

Science for Emerging Adults

Michael Gannotti

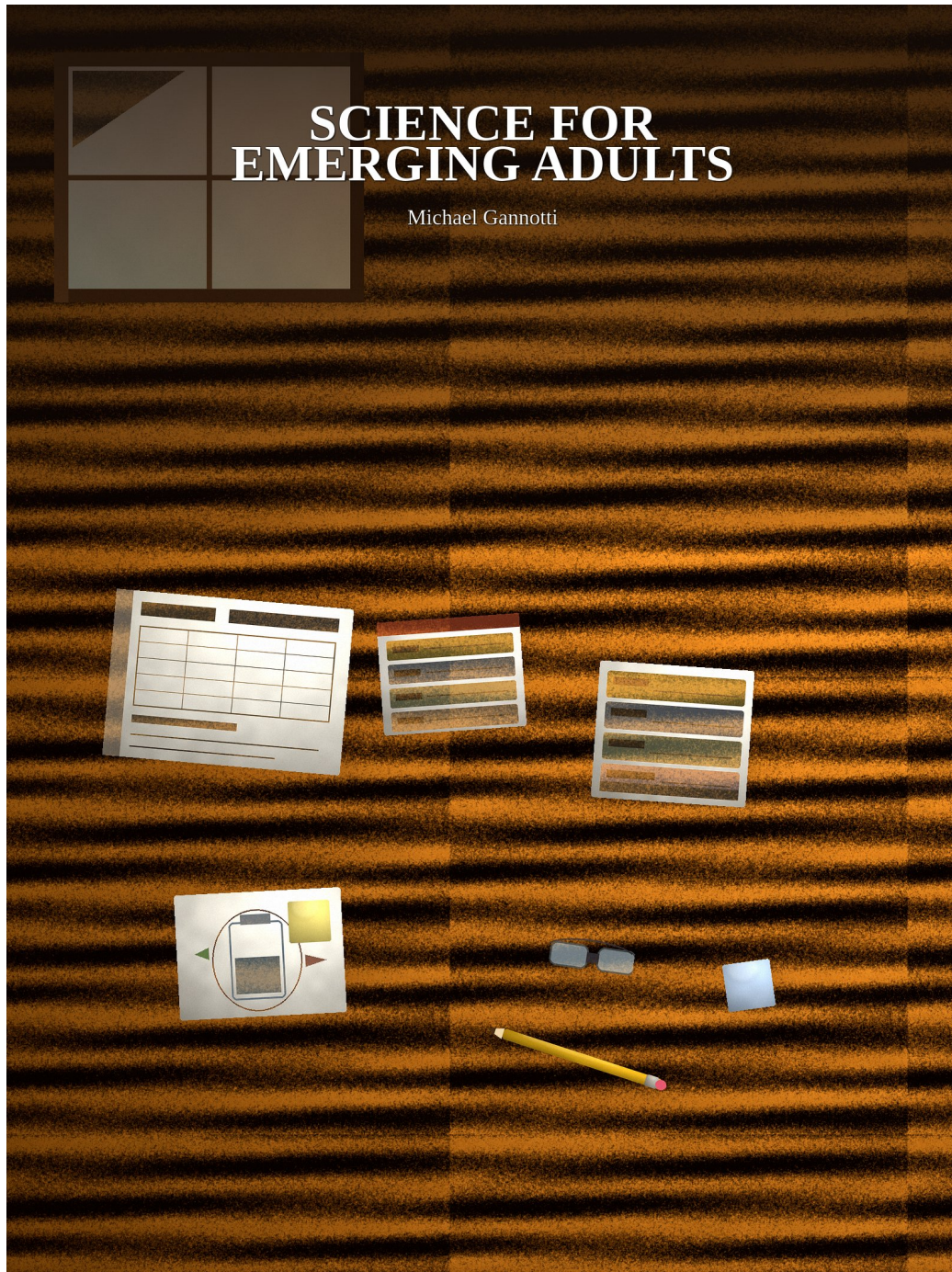


Figure 1: Cover

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This illustrated edition is the teaching-manual of 17 September 2026. Endnotes run in one series. Chapter-opening images are original still-lives, not portraits of persons or children. Documents still constrain the facts.

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Welcome

This book is for you and the fifteen- to eighteen-year-old at your table.

You do not need to be a scientist. You do need to put a system on the table with a blank notebook, ask what they measured, and wait for an answer that points at that notebook. That is the work. The rest of these pages teach the moves.

Why this book exists

At fifteen through eighteen, science can mean looking at a named system — a jar garden, a body subsystem, a reaction you can stop and record, a change of motion — and leaving the hour with a claim that points at evidence from *this* trial. The claim gets denser than it was at eleven to fourteen: a warrant that names the idea, a limitation or an alternative explanation, a notebook a stranger could almost reconstruct without watching.

Many adults feel rusty. The science they remember was a vocabulary list, a laminated “scientific method” poster, and a year that never left the textbook. That is ordinary. It is not a character flaw. This book makes you fluent enough in today’s looking move to hear a force-as-fuel jab, a cells-as-tiny-mouths claim, a confounded “proof,” neat invented rows, a generated gel filed as the student’s result, a model summary sitting on the table as the observation, a demo with no student’s record, an isolated lab-day with no talk, a coverage lecture with no system on the table, a kitchen picture sold as Chemistry credit, a chatbot CER with no trial, method-poster theater, and AP-as-weekly-spine — and to ask a good question without grabbing the answer.

The student is a person, not a percentile. At fifteen and sixteen they can draw a system boundary with help, keep a stranger-readable notebook, redesign a con-

founded fair test, write denser CER with an explicit warrant and one limitation or alternative, and use Biology or Chemistry or Physics as this week's vehicle. At seventeen and eighteen they can revise a systems model against data, integrate evidence across linked trials, name alternative explanations *and* limitations, use denser precision talk, sit an occasional FRQ-shaped stretch or an AP or CLEP edge that remains their own work, and plan a lab-path neighbor when the try needs real glassware. Place by skill, not birthday.

What a good Science Hour looks like

Thirty to fifty minutes. Five beats you will meet again in the next section: open with a system or question on the table (and a RAMP check if heat, chemicals, glass, living specimens, or outdoor water are coming); a short look or prior-idea card without dumping the tidy answer yet; one try — measure and record; a talk box and denser CER; a short exit ticket. The student looks. You ask one authentic question and wait. Biology, Chemistry, or Physics is the vehicle for the week, not an encyclopedia year. Coverage is a map. Depth is the hour. AP is an edge, not the spine.

The work lives in the home and outside it. A system boundary on a jar. A stranger-readable lab notebook. A fair-test redesign sticky. A denser CER three-box with a warrant line. A museum one-exhibit systems sketch. A park transect. A night-sky log with an adult. A lab-path neighbor bench when the try needs supervised glassware. Shared looking and outings motivate. They do not replace the systems-and-claim move.

What this book will not do

It will not give you a 180-day worksheet dump. It will not sell a curriculum franchise. It will not promise a score, a diploma, or a percentile. It will not reprint *Science for Young Minds* (ages 11–14 fair test with notebook and CER light), *Science for Little Thinkers* (ages 5–10 observe-before-explain), or *Science for Home-schooling* (grades 1–12 survey and transcript architecture). One pointer each, then teach fifteen-to-eighteen science. It is not a sequel to *Critical Thinking for Emerging Adults*, *English for Emerging Adults*, *History for Emerging Adults*, or *Math for Emerging Adults*. One pointer each, then teach looking at a named system and claiming from *this* notebook.

