Mississippi Delta: a vast spread of new land at the mouth of the river, built up by sediment deposited over the same kinds of timescales. One river. Two opposite stories. One side carves rock away. The other side piles sediment up. Use this one to sharpen the lens the anchor is pushing on: same kind of process (water moving), wildly different outcomes depending on where you stand on the river.

> DRIVING QUESTION
>
> *"How can one river be tearing down a landscape in one place and building one up in another?"*

INVESTIGATIVE 2

A Sand Dune in Time-Lapse

A time-lapse video of a sand dune migrating across a desert. In real time, you'd never notice it. Sped up, the dune walks. Wind picks up grains on the windward side, carries them over the crest, and drops them on the leeward side. The whole dune slides forward, sometimes several meters a year. Same kind of slow-and-steady change as the anchor was hiding behind, except this one's running fast enough that time-lapse can catch it.

> DRIVING QUESTION
>
> *"If a dune can move that much in a year, what's it going to look like in a hundred years? In ten thousand?"*

THE STANDARD

Past Plate Motions

Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

ANCHORING PHENOMENON

Mesosaurus on Two Continents

A small freshwater reptile called Mesosaurus lived about 290 million years ago. Its fossils are found in only two places: a band along the coast of southern Africa and a matching band along the coast of South America. Nowhere else. It lived in lakes and rivers, not oceans, so it couldn't have swum across the Atlantic. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can the same freshwater animal end up fossilized on two continents separated by an ocean it couldn't cross?"*

INVESTIGATIVE 1

The Atlantic's Hidden Mountain Range

A topographic map of the Atlantic Ocean floor shows a long mountain range running straight down the middle, from the Arctic almost to Antarctica. The seafloor closest to the ridge is the youngest. The seafloor near the continents is the oldest. Use this one to sharpen the lens the anchor is pushing on: continents aren't just sitting still, they're being actively pushed apart.

> DRIVING QUESTION
>
> *"Why is there a giant mountain range running down the middle of the Atlantic Ocean, and why is the rock newer in the middle than at the edges?"*

INVESTIGATIVE 2

The Ring of Fire

A world map showing every major volcano and earthquake from the past 50 years. The dots aren't spread evenly. They trace a giant ring around the Pacific Ocean, line up along the Andes, run through Japan, the Philippines, Indonesia, and Alaska. Same kind of pattern shows up in a thin line down the middle of the Atlantic. The dots draw the plate boundaries. Same kind of pattern-thinking the anchor demands, only the pattern is in active geologic activity instead of fossils.

> DRIVING QUESTION
>
> *"Why do volcanoes and earthquakes happen in such specific places instead of being spread evenly across Earth's surface?"*

THE STANDARD

Cycling of Water

Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

ANCHORING PHENOMENON

The Sealed Terrarium That Lives for Years

A glass jar with soil, a plant, and a little water, sealed shut. No watering, no air exchange, nothing added. The plant stays alive for months or years. Some sealed terrariums have lasted over 50 years. Same water, same plant, going round and round. Students will keep circling back to this all week.

DRIVING QUESTION

"How can a sealed system keep a plant alive for years with no new water added?"

INVESTIGATIVE 1

Morning Dew on Grass

Walk across a lawn early in the morning and your shoes are soaked. It hasn't rained. The grass is wet because overnight, the ground cooled below the air's dew point, and water vapor in the air condensed back into liquid right on the blades. Same condensation process happening in the terrarium, only on a bigger scale. Use this one to sharpen the condensation lens the anchor is pushing on.

DRIVING QUESTION

"Where does the water on the grass come from if it didn't rain?"

INVESTIGATIVE 2

A River That Runs Dry

A wide river that flows year-round suddenly dries to cracked mud during a long drought. The riverbed is still there. The watershed is still there. But the cycle's timing has shifted. Less rain falling, more evaporation, less runoff reaching the river. Same kind of imbalance as the terrarium drying out, only on a regional scale. Use this one to show that the cycle still runs during drought, just unevenly.

DRIVING QUESTION

"If water on Earth never goes away, how can a whole river run dry?"

THE STANDARD

Interactions of Air Masses

Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

ANCHORING PHENOMENON

The Sudden Afternoon Thunderstorm

A hot humid morning. Clear skies, maybe a few puffy clouds. By 3 p.m. the clouds are towering, dark on the bottom, and lightning is cracking. By 5 p.m. it's pouring. By 7 p.m. the sky is clear again and the air feels cooler and lighter. Same day, totally different weather, no warning unless you were watching the data. Students will keep circling back to this all week as they learn what was actually happening above their heads.