It will not invent a course titled Emerging Adults Science I. It will not treat a kitchen vinegar-and-soda picture as Chemistry credit. It will not make AP Biology, Chemistry, or Physics the year's identity. It will not file invent-data neat rows, a generated gel, or a model summary as the student's looking. It will not turn every Thursday into an FRQ packet. It will not add a ninth teaching chapter called "life of the habit." The habit lives in the Science Hour rhythm, in done-enough checklists, and in the records you keep.

How the twin spines sound in ordinary words

Systems looking. Where is the boundary? What are the parts and flows? What does the model leave out? How would a change inside or at the boundary matter?

Lab claim with evidence (CER denser). What do you claim? Which numbers or observations in *this* notebook support it? Why would that measurement count as evidence for *this* scientific idea — that is the warrant? What else could explain these numbers? What can't this dataset tell us?

You will practice those spines on safe objects: a jar, a notebook, a redesign sticky, a photosynthesis inputs–outputs picture, a change-of-motion card, a RAMP card beside goggles, a kitchen honesty card labelled *not Chemistry credit*. Soft entry on living things: care, return organisms, wash hands. Home vertebrate dissection is optional, never required. Mold cultivation is refused by default. Curiosity is not a permit for unauthorized mixing.

Encouragement that is specific

This week you can learn to name today's system in ordinary words before any vocabulary list, and to hear coverage panic without grabbing a unit calendar. Today they can draw one boundary and point at one notebook row that could support a claim.

You are allowed to feel rusty and still teach well. They are allowed to wait, to revise, and to change their mind when the table disagrees with the tidy idea. Put the system down. Open the notebook. Ask the question. Wait.

Then teach.

How to use this book this week

You do not need to finish the book before you begin. You need one Science Hour shape, one focus move, and one try the student can see.

The honest this-week plan

1. Choose one spine emphasis: **systems looking** or **lab claim with evidence** (often both lightly).
2. Choose one named try-it from the chapter you are in — for example a system-boundary sketch, a stranger-notebook repair, a fair-test redesign, or a denser CER three-box.
3. Choose one vehicle for the week: *Biology or Chemistry or Physics* (Earth soft when the question asks for it). The vehicle carries the spine. It is not a survey dump.
4. Run a RAMP card if heat, chemicals, glass, living specimens, outdoor water, or electricity beyond a battery toy are coming. Stop if you cannot minimize the risk. Adult present for the whole try.
5. Run three to five Science Hours of the named shape (~30–50 minutes each).
6. Add one out-of-home or lab-path try-it when the week needs it — museum one-exhibit systems, park transect, night sky with adult, or a supervised neighbor bench.
7. On Friday: one exit ticket, one diagnostic wrong sticky, and a done-enough check (showable two ways; still holds after a night).

That plan is smaller than “units” and “tests.” It is the honest lesson plan this book promises. Coverage itch is the enemy of looking. One system question and one claim move done well beat three topics with no notebook.

How to open any teaching chapter

Every teaching chapter uses the same eight headings, in this order:

1. **Why this matters**
2. **For the parent: understand it yourself**
3. **How to teach it this week**
4. **Practice that actually builds learning**
5. **For the student**
6. **If it isn't clicking**
7. **Tools, including AI**
8. **What “done enough” looks like**

Read the first two alone, once. Do the five-to-eight-minute parent warm-up with tomorrow's apparatus — a jar, a notebook page, a redesign sticky — before any vocabulary lecture. Then teach from **How to teach it this week** and **Practice that actually builds learning**. Hand the student **For the student** when they sit down. Use **If it isn't clicking** only when the hour stalls. Keep **Tools, including AI** short and point back to the Science Hour AI box. End with **What “done enough” looks like** before you move on. Notes live at the back of the book, not in the teaching voice.

No ninth teaching chapter titled “life of the habit.” The habit lives in the hour rhythm, the Friday check, and the dated notebook.

Placement by skill, not birthday

Inside chapters you will see **15–16** and **17–18**. Those are planning bands, not birthday gates.

If they can name IV and DV, write CER light with a notebook pointer, and catch an obvious confound, start the 15–16 systems-and-denser-CER lane — even if the birthday says seventeen. If they already write denser CER with warrant and limitation, revise a model, and name an alternative, use the 17–18 multi-investigation edges — even if the birthday says fifteen. If they still meld expectation with data, never look at the notebook, or answer only with vocabulary, back up to a simpler lookable and fair-test / CER-light work. A “grade 11 Biology workbook” is a publisher's scope, not a legal grade, and not a transcript line.

What to keep on the table

- A blank dated notebook titled Biology, Chemistry, Physics, Earth Science, Environmental Science, or Science — never a brand, never Emerging Adults Science I.
- Today’s system or question card.
- A RAMP card and goggles when the try needs them.
- A denser CER three-box with a warrant line when claim week is on.
- One talk-box opening from the chapter (locked wording).

What to skip this week

A 180-day worksheet packet. An AP unit as every Friday. A kitchen fizz filed as Chemistry credit. Invented neat rows to “make the graph pretty.” A generated gel or micrograph filed as their result. A model summary sitting as the observation. An unsupervised chatbot as the only partner during the attempt. Unauthorized mixing. A cold public quiz of strangers. Coverage panic that turns the hour into three topics with no notebook. Method-poster theater with apparatus as decoration.

Sister books — one pointer, then teach

Science for Young Minds owns ages 11–14 (fair test with notebook; CER light). *Science for Little Thinkers* owns ages 5–10 (observe before explain). *Science for Homeschooling* owns the grades 1–12 map and transcript architecture. *Critical Thinking, English, History, and Math for Emerging Adults* own their own Hours. Point once if you already use them. Then teach fifteen-to-eighteen science as systems looking and denser CER from *this* notebook.

Records you will need later

Keep the dated investigation notebook: named question, method crumb, data, claim. Add denser CER or a short lab report that points at the notebook. Optional vendor review. Optional AP, CLEP, or dual-enrollment edge. “With Lab” is a claim that needs supervised investigation evidence. Titles a stranger can read are listed in the records chapter. You do not need that chapter finished to begin tomorrow’s hour.

Start with the Science Hour chapter once. Then open Chapter 1.

If you only remember five things

1. **Systems looking and denser CER are the twin spines.** Put a named system on the table — a jar, a body-subsystem card, a reaction you can stop, a change of motion. Leave the hour with a claim that points at *this* notebook, names a warrant (why that measurement counts for *this* idea), and can say what the data cannot tell you. Biology, Chemistry, and Physics are this week's vehicles — not encyclopedia years. AP is an edge, not the weekly spine. Coverage is a map. Depth is the hour.
2. **The student looks, measures, and records first.** You ask one authentic question and wait. Struggle before rescue. Point at the materials, the table, the system diagram, or the notebook — not at the tidy vocabulary list — if the silence is hard. Hearing a wrong reason (force-as-fuel, cells-as-tiny-mouths, a confounded “proof”), then asking a better question, is teaching. Grabbing the answer or filling the silence with the explanation is not.
3. **A stranger-readable notebook is the high-school record.** Question, units, table before graph, uncertainty crumb, claim pointer. Invented neat rows are not data. A generated gel or micrograph is not a result. A model summary is not the observation. Kitchen change-of-matter pictures stay pictures — not Chemistry credit. Drawing alone was for younger bands; CER light was middle grades; raise the warrant and the limitation here.
4. **Safety is ordinary and non-negotiable.** Adult present for heat, chemicals, glass, living specimens, outdoor water, and any kitchen chemistry picture. RAMP before the try: Recognize, Assess, Minimize, Prepare. No unauthorized mixing. Stop is always allowed without penalty. Lab-path neighbors exist when the try needs real glassware. Soft entry on living things: care, return, wash hands; refuse home vertebrate dissection as default; mold cultivation refused by default.