> DRIVING QUESTION
>
> *"What was the atmosphere doing this morning that we couldn't see, but that guaranteed this storm by afternoon?"*

INVESTIGATIVE 1

The Calm Before the Storm

Right before a severe thunderstorm or tornado, the wind often dies down completely. Birds stop singing. The light turns greenish or yellow. People who live through tornadoes describe the same eerie quiet again and again. Use this one to sharpen the pressure-and-air-movement lens the anchor is pushing on: the calm isn't random, it's what happens when air is being pulled upward into a developing storm.

> DRIVING QUESTION
>
> *"Why does it feel calm right before the worst part of the storm?"*

INVESTIGATIVE 2

Citrus-Killing Cold in Florida

Every few years, a hard freeze hits Florida or south Texas and wipes out orange or grapefruit crops. Florida isn't supposed to freeze. The reason is an Arctic air mass that has slid all the way south from Canada, riding through the middle of the country and reaching the Gulf Coast. Same kind of change as the anchor, only on a continental scale: a moving air mass shows up where you didn't expect it and the weather changes hard.

> DRIVING QUESTION
>
> *"How can a freeze from Canada reach Florida, and why doesn't it happen every winter?"*

THE STANDARD

Unequal Heating of Earth

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

ANCHORING PHENOMENON

The Sahara, the Amazon, and the Same Strip of Sunlight

Pull up a world map and draw a band from about 10 degrees north of the equator to 10 degrees south. That band crosses the Amazon rainforest in South America and the Sahara Desert in northern Africa. Same latitude range, same overhead sunlight, completely different climates. One is the wettest place on the planet. The other is one of the driest. Students will keep circling back to this all week.

> DRIVING QUESTION
>
> *"How can two places sitting in the same band of sunlight end up with such completely different climates?"*

INVESTIGATIVE 1

Trade Winds and the Sailing Ships

For hundreds of years, ships crossing the Atlantic from Europe to the Americas didn't sail straight across. They first sailed south to the Canary Islands, then turned west. The reason is steady winds in the tropics that always blow from east to west: the trade winds. Sailors learned the pattern long before anyone knew why it worked. Use this one to sharpen the rotation-bends-moving-air lens the anchor is pushing on.

> DRIVING QUESTION
>
> *"Why do winds in some parts of the world blow steadily in the same direction year after year?"*

INVESTIGATIVE 2

London vs. Labrador

London, England sits at about 51 degrees north. Goose Bay, Labrador sits at about 53 degrees north. Almost the same latitude. London's average January temperature is around 5 degrees Celsius. Goose Bay's is around minus 17 degrees Celsius. Twenty-two degrees colder, at almost the same distance from the equator. Use this one to sharpen the ocean-currents-move-heat lens.

> DRIVING QUESTION
>
> *"Why are two cities at almost the same latitude separated by more than 20 degrees in winter temperature?"*

THE STANDARD

Earth's Resource Distribution

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

ANCHORING PHENOMENON

Texas Used to Be Underwater

Texas sits on top of one of the largest oil reserves in North America. It's also covered in fossilized seashells, ancient coral reefs, and limestone made from billions of dead sea creatures. The whole state used to be ocean floor. Then plate tectonics, climate shifts, and millions of years turned a shallow sea into the place where the modern oil industry was born. The oil under Texas isn't a coincidence. It's the inheritance of that ancient ocean.

> DRIVING QUESTION
>
> *"Why do we find oil in Texas and not, say, the middle of the Rocky Mountains?"*

INVESTIGATIVE 1

The Coal Belt and the Old Swamps

Pennsylvania and West Virginia have huge coal deposits. So does Illinois. So does eastern Kentucky. Map them and the pattern is unmistakable: a wide belt running through the Appalachians and into the Midwest. Map the same area 300 million years ago and you'll see something else: a vast network of swampy lowlands during the Carboniferous Period. The coal is the buried, compressed remains of those swamps. Same idea as the anchor, different resource, different process.

> DRIVING QUESTION
>
> *"What does the current location of coal tell us about what that land used to look like?"*

INVESTIGATIVE 2

The Ogallala Aquifer Is Draining Fast

The Ogallala Aquifer stretches under eight states in the Great Plains. It holds enough water to cover the entire continental US in a foot and a half. The water in it accumulated over thousands of years from slow seepage through soil and rock, and USGS estimates it would take roughly 6,000 years to refill at natural recharge rates if drained today. Since the 1950s, we've pumped it for crop irrigation. In some parts, water levels have dropped over 150 feet. Replenishment happens on a geologic clock. Extraction happens on a human clock. The two don't match.