5. **Place by skill, not birthday.** Unaided first on looking, measuring, and recording. The tool is parent-hosted, not a secret friend. COPPA does not bind ages 15–18; you still host and stay in the loop — in the room at 15–16; co-hold with AP and Common App integrity at 17–18. A path through high-school science looking is the promise. A diploma is not. A percentile is not. A culture-war win is not.

Keep these five on a sticky near the notebook. When the week frays, return to them before you reach for another packet.

If you forget everything else, remember this: a named system on the table, a stranger-readable page, a denser claim with a warrant, a RAMP card when heat is coming, and skill-based placement. That is enough to begin tomorrow.

The Science Hour



Figure 2: A kitchen lab table with a RAMP safety card, systems-boundary card, denser CER card, and dated lab notebook — still-life, no people, no logos.

This is the session shape for the whole book. Learn it once. Later chapters point back here in a sentence.

Science Hour is thirty to fifty minutes. It is not a museum field trip every day. It is not a silent “read your AP chapter” hour. It is not activity mania. It is not inventing neat rows to finish a graph. It is a repeating five-beat rhythm: open a system or question; take a short look; try, measure, and record once; talk and build denser CER; exit with a small ticket. The student looks. You ask one good question and wait.

Five beats (~30–50 minutes)

1. Open / system or question on the table (3–7 min).

Name today’s outcome in ordinary words. If this is a systems week, sketch or reveal a system — a jar, a body-subsystem card, a watershed map, a household-safe circuit. If this is a lab or fair-test week, pose a question that could come out otherwise. Run a RAMP check if heat, chemicals, glass, living specimens, outdoor water, or electricity beyond a battery toy are coming. Adult present for the whole try.

2. Short look or prior-idea card (3–8 min).

What do you already think will happen? What does the model leave out? Hold the textbook answer for later. Optional: one labelled secondary figure with an honesty card — *not your data*.

3. One try (15–25 min).

One fair test, one focused observation with measurement, one systems diagram plus one probe, or one denser-CER build from an existing notebook page. One try. Not a packet. Not five cookbook stations. Record in a notebook a stranger could almost read.

4. Talk box + denser CER (5–10 min).

One authentic question about the evidence; wait three to five seconds; uptake to the table or diagram; optional revoice; “what would change the claim?” Build claim + notebook pointer + warrant (because-the-idea). Prompt one limitation or one alternative at 15–16; both at 17–18 when ready.

5. Exit ticket (2–5 min).

Spoken CER crumb, systems boundary plus one flow, “can we tell for sure?” sentence, RAMP hazard named, or one diagnostic-error sticky. Done-enough is “right, or wrong-with-a-reason we can use tomorrow,” not a percentage.

Optional sixth beat for siblings: post-response wait so each speaker is heard. Lab-path days may stretch the try; still end with CER or systems exit.

Band moves inside the hour

15–16. System boundary scaffolded by the adult → short look → try that may include one fair-test repair, one simple measurement table, or one denser CER with two evidence bullets and an explicit warrant → exit as oral CER or labelled diagram. One limitation or alternative prompted. Biology or Chemistry or Physics as *this week's vehicle*. Adult present. AP labelled only.

17–18. More independent system model (what the model leaves out) → try that may include multi-trial comparison, uncertainty talk, or CER with explicit reasoning to a named idea → occasional lab-path neighbor for regulated techniques → exit as short paragraph or annotated graph. Alternative explanations *and* limitations. Integrate evidence across linked trials when the week asks. Occasional FRQ-shaped stretch — still not AP as weekly spine. Still refuse invent-data.

Dose honesty

School science blocks run long with specialists and fume hoods. A parent hour is not a failed block. If a day only holds thirty minutes: RAMP (if needed) + system or question card + one measurement or one CER from yesterday's table + exit ticket. One named move done well beats a rushed medley. Lab-path neighbors are scheduled honesty, not guilt. A second sitting later in the week beats one long sit that frays.

Hour debug table

Symptom	Likely cause	Move
Hour is only worksheets / AP FRQs	Missing look + talk	One real try or notebook page; one oral CER; one wait
Hour is only demos that "show the point"	Record and claim skipped	Learner records; exit ticket claim from <i>their</i> numbers

Symptom	Likely cause	Move
Learner invents numbers to fit the hypothesis	Invent-data fail	Stop; label honesty; redesign or use labelled secondary data
Learner files AI gel / perfect curve as result	Generated-result fail	Label fiction; reopen real photo or skip that try
Learner freezes when asked	Wait-time 1 was zero / question unclear	One clear question; count three
Design confounded; claim still confident	Fair-test rule not taught	Show confound vs fair; “can we tell for sure?”
Kitchen fizz filed as Chemistry credit	Path honesty fail	Label picture; point to lab-path neighbor for credit path
Session becomes AP dump every week	Weekly spine wrong	One system or one claim move; save FRQ for occasional stretch
Materials out, no talk	Facilitation skipped	Pose, wait, point at notebook row
Unsafe mixing / heat without plan	RAMP skipped	Stop; SAFE card; do not continue until minimized
Everything is a “system” with no boundary	SYS slogan without diagram	Draw boundary; name what is outside
Two trials → “prove the textbook”	Confirmation bias	Ask what result would falsify the claim

Talk-box shape (once)

Exact opening question: authentic, about what system we are looking at and what claim the notebook could support before the tidy idea — or what a stranger would need to reconstruct the trial, what changed and what stayed the same and whether we can tell for sure, where the system boundary is and what the model leaves out, what is happening in this living system with notebook evidence, what changed in matter or motion and how we know safely, what they claim with evidence and warrant, what they can show two ways. Not “did you have fun.” Not “what is the AP vocabulary word.”

Each teaching chapter locks one opening. Follow with three to five follow-ups: one for observe (“what do you *see* / *measure*?”); one for record (“what does the notebook / table show?”); one for reason tied to the try (“how do you know from *this*?” / “what is the warrant?”); one for check or alternative (“what else was different / can we tell for sure? / what does the model leave out? / what else could explain these numbers?”); one that lets them revise (“you may change your mind” / “try another look” / “redesign once”).

How to wait. After you ask, a slow three is a convention, not a sacrament (Rowe 1972 elementary *science* wait; Stahl 1994 think-time, labelled classroom-origin). After they stop, wait again. If they are mid-measure or mid-claim, do not cut them off. Look at the materials, the table, the system diagram, or the notebook, not at the adolescent, if the silence is hard. This book owns Rowe as science class — still. This book claims no kitchen wait coefficient.

Stuck silence usually means: the question was vague; wait-time 1 was zero; they are hunting a vocabulary word because you asked name-first; they are guessing what you want; the materials never landed; they offered a book-only guess; they think science means “repeat the parent’s explanation”; they think looking means “say what the screen already told me”; they invent neat rows because the trial was messy; they are bracing for an AP rubric sentence. Pose, wait, and point back at the notebook — do not fill the silence with the right vocabulary, and do not turn the table into a fight.

In-home try-it shape (once)

Every teaching chapter names try-its with **time, materials, safety, the fun, the skill**. At least one try-it lives inside the home: system boundary on a jar; stranger notebook test; confound vs fair side-by-side; denser CER three-box; photosynthesis inputs–outputs picture; change-of-motion card; RAMP card before heat; kitchen picture honesty card labelled *not Chemistry credit*; conservation weighing. Pick one named card per hour from the banks (SAFE, LAB, REC, FAIR, CER, SYS, BIO, CHEM, PHYS, and the rest). Do not assign all eighty.

How to pick this week: choose one spine emphasis (systems looking or lab claim-with-evidence, often both lightly); choose one bank + one ID; one idea per hour; match band 15–16 or 17–18; run RAMP if the card says so; end with the exit ticket; note one diagnostic error.

Out-of-home try-it shape (once)

At least one try-it lives outside unless the chapter is purely definitional — and even then, give a walk-sized instance: museum one-exhibit systems; park or yard transect; stream clarity soft; grocery produce structure–function; night sky with adult; lab-path neighbor bench session. Library, museum, and nature motivate. They do not replace the systems-and-claim move. Lab-path neighbors (community college open lab, supervised co-op, museum bench, field station day) are labelled as neighbors — not as “the kitchen is Chemistry.” Schedule honesty, not guilt.

RAMP / safety spine (once)

ACS RAMP: **Recognize** hazards; **Assess** risks; **Minimize** risks; **Prepare** for emergencies. School ACS / NSTA / Flinn / Roy documents are the **ceiling**, not a DIY license.

Before any try with heat, chemicals, glass, sharp tools, living specimens, outdoor water, or electricity beyond battery toys:

1. Recognize hazards on today’s materials list.
2. Assess who could be harmed and how.
3. Minimize (lowest concentration or volume; substitute; PPE; clear space).
4. Prepare (what if spill / burn / broken glass — adult actions).
5. Decide go / redesign / lab-path neighbor / skip.

Adult present for the entire try. Stop is always allowed without penalty. No unmarked bottles. No bleach mixes. No drain cleaners. No alcohol flames. No sealed pressurized fizz bottles. No lasers in default banks. Living things — no harm, return, wash hands; mold cultivation refused by default; home vertebrate dissection refused as default; dissection optional never required. A vinegar-and-soda fizz is a change picture. It is not a Chemistry credit. Curiosity is not a permit for unauthorized mixing. Regulated chemicals, burners, and electrophoresis belong on a lab-path neighbor, not in a default home bank. If PPE is missing, do not run.

Keep a house RAMP card and a stop-authority phrase where everyone can see them. Walk the emergency mini-map once (extinguisher / water shutoff / adult phone / first-aid) before heat or chemical weeks. Practice the stop phrase on hypothetical cards — never with a live unsafe demo.

AI box for ages 15–18 (once)

The student looks at a real trial, measures, and records what happened. The parent may use a tool. The student does not sit alone with an open chat as the only partner when the parent is co-teacher. Say this box once; later chapters point back in one sentence.

Ages 15–16 (COPPA off; parent still in the room)

Parent co-holds the account. **Still in the room** for Science Hour. Scripts and parent–student talk. **Not** live open chat as the student’s only partner. Unaided first on looking, measuring, and recording. SCRIPT after the try. COPPA’s under-13 line is **behind them** — name that once as why *Science for Young Minds* was stricter at 11–12. The lock is still pedagogical. Turning 15 is not a licence for a secret science friend.

Ages 17–18 (more agency; co-hold; AP / Common App integrity)

Parent co-holds / can audit. Turning 17 or 18 is **not a licence**. Same bans. The student may sit next to the parent while the parent uses a tool. They may hear revision questions after they have drafted a claim or lab report. They may not have an unsupervised companion account as only partner during the attempt. They may not be asked to “prompt the tutor until it agrees.” Unaided first. SCRIPT after the try. **Integrity add-ons:** no AI-generated AP Test submissions (College Board 2026 AP Exam Terms); Common App fraud examples include misrepresenting AI substantive output as one’s own — revision questions after *the student’s* draft remain allowed; “write my Common App essay” / “write my lab report” is the ban.

COPPA does **not bind** ages 15–18. Parent still hosts / stays in the loop.

You may (parent account; after the student has tried, or before for parent prep)

- Explain this idea *to you* from a named lesson (title, page, CED, or today’s apparatus: system jar, notebook page, fair-test redesign, denser CER card).
- Extra isomorphic practice with the answer key held by the parent (a blank observation line, empty data table to fill from a *new* try, FRQ stem, claim–evidence–reasoning card). The student never sees the key.

- A labelled SCRIPT after the try — a short spoken sequence for *you* to say, not a paragraph for the student to copy as their observation or CER.
- Revision questions after a claim or lab-report draft — not a rewrite of the student's lab report.
- A hint after an attempt. A hint is a question or a named idea, not the finished observation or a fake data table.
- Diagnose work the student already produced. You hear the diagnosis and decide. Crop to the paper. Do not upload the student's face.
- Discussion questions you will vet and ask yourself — the student answers you, not the tab.
- A labelled schematic (not a result) to look at together, then put away before the try.

You may not

- Paste the worksheet / blank data table / FRQ packet and ask the tool to complete it (photo-to-key).
- Ask “what's the answer” or “just write what I should have seen” during the student's attempt, or let the student ask that of a window.
- **Invent an observation or a data table** and file it as the student's looking.
- Put a **model summary** on the table as the observation instead of a real trial.
- Generate a gel, micrograph, sky photo, titration curve, or “what I saw under the glass” and treat it as the student's result. **Generated image $\neq$ data.**
- Park an unsupervised chatbot as the student's only partner during the attempt — not at 15, not at 18 — when the parent is co-teacher. No “scientist friend” account.
- Write the student's observation, caption, CER paragraph, Materials–Methods–Results–Discussion, FRQ, or lab report (write-my-lab-report).
- Invent facts (what the mass did, what the temperature measured, whether the magnet stuck). Look.
- Use TTS, narrated rewrite, or a voice-clone toy to **replace looking/measuring** at the trial that is today's lesson.
- Grade the student's work from a detector score.
- Print a certificate of science.
- Hand the student an agent (Hermes Agent, Grok Bot, or any cloud-computer worker) as a science partner.
- Coach live-exam cheating or college-application fraud.

One crutch sentence, labelled, then teach: in a **high-school math** trial, an unguarded chatbot made practice look better and left students worse on the test with the window closed (Bastani et al., 2025). **That is not a 15–18 science RCT. OFF-AGE for science hour.** (*Math for Emerging Adults* may call the same paper ON-AGE for math — keep those labels separate.) The kitchen-table rule it supports: the model may prepare the adult and the next looking page; it may not do the student’s looking, measuring, recording, live exam, or lab report when those are the lesson.

A fluent filled blank from a machine is performance, not the student’s science looking. Keep accounts where the parent can open them. A science tool is not a secret friend.

Names that stay separate: Hermes 4 is not Hermes Agent. Grok is not Grok Bot and is not El Salvador Grok-as-tutor. There is no Grok Bot education SKU. Agents are not chatbots. Detectors fail; do not detector-grade a student’s “the mass went from 12.4 g to 11.1 g.” Fabricated citations are parent-side — if you asked a tool for a paper on fair tests or systems models, open a named Framework PDF or a named curriculum page.

Life of the habit (session rhythm)

Revisit yesterday’s system boundary. Mix last week’s fair test. Name this week’s system. Stop while a look remains. The habit lives here, in Friday’s check, and in the dated notebook — not in a ninth teaching chapter.

This-week plan (honest “lesson plan”)

1. Choose one spine emphasis: systems looking *or* lab claim-with-evidence (often both lightly).
2. Choose one bank + one ID (for example SYS-01, REC-01, FAIR-01, CER-01).
3. Choose one Bio *or* Chem *or* Phys vehicle for the week (or Earth soft).
4. Run RAMP if the card says so; stop if you cannot minimize.
5. Three to five Science Hours of the named shape (~30–50 min).
6. One OUT / lab-path try-it as needed.

7. Friday: exit ticket + one diagnostic error sticky + done-enough (showable two ways, holds after a night).

Not 180 worksheets. Not a percentile. Not AP FRQ as Tuesday.

Open Chapter 1.