> DRIVING QUESTION
>
> *"If an aquifer takes thousands of years to fill, what does it mean to call groundwater renewable?"*

THE STANDARD

Forecast Catastrophic Events

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

ANCHORING PHENOMENON

Two Mountains, Two Endings: Mt. St. Helens, 1980

On March 20, 1980, a magnitude 4.2 earthquake hit Mt. St. Helens, the first major quake in a swarm that had started a few days earlier. Over the next eight weeks, the north flank of the mountain bulged outward by more than 450 feet (about 135 meters), growing up to 5 feet per day. Gas emissions climbed. Small quakes swarmed under the summit. On May 18, the mountain exploded sideways and the eruption killed 57 people. Scientists had been watching the whole time and had already restricted access. The hazard was unstoppable. The disaster was partly reduced because the data was being read.

> DRIVING QUESTION
>
> *"If a volcano shows weeks of warning signs, why don't we get the same kind of warning from an earthquake?"*

INVESTIGATIVE 1

The 2004 Indian Ocean Tsunami and the Sirens That Weren't There

On December 26, 2004, a magnitude 9.1 earthquake off Sumatra sent a tsunami racing across the Indian Ocean. Over 230,000 people died across 14 countries. At the time, the Indian Ocean had no tsunami warning system. The Pacific had one. The technology existed. After 2004, a network of deep-ocean buoys and coastal sirens was built across the Indian Ocean. Use this one to sharpen the mitigation lens the anchor opens up: same kind of hazard data, completely different outcome when the warning system is there.

> DRIVING QUESTION
>
> *"If the science to predict a tsunami already existed, why didn't every ocean have a warning system?"*

INVESTIGATIVE 2

The Building That Stayed Standing in Tokyo, 2011

The March 11, 2011, Tōhoku earthquake hit magnitude 9.1. Skyscrapers in Tokyo, 230 miles from the epicenter, swayed for several minutes. Most of them stayed standing. Many newer Japanese high-rises are built on base isolators, rubber and steel pads that let the building rock slightly while the ground shakes underneath. Same kind of pattern reading as the anchor, only this time the data shaped engineering, not just monitoring. Decades of earthquake data told Japanese engineers what their buildings had to survive.

> DRIVING QUESTION
>
> *"If we can't predict when an earthquake will happen, how do we engineer for the one that's coming anyway?"*

THE STANDARD

Minimizing Human Impact

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

ANCHORING PHENOMENON

The River That Caught Fire and the River That Didn't

The Cuyahoga River in Cleveland caught fire in 1969 because surface oil and industrial waste were thick enough to ignite. Today the same river supports fish populations and recreation. The water didn't fix itself. People started measuring it, set limits on what could be discharged, and kept monitoring. The river that was once burning is now a working ecosystem. The thing that changed was the design of the system around it.

> DRIVING QUESTION
>
> *"What does it take to turn a measurably damaged environment into a measurably healthier one, and how would we know it worked?"*

INVESTIGATIVE 1

Two Photos of the Amazon, Five Years Apart

Two satellite images of the same region of the Amazon, taken five years apart. In the first, mostly green. In the second, a fishbone pattern of cleared roads cutting into the forest. The same tool that took the photos is being used by researchers to count how many square kilometers of cover were lost between the two dates. Use this one to sharpen the monitoring lens the anchor is pushing on: you can't manage what you don't measure, and you can measure things from space.

> DRIVING QUESTION
>
> *"How do you decide what to measure when the change you're studying is too large to see from the ground?"*

INVESTIGATIVE 2

The Classroom CO_2 Curve

A CO_2 sensor sits on the front desk and records every five minutes during one school day. The line is low in the morning, climbs steeply during first period as students fill the room, drops at lunch when the room empties, and climbs again in the afternoon. The classroom is a measurable system, and the human activity that changes its air is just sitting and breathing. Same monitoring logic as the anchor, only in a small space and a short time.

> DRIVING QUESTION
>
> *"If a sealed room can change in measurable ways from a class period of breathing, what does that tell us about how human activity changes the larger systems we live in?"*

THE STANDARD

Populations & Earth's Systems

Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

ANCHORING PHENOMENON

The Hockey Stick Population Graph

A line graph of world population from 1800 to 2025. For most of the chart, the line creeps along the bottom. Then it bends sharply upward in the 1900s and keeps climbing. World population was around 1 billion in 1800 and is around 8 billion in 2025. The shape is what students keep noticing. Why the bend? What changed?

> DRIVING QUESTION
>
> *"What changed about how humans live that turned a slow climb into a steep one, and what does that mean for Earth's systems?"*

INVESTIGATIVE 1

Two Cities, Same People, Different Footprints

Singapore and a similarly sized U.S. metro area have comparable populations. Their per-capita energy use, water use, and emissions are not comparable. Public data shows the U.S. metro uses significantly more of each per person. Same population count, very different footprints. Use this to sharpen the lens the anchor is pushing on: population is only half the story.

> DRIVING QUESTION
>
> *"If two places have the same population, why do they push on Earth's systems differently?"*

INVESTIGATIVE 2

Forest Cover and People, Side by Side

A pair of maps and graphs showing one region's population growth over the last 60 years next to its forest cover over the same period. The Brazilian Amazon, parts of Southeast Asia, and parts of Central Africa all show clear, measurable patterns. Population and resource demand rise. Forest cover drops. The chain is not subtle in the data, but it is multi-causal in real life.

> DRIVING QUESTION
>
> *"What does it take to be confident a change in Earth's systems was caused by population and consumption, and not by something else?"*

THE STANDARD

Changing Global Temperatures

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

ANCHORING PHENOMENON

The Hockey Stick Graph

A graph of Earth's average surface temperature from the year 1000 to today. For nine centuries, the line wobbles slightly but stays roughly flat. Then around 1900, it bends upward sharply. The shape looks like a hockey stick lying on its side: a long flat handle, then a blade that turns straight up. Students will keep circling back to this all week. What changed?

> DRIVING QUESTION
>
> *"What happened around 1900 that pushed a thousand-year temperature pattern straight upward?"*

INVESTIGATIVE 1

800,000 Years of CO_2 in an Ice Core

A graph from Antarctic ice cores showing atmospheric CO_2 for the past 800,000 years. The line cycles between about 180 ppm and 280 ppm, over and over, matching ice ages and warm periods. Then in the last 150 years, it shoots past 430 ppm. The modern spike doesn't fit the natural cycle. Use this to sharpen the question the anchor is pushing on: what made the recent change different?

> DRIVING QUESTION
>
> *"If CO_2 has cycled naturally for hundreds of thousands of years, why is the modern level so far outside the cycle?"*

INVESTIGATIVE 2

Arctic Sea Ice Then and Now

Satellite images of Arctic sea ice at the end of summer in 1979 and again in 2024. The 1979 image shows ice covering most of the Arctic Ocean. The 2024 image shows roughly half that area, with open water reaching much closer to the North Pole. Same satellite system, same time of year, same measurement method. The change is the ice itself. Same kind of gradual change as the anchor, only visible on a map.

> DRIVING QUESTION
>
> *"What does a shrinking ice cap tell us about how stable Earth's climate system is right now?"*

THE STANDARD

Defining Design Problems

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

ANCHORING PHENOMENON

The Mars Rover Design Brief

Before NASA built Perseverance, engineers wrote a design brief that specified every condition the rover had to survive. It had to survive Martian nights colder than -90°C while keeping its electronics between -40°C and +50°C. It had to roll over rocks up to 40 cm tall. It had to land within a target zone smaller than a small town (a 7.7 by 6.6 km ellipse). It had to carry instruments under tight mass limits because every extra kilogram added enormous launch cost. The brief was hundreds of pages before any hardware was built. Students see the gap between "send a robot to Mars" and the precise spec that made the mission possible.

DRIVING QUESTION

"Why do real engineers spend so much time writing before they start building?"

INVESTIGATIVE 1

Two Product Listings, Same Product Category

Pull two real spec sheets for similar products. Two water bottles, two flashlights, two backpacks. They look like the same thing on the shelf, but their spec sheets reveal different criteria and constraints. One bottle is rated for boiling water, the other isn't. One flashlight is rated waterproof to 10 meters, the other to splash-resistant. Use this to sharpen the precision lens the anchor is pushing on: tiny spec differences cause real differences in what the product can do.

DRIVING QUESTION

"Why do two products that look the same end up with such different specs?"

INVESTIGATIVE 2

The School's Locker Request

A school is replacing the lockers in a hallway and the principal hands out a one-page request: "We need new lockers." Students read it and immediately realize the request is unsolvable as written. How tall? How many? How secure? Compliant with which safety codes? Within what budget? Same kind of vague-to-precise rewrite as the anchor, only the stakes are local instead of interplanetary.

DRIVING QUESTION

"What would a useful version of the principal's request actually say?"

THE STANDARD

Evaluating Design Solutions

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

ANCHORING PHENOMENON

Three Lunchboxes, One Lunch

Same sandwich, same ice pack, same gym class day. Three different lunchboxes. A plain insulated lunchbox, a regular cloth bag, and an insulated lunchbox with a built-in cooling gel pack. By lunch, the sandwich in the cloth bag is room temperature. The other two are still cold, but one is heavier and cost three times as much. Which one is "best"? Students will argue about that all week.