Chapter 1 — What science looks like at 15–18

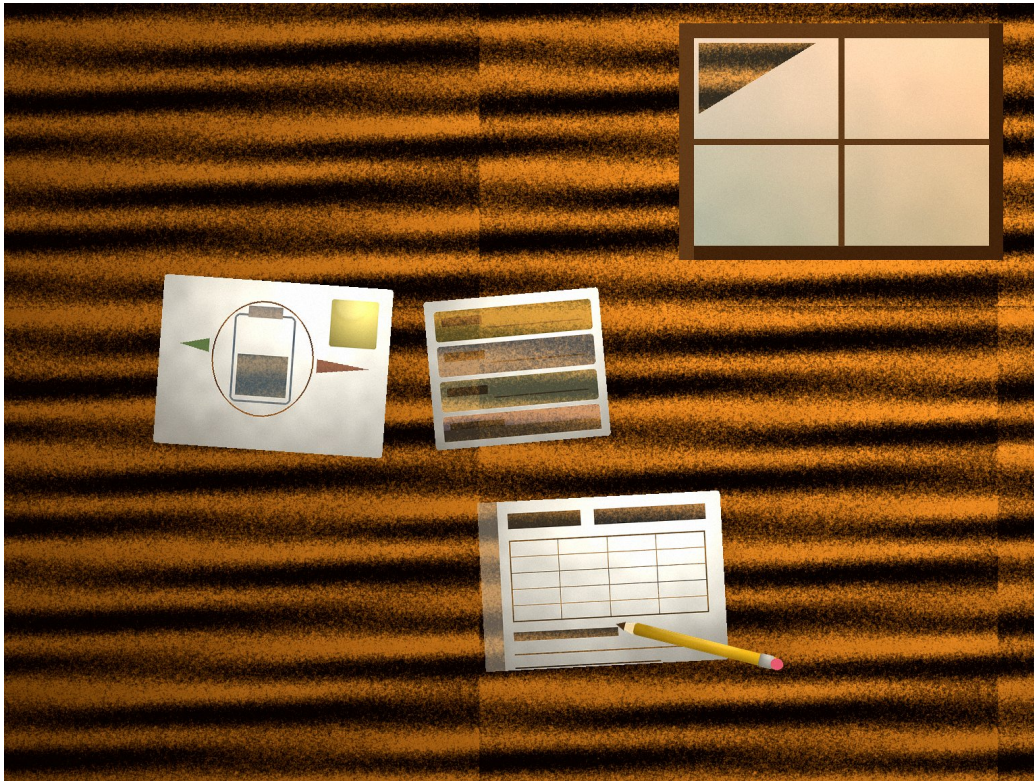


Figure 3: A systems-boundary jar card beside a denser CER card and a dated lab notebook — still-life, no people, no logos.

Why this matters

Fifteen-to-eighteen science is not a laminated method poster on the wall. It is not a coverage march through every vocabulary list in a publisher's scope-and-sequence. It is not an AP unit calendar taped to the fridge as the year's identity. It is twin spines you can practice this week: **systems looking** and **lab claim with evidence** — denser CER with a warrant that ties *this* notebook to a scientific idea, plus a named limitation or alternative.

When those spines hold, an adolescent can put a jar, a body-subsystem card, a reaction you can stop, or a change of motion on the table, look before the tidy explanation, and leave with a claim a stranger could almost follow. Biology, Chemistry, and Physics become this week's vehicles — not encyclopedia years. AP becomes an edge you may choose later, not every Friday's spine.

This chapter ages up from *Science for Young Minds* (fair test with notebook; CER light) without reprinting middle-grade banks. It is not a reprint of *Science for Little Thinkers* or *Science for Homeschooling*. One pointer each, then teach fifteen-to-eighteen looking. Place by skill, not birthday. Coverage is a map. Depth is the hour.

Homeschool families with high-schoolers are not rare. National survey rows put homeschooled students near three percent of K–12, with a high-school band near that same grain — and many of those families still report science as inquiry or as biology / chemistry / physics unevenly across a year. That is context, not a verdict on your table. Your job this week is smaller and more honest: one system on the table, one notebook page, one denser claim crumb.

What unlocks for you this week: hear force-as-fuel and coverage panic without grabbing a unit calendar; name today's system in ordinary words before any vocabulary list. What they try today: draw one boundary and point at one notebook row that could support a claim — before the tidy idea.

For the parent: understand it yourself

Everyday picture. Imagine a closed jar with soil, a seedling, and condensation on the glass. The jar wall is a boundary. Light and water are inputs. Growth and vapor are outputs you can talk about carefully. “What is inside / outside?” is systems looking. “The leaves got bigger because I watered them — see day-1 and

day-7 height in the notebook — because plants use water and light as inputs for growth” is denser CER starting to form: claim, evidence pointer, warrant tied to an idea. Saying “ecosystems are systems” while staring at a vocabulary list is not.

Precise picture. Systems looking means the learner can (1) draw or state a boundary, (2) name parts and interactions inside, (3) name inputs, outputs, and (when relevant) feedback, (4) say what the model leaves out, and (5) ask how a change inside or at the boundary would matter. Framework crosscutting concept “systems and system models” is the map; the Hour owns the diagram and the talk, not a poster quiz.

Lab claim with evidence means a statement about the material world that answers this week’s question; evidence that is numbers, observations, or labelled secondary data the learner did not invent; reasoning that ties evidence to claim through a scientific idea (the warrant); willingness to revise. America’s Lab Report design principles travel here: clear outcomes; thoughtfully sequenced experiences; content and process together; ongoing reflection and discussion — not isolated “lab day” theater. Framework / NGSS 9–12 are a moves map — practices, crosscutting concepts, core ideas — not a franchise to cover and not a statute for your kitchen. Bio → Chem → Physics is not a universal law of sequencing.

Prior ideas are the mind at rest. Force-as-fuel, cells-as-tiny-mouths, plant food only through roots — these do not magically expire at fifteen. Hear them. Repair with another look + a named idea just-in-time. Do not scold. Do not equation-punish.

Wrong answers you should be able to hear (illustrations, not data):

1. **Force-as-fuel / “the push ran out” / “the table doesn’t push.”** Still heard into high school and college. Miss: Newtonian construction is not obvious even after a mechanics course. Repair: another look; revoice; notebook; name change-of-motion lightly.
2. **Cells as tiny mouths / plant food only through roots.** Miss: living systems need inputs–outputs talk with evidence. Repair: systems arrows; mass or observation question; named figure — not an AP dump.
3. **Coverage panic / “we have to finish the unit.”** Miss: depth is the hour; coverage is a map. Repair: one system question this week; park the rest of the list.
4. **Method-poster theater.** Laminated steps with apparatus as decoration. Miss: practices need a real try and talk. Repair: look first; denser CER

from *this* trial.

5. **AP-as-weekly-spine / birthday placement / scientist cosplay.** “They’re fifteen so it must be AP Bio.” Miss: skill, not birthday; AP is edge; looking moves are not an identity costume. Repair: skill check; one system + denser CER this week.

How the twin spines share a week (illustration, not a calendar). Monday: SYS-01 boundary on the phenomenon. Tuesday: LAB-01 outcome sentence and a short look. Wednesday: SAFE-01 if heat is coming Thursday; otherwise clean the notebook page. Thursday: talk box + denser CER crumb. Friday: exit ticket + one diagnostic sticky. OUT-01 once this month. Chemistry pictures stay pictures. AP FRQ, if used at all, is an occasional stretch — not every Thursday.

What “denser CER” adds beyond middle-grade CER light. Claim still answers the question. Evidence still points at locatable notebook rows. Reasoning now names the scientific idea as a warrant — *why those numbers count for this idea*. Then one limitation *or* one alternative at 15–16; both when ready at 17–18. You do not need a full lab report in week one. You do need a claim that could not float free of the page.

America’s Lab Report in kitchen language. Isolated “lab day” with no talk was no better than reading for content mastery in the studies that report reviewed. Units that integrated the try with instruction and discussion did better (often small-scale). Design principles travel: clear outcomes; thoughtful sequence; integrate content with process; ongoing discussion. Implication for your table: the try lives inside the idea and the talk. Refuse isolated lab-day theater. This is a useful study shape, not a promise that every home will see the same result.

Framework / NGSS as a moves map. High-school grain emphasizes scatterplots and covariation when the math band supports it, precision and controls, models, alternative explanations, and limits of the data. Translate to the kitchen: one system question; one fair test or focused observation; one stranger-readable page; one denser CER with warrant and a limitation or alternative; RAMP if needed. Do not import AP unit pacing as the family’s year. Do not assign every performance expectation.

Parent warm-up (5–8 min), alone with tomorrow’s apparatus. Take the jar or body-subsystem card. Draw the boundary. Write one claim a notebook *could* support before any vocabulary list. Practice hearing “we have to finish the unit” without grabbing coverage. Cut denser CER to claim + notebook pointer + because-

the-idea. Stop when you can say today's system in ordinary words.

How to teach it this week

Session shape (~30–50 min). Warm-up looking (jar or card on the table) → materials down → RAMP if a later try needs heat or chemicals (today may be SAFE-01 on paper only) → frame the system or question → short systems probe or LAB-01 outcome sentence → try / measure / record → one authentic question + wait → denser CER crumb → exit ticket.

Exact wording you can say.

- “What system are we looking at — and what claim could this trial's notebook support — before we explain the tidy idea?”
- “Where is the boundary? What is inside? What is outside on purpose?”
- “Point at a row that could support a claim — even if we have not named the tidy idea yet.”
- “What does this model leave out?”
- “You may change your mind when we look again.”

First try-it for the student. SYS-01 Boundary First on a closed jar or a body-subsystem card: draw the boundary; list inside/outside; leave one sticky “what we have not explained yet.” Pair lightly with LAB-01: write the outcome sentence *before* materials. If next week's try involves heat or chemicals, run SAFE-01 RAMP on paper this week and decide go / redesign / lab-path neighbor / skip.

How to fade help. At first, draw the boundary with them. Then ask them to draw; you only point. Then they draw and you ask only the talk-box opening. Stop talking when the pencil is moving and the notebook has a date and a question. Do not narrate the tidy idea while they are still looking.

Age-band moves.

- **15–16:** Scaffold the boundary; one input and one output arrow; denser CER as claim + two notebook bullets + because-the-idea; one limitation *or* alternative prompted; Bio or Chem or Phys as this week's vehicle; adult present; AP labelled only.
- **17–18:** More independent model; name what the model leaves out; integrate one prior page with today's look; alternative *and* limitation when ready;

occasional FRQ-shaped stretch labelled as stretch — still not AP as weekly spine; still refuse invent-data.

Vehicle choice (one this week). Biology vehicle examples: jar seedling as a living system; body-subsystem card (circulatory or respiratory at plain grain — not medical school). Chemistry vehicle examples: properties before names on safe household substances with honesty card *not Chemistry credit*; conservation weighing picture. Physics vehicle examples: change-of-motion card (not force-as-fuel); shadow-length measurement as a rate picture. Pick one vehicle. One vehicle is enough.

Exit ticket shapes for this chapter. (1) Boundary sentence + two outside items. (2) Claim crumb that points at a notebook row + because-the-idea. (3) “Leaves out ____.” (4) Tag: my measurement / labelled secondary / not invent. (5) Diagnostic sticky: force-as-fuel or coverage panic named and repaired with a next look.

When to stop talking. After the authentic question. During the measure. When they are mid-sentence revising a boundary. Fill silence with another look at the jar, not with the chapter summary.

Refuse this week. Method-poster theater; AP pacing as identity; Young Minds bank reprint with longer words; Homeschooling survey dump as this Hour’s TOC; invent-data neat rows; generated gel as result; model summary as the observation; isolated lab-day with no talk; kitchen fizz as Chemistry credit.

Practice that actually builds learning

Talk box

Opening (locked): “What system are we looking at — and what claim could this trial’s notebook support — before we explain the tidy idea?”

Follow-ups: 1. Observe: “What do you *see* at the boundary — what is inside, what is outside?” 2. Record: “What does the notebook page show that a stranger could use?” 3. Reason: “How do you know from *this* page — what warrant ties that row to an idea?” 4. Check / alternative: “What does this model leave out? What else could explain what we see?” 5. Revise: “You may change your mind — try another look or redraw the boundary once.”

How to wait. Pose. Count three to five silently. Look at the jar or the notebook,

not at their face, if the silence is hard. After they speak, wait again before evaluating. Revoice without stealing: “So you’re saying the jar wall is the boundary and condensation is inside — is that what your diagram shows?” This book owns Rowe as science class — still. This book claims no kitchen wait coefficient.

Stuck silence usually means: the question was vague; wait-time 1 was zero; they are hunting a vocabulary word because you asked name-first; they are guessing what you want; the materials never landed; they offered a book-only guess; they think science means “repeat the parent’s explanation”; they think looking means “say what the screen already told me”; they invent neat rows because the trial was messy; they are bracing for an AP rubric sentence. Pose, wait, and point back at the notebook — do not fill the silence with the right vocabulary, and do not turn the table into a fight.

In-home try-its

SAFE-01 RAMP Card Before Any Heat or Chemical

- **Time:** 20–35 min (may precede a paired try another day)
- **Materials:** RAMP card template; today’s planned materials list; goggles if a later try needs them
- **Safety:** This is the RAMP practice. Adult present. No unauthorized mixing.
- **The fun:** Decide go / redesign / lab-path neighbor / skip — real authority.
- **The skill:** Four RAMP lines filled for *this* plan; go/redesign/skip circled.
- **Steps:** (1) Recognize hazards on the list. (2) Assess who could be harmed and how. (3) Minimize (lowest volume; substitute; PPE; clear space). (4) Prepare (spill / burn / glass — adult actions). (5) Decide go / redesign / lab-path neighbor / skip.
- **Error patterns:** Skipping to “we’ll be careful”; treating ACS as permission for garage chemistry; learner alone with heat.

SAFE-02 Stop Authority Drill

- **Time:** 15–25 min
- **Materials:** Two hypothetical unsafe scenario cards (labelled hypothetical); stop-phrases card
- **Safety:** Verbal rehearsal only; no live unsafe demo.
- **The fun:** Practicing “stop” without penalty.
- **The skill:** “I stop when . ***The hazard was .***”
- **Steps:** Read scenario; learner says stop and names the hazard; adult confirms stop is always allowed.

- **Error patterns:** Treating stop as failure; adult pressure to finish the “cool” demo.

LAB-01 Clear Outcome Before Materials

- **Time:** 30–45 min
- **Materials:** Outcome card (“By the end I can ____ using evidence from ____”); materials for a short try OR yesterday’s leftover setup
- **Safety:** Per materials; default no heat.
- **The fun:** Outcome first feels like a secret adult move.
- **The skill:** Outcome sentence + one evidence row cited.
- **Steps:** Write outcome first; only then set materials; run short try or analyze prior data; check outcome met or revise tomorrow.
- **Error patterns:** Pulling materials first; vague “learn about photosynthesis.”

LAB-05 Sequence Idea–Try–Talk

- **Time:** 35–50 min
- **Materials:** Three sticky sequence cards; short household-safe phenomenon (ice melt rates, shadow length, battery brightness)
- **Safety:** Household-safe only.
- **The fun:** Catching the urge to explain first.
- **The skill:** “We looked before naming ____.”
- **Steps:** Order the hour as idea crumb → try → talk; deliberately avoid “talk first dumping the answer”; record; exit.
- **Error patterns:** Explanation swallow before looking; try with no talk.

SYS-01 Boundary First

- **Time:** 30–45 min
- **Materials:** Phenomenon (jar garden, aquarium photo, house HVAC vent, watershed map print); blank paper
- **Safety:** Observation only unless a paired try is approved.
- **The fun:** Argue about what counts as “inside.”
- **The skill:** Boundary sentence + two outside items.
- **Steps:** Draw boundary; list inside/outside; revise after talk; refuse “the universe” as default boundary.
- **Error patterns:** No line drawn; everything inside.

Prior-idea card (force-as-fuel or cells-as-tiny-mouths)

- **Time:** 15–25 min
- **Materials:** One prior-idea card; blank notebook page; no scolding script
- **Safety:** None.
- **The fun:** Naming a wrong idea without shame.

- **The skill:** Hear → another look → named idea just-in-time.
- **Steps:** Student writes what they think will happen / how the system works; look; revise sticky; parent does not equation-punish.
- **Error patterns:** Scolding; dumping the tidy idea before the look.

Out-of-home try-its

OUT-01 Museum One-Exhibit Systems

- **Time:** 45–90 min outing (plus travel)
- **Materials:** Notebook; pencil; one-exhibit rule card
- **Safety:** Adult present; museum rules; no touching restricted objects.
- **The fun:** One exhibit deep beats a hallway sprint.
- **The skill:** Boundary + one flow + one “leaves out” sticky from a real exhibit.
- **Steps:** Choose one exhibit; sketch system boundary; name one input/output or interaction; write one claim the exhibit’s evidence could support; honesty card if using secondary labels — *not your measurement*.
- **Error patterns:** Ten exhibits, zero notebook; copying wall text as “my looking.”

Library journal peek soft

- **Time:** 30–45 min
- **Materials:** Library card; one journal article or textbook figure; honesty card
- **Safety:** None.
- **The fun:** Feeling like a researcher with an honesty label.
- **The skill:** Label secondary data; refuse filing it as “my trial.”
- **Steps:** Find one figure; copy title and date; write “secondary — not my data”; one question the figure raises for a future home try.

OUT-02 Park / Yard Transect soft

- **Time:** 40–60 min
- **Materials:** Notebook; meter tape or step count; transect card
- **Safety:** Adult present outdoors; no protected-species collecting; wash hands.
- **The fun:** A straight line that turns a yard into a dataset.
- **The skill:** Boundary of the transect strip + one countable observation with units.
- **Steps:** Mark a short transect; count one named feature (plant type, insect sighting soft); sketch system of the strip; one claim pointer.
- **Error patterns:** Wandering with no notebook; collecting without return plan.

How banks work this week. Banks are reusable try-its, not a 180-day script. Pick one named activity per Science Hour (sometimes a talk or write card paired lightly

with SYS/CER). Match band. Run RAMP if the card says so. End with the exit ticket; note one diagnostic error. Global refuses for every bank: 180-day dump; worksheet packets as the program; invent-data; generated gel/results as student data; AI observation log filed as looking; AP FRQ / AP lab as the weekly spine; kitchen fizz as Chemistry credit; unauthorized mixing; cookbook-only with no talk; activity mania; cold public quiz of strangers; Little Thinkers / Young Minds activity reprints with longer words; Homeschooling chapter dumps as the Hour.

LAB-02 Cookbook vs Integrated Contrast (paper first). Time 35–50 min. Materials: one short cookbook-style procedure card; same question rewritten as frame → design choice → measure → argue. Steps: do *not* run an unsafe cookbook; on paper mark where cookbook hides the question; rewrite one step as a design choice; run the redesigned light try if safe. Error patterns: declaring all procedures evil; skipping safety steps labelled as “cookbook.” Exit: “Cookbook hid . ***Our re-design asks*** .” Safety: paper contrast first; try only if minimized. This card teaches America’s Lab Report grain without pretending your kitchen is a secondary lab.

LAB-04 Data Drawn from the Material World (preview for ch02). Time 30–45 min. Materials: honesty card; one real measurement; one labelled secondary public data snippet. Steps: sort my measurement / labelled secondary / forbidden invent / forbidden generated gel; file only allowed types. Exit: tag today’s data type in notebook margin. Use lightly here so chapter 2 can deepen stranger-readable records.

SYS-04 What the Model Leaves Out (soft). Time 30–45 min. Materials: simple model (food-web card or jar diagram). Steps: list three omissions; ask which omission would change a prediction; revise model note. Exit: “Leaves out, ***which matters if*** .” Error patterns: treating model as the thing; mocking models as “just lies.” Pair after SYS-01 once the boundary exists.

SYS-02 Inputs and Outputs Arrows

- **Band:** both
- **Time:** 30–45 min
- **Materials:** System diagram from SYS-01 or new; arrow stickies
- **Safety:** None if diagram-only
- **The fun:** Arrows make the system feel alive.
- **The skill:** Two labelled arrows (energy or matter) with direction.
- **Steps:** Add energy/matter arrows; label direction; ask what is conserved vs transformed in plain words; honesty about limits of the model.

- **Error patterns:** Arrows with no labels; perpetual-motion vibes; skipping the boundary first.

LAB-02 Cookbook vs Integrated Contrast (paper first)

- **Band:** both
- **Time:** 35–50 min
- **Materials:** One short cookbook-style procedure card; same question rewritten as frame → design choice → measure → argue
- **Safety:** Paper contrast first; try only if minimized
- **The fun:** Spotting where the cookbook hid the question.
- **The skill:** “Cookbook hid . *Our redesign asks* .”
- **Steps:** Do *not* run an unsafe cookbook. On paper: mark where cookbook hides the question; rewrite one step as a design choice; run the redesigned light try if safe.
- **Error patterns:** Declaring all procedures evil; skipping safety steps labelled as “cookbook.”

TALK-01 One Question, Three Seconds

- **Band:** both
- **Time:** 15–25 min
- **Materials:** Today’s notebook page; timer optional
- **Safety:** None
- **The fun:** Practicing silence as a tool.
- **The skill:** Parent poses one authentic question; waits three to five; student answers from the page.
- **Steps:** Pose locked talk-box opening; wait; revoice without stealing; point at notebook.
- **Error patterns:** Filling silence with the tidy idea; asking three questions at once.

A sample week (illustration, not a mandate)

Monday SYS-01. Tuesday LAB-01 + short look. Wednesday SAFE-01 if Thursday needs heat, else clean the notebook. Thursday talk box + denser CER crumb. Friday exit ticket + diagnostic sticky (force-as-fuel or coverage panic). OUT-01 once this month. One Bio *or* Chem *or* Phys vehicle all week. That is enough.

Diagnostic wrongs for the fridge sticky

1. Force-as-fuel jab → another look + change-of-motion card.
2. Coverage panic → one system question sticky.
3. Method-poster theater → look first, denser CER from this trial.
4. Invent neat rows → stop; honesty label; redesign.
5. Chatbot CER with no trial → close the window; open the notebook.
6. Kitchen fizz as Chemistry credit → honesty card; lab-path neighbor for credit path.
7. AP packet as every Friday → one system or one claim move; FRQ occasional only.

Blocked / mixed / incorrect example

Blocked (new move): Only SYS-01 + talk box — boundary before vocabulary.

Mixed (when to use it): Pair SYS-01 with LAB-01 outcome sentence the same week; add SAFE-01 before any heat week; add OUT-01 once this month.

Incorrect example to diagnose: Parent narrates the photosynthesis chapter for twenty minutes, then asks for a CER with no apparatus and no notebook row. Miss: look before tidy idea; denser CER needs locatable evidence. Repair: flip order; jar or leaf on the table; claim points at a row. Neighbor wrongs: inventing neat growth numbers because “the plant should have grown”; filing a chatbot paragraph as the observation; treating a vinegar-and-soda fizz as Chemistry credit; running AP FRQs every Friday as the Hour’s identity.

For the student

Science at your age is looking at a **system** and making a **claim from a notebook** — not memorizing a poster called “the scientific method,” and not racing every chapter by Friday.

A system has a boundary. Inside the jar: soil, seedling, air, water vapor. Outside:

the room, the lamp, your hand. Inputs cross the boundary (light, water you add). Outputs or changes show up (condensation, height). The model always leaves something out. Naming what it leaves out is part of the work.

A denser claim sounds like: *I claim . **My evidence is row / measurement** . This counts because ____ (the idea). This dataset cannot tell us ____ / another explanation could be ____.*

Tiny worked example. Jar wall drawn. Sticky: “outside = room air, lamp.” Notebook: Day 1 height 4.2 cm; Day 7 height 5.1 cm. Claim crumb: “The seedling grew taller over six days — see Day 1 and Day 7 — consistent with water and light as inputs for growth.” Limitation: “We did not measure CO₂.” Alternative: “Maybe the lamp also warmed the soil — we did not separate light from heat.”

Try 1. Draw a system boundary on a jar or a body-subsystem card. List two things inside and two outside. Leave one sticky: “what we have not explained yet.”

Try 2. Write one claim a stranger could check against your page — before anyone explains the tidy idea. Point at the exact row.

Explain it back. Tell someone: what is the boundary, which notebook row could support a claim, and what does your model leave out?

Challenge. Redesign once: change one input at the boundary and predict what you would measure — then, if safe and approved, try it and revise.

Two bands, same respect. At 15–16, you may need a scaffolded boundary and a prompted limitation *or* alternative — that is normal, not “behind.” At 17–18, you may revise a model against data, name alternative *and* limitation, and integrate two linked trials — that is growth, not a licence to skip the notebook. Either way, the adult is still present for heat, chemicals, glass, living specimens, and outdoor water. Turning seventeen does not unlock unsupervised mixing.

What this is not. This is not “you are a scientist now.” This is not a culture-war pamphlet hour. This is not a kitchen fizz filed as Chemistry with Lab. This is not a chatbot CER with no trial. This is looking at a named system and claiming from *this* notebook.

You are allowed to wait. You are allowed to change your mind when you look again. You are not required to sound like a textbook on the first try. You are not a “scientist” because someone bought a binder. You *are* someone who can look, measure, record, and claim from *this* page.

If it isn't clicking

1. They draw no boundary / everything is “the universe.”

Next move: Hand a physical jar. Ask only “finger on the wall — inside or outside?” Fade to paper after the finger works. If they still freeze, you draw once while they name inside/outside aloud; then trade roles next day.

2. They recite vocabulary with no notebook pointer.

Next move: Cover the textbook. Ask for one row. If there is no row, run a five-minute look and write one number before any claim. Praise the pointer, not the fancy word.

3. Coverage panic (yours or theirs) swallows the hour.

Next move: Write this week's one system question on a sticky. Park the unit list in a folder. One question done well beats three topics with no looking. If AP anxiety is driving the panic, label AP as edge and return to the jar.

Slow down when expectation still melds with data, or when invent-data neat rows appear — stop and redesign rather than “fixing” the table. Go ahead when they can draw a boundary and point at a row without prompting. Get a human tutor when anxiety or a long stall makes every hour a fight — no shame. Correct a wrong reason (“the push ran out”) with another look + a named idea, without crushing the look. “Never correct the adolescent” is not this book's rule.

If the hour collapses into lecture. Stop. Put the jar back on the table. Ask the locked talk-box opening. Wait. Point at the notebook. Resume looking.

If siblings share the hour. Give each a sticky boundary or a row to own. Use Stahl's post-response wait so each speaker is heard. Do not turn the table into a competition for the “right” vocabulary word.

If you feel rusty on vocabulary. You do not need the full glossary this week. You need to name the system in ordinary words, hear force-as-fuel, and ask where the notebook points. Vocabulary arrives just-in-time after the look.

Tools, including AI

Optional helpers for you, the adult. Keep this short. Point back to the Science Hour AI box.

You may ask a tool, on your account, to explain systems and system models *to you* from a named Framework page or today’s jar card; to draft a blank boundary worksheet with the key held by you; to give you a labelled SCRIPT after the try; to suggest revision questions after *their* claim draft. Unaided first on looking and recording. SCRIPT after the try.

You may not invent an observation, paste a model summary as the observation, generate a gel or micrograph as their result, write their CER, or park an unsupervised chatbot as their only partner during the attempt. COPPA does not bind ages 15–18; you still host — in the room at 15–16; co-hold with integrity at 17–18. Bastani is OFF-AGE for science hour — one caution in the Science Hour chapter.

What “done enough” looks like

Before you move on:

- ☐ Student can draw or state a system boundary on a real object and name two outside items.
- ☐ Notebook has a dated page with a question and at least one measurement or observation a stranger could find.
- ☐ Student can say a claim crumb that points at that page, with a because-the-idea warrant (even if short).
- ☐ One limitation *or* alternative prompted (15–16); both when ready (17–18).
- ☐ Parent can hear force-as-fuel / coverage panic / method-poster theater without grabbing the wrong rescue.
- ☐ This week used Bio *or* Chem *or* Phys as a vehicle — not a survey dump.
- ☐ Placement by skill, not birthday. A “grade 11 Biology workbook” is a publisher’s scope, not a legal grade, and not a transcript line.

Done enough is showable two ways and still holds after a night. Not a percentile. Not Emerging Adults Science I. Revisit next Tuesday’s boundary sticky; mix last week’s look if needed — the habit lives in the Hour rhythm, not in a ninth teaching chapter.

Chapter 2 — Lab notebooks and stranger-readable data



Figure 4: An open stranger-readable lab notebook with blank data table, uncertainty crumb, and pencil — still-life, no people, no logos.

Why this matters

High-school science looking dies when the record cannot travel. A stranger — an evaluator, a co-op teacher, future-you next Tuesday — should reconstruct the trial without watching it: question, materials, procedure crumb, table with units, uncertainty crumb, claim pointer. That is the high-school record. Drawing alone was for younger bands. CER light with a notebook pointer was middle grades. Here you raise stranger-reconstruct and uncertainty, and you refuse invent-data neat rows, adult-filled tables, and generated “perfect” logs.

When the notebook can travel, denser CER has somewhere to point. Systems looking has a dated page. “With Lab” on a later transcript becomes a claim you can defend with supervised investigation evidence — not a vinegar volcano sticker. Biology / Chemistry / Physics titles a stranger can read live *inside* the notebook header, never as a brand and never as Emerging Adults Science I.

This chapter ages up from *Science for Young Minds* table→graph→sentence without reprinting middle banks. One pointer, then teach. Place by skill, not birthday. Neatness is not honesty. Honesty is the science.

What unlocks for you this week: stop filling the table for them; ask the stranger question; smell invented neat rows. What they try today: rewrite one messy page so a stranger could follow — without inventing numbers.

For the parent: understand it yourself

Everyday picture. Hand last week’s notebook to a neighbor with the apparatus covered. Can they tell what question was asked, what was measured, in what units, and what claim was attempted? If they cannot, the page is a private diary, not a high-school science record. Fix the page — prettier invented numbers are not the fix.

Precise picture. America’s Lab Report defines laboratory experiences as interactions with the material world — or with data drawn from the material world. Fake teacher sets do not count. Framework high-school record densening includes tables, scatterplots when ready, and precision talk. Kitchen translation: table before graph; units; operational definitions; uncertainty crumb in plain language; photo of *this* setup as context (not a stock photo, not an AI bench). Generated gel $\neq$ data. Model summary $\neq$ observation. Invented neat rows