DRIVING QUESTION

"How do you decide which design is best when each one wins on different things?"

INVESTIGATIVE 1

The Bridge Bid

A city needs a new bridge across a river. Three construction companies submit proposals. Company A: cheapest, finishes fast, expected lifespan 30 years. Company B: most expensive, beautiful, lifespan 80 years. Company C: mid-range cost, 50-year lifespan, lowest expected traffic disruption during construction. The city council has to pick one. Use this to sharpen the trade-off lens the anchor is pushing on: the cheapest option isn't automatically the best, and "best" depends on the criteria the council weighs heaviest.

DRIVING QUESTION

"If the council picks the cheapest bridge to save tax money, what could that cost the city over 30 years?"

INVESTIGATIVE 2

Two Product Reviews, Same Product

Two online reviews of the exact same wireless earbuds. Reviewer A gives them 5 stars, focusing on sound quality and battery life. Reviewer B gives them 2 stars, focusing on price, comfort during long use, and microphone clarity for calls. Same product, opposite verdicts. The difference isn't the product. It's the criteria each reviewer used. Same idea as the anchor, only smaller: change the criteria, change the winner.

DRIVING QUESTION

"How can two people evaluating the exact same product reach opposite conclusions?"

THE STANDARD

Comparing Design Solutions

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

ANCHORING PHENOMENON

The Hybrid Car That Took Over the Driveway

Two engineers walk into a problem. One has a gas engine that's powerful but burns fuel. One has an electric motor that's clean but runs out of charge fast. Each design solves part of the problem and fails at another part. Then somebody combined them, put a small gas engine and an electric motor in the same car, and the hybrid was born. Same fuel tank, way more miles. Students will see hybrids on the road all week.

> DRIVING QUESTION
>
> *"How do engineers decide which parts of two different designs to combine, and how do they know the combination will be better than either one alone?"*

INVESTIGATIVE 1

The iPhone Was Never Just a Phone

Pull up a picture of a 2006 desk: a flip phone, an iPod, a digital camera, a planner. Then a 2007 iPhone. Same functions, one device. Steve Jobs introduced it as a combination of three products: a widescreen iPod with touch controls, a mobile phone, and an Internet communicator. The iPhone wasn't a brand-new invention. It was a combined solution that pulled the best features from several products into one design. Use this one to sharpen the lens the anchor is pushing on: combining beats inventing from scratch.

> DRIVING QUESTION
>
> *"When engineers combined the features of several products into one, what trade-offs did they have to make for it to work?"*

INVESTIGATIVE 2

Three Backpacks, One Better Backpack

A student tested three backpacks on the way to school. One had great straps but a tiny main pocket. One held everything but the zipper broke in a week. One was waterproof but heavy. None was great. The student sketched a v4 combining the straps from Bag 1, the layout from Bag 2, and the waterproofing from Bag 3. Same kind of design analysis the anchor demands, only with something every middle schooler has tested in real life.

> DRIVING QUESTION
>
> *"How would you decide which features from three so-so backpacks to combine into a v4 worth carrying?"*

THE STANDARD

Iterative Testing & Modification

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

ANCHORING PHENOMENON

SpaceX, Year of the Exploding Rockets

Show students the Starship test footage from 2020 and 2021. Rocket after rocket. Some make it most of the way. Some explode on launch. Some explode on landing. By 2024 SpaceX is catching the rocket booster out of the sky. The whole journey is iteration in front of a camera. Engineers don't hide the failures. They use them.

> DRIVING QUESTION
> *"If their rockets keep blowing up, why do we still call SpaceX successful?"*

INVESTIGATIVE 1

The Paper Helicopter That Won't Quit

A single paper helicopter design, dropped from the same height ten times in a row, lands at slightly different spots each time. Same paper, same fold, same drop. The data isn't identical. Use this to sharpen the lens the anchor is pushing on: iteration isn't just about changes between versions. You have to know how much variation your test has before you can trust that a change to v2 actually mattered.

> DRIVING QUESTION
> *"How big does a change have to be before you can trust it actually made a difference?"*

INVESTIGATIVE 2

The iPhone Lineup

Show the lineup of iPhones from 2007 to today. Side by side. Same product family, totally different machines. The first one has no app store, no front camera, no fingerprint reader. Each year added one or two new pieces. The change from year to year is small. The change from start to finish is enormous. Same loop as the anchor, only stretched across two decades instead of two years.

> DRIVING QUESTION
> *"Could Apple have built today's iPhone in 2007 if they'd just tried harder, or did each version have to come first?"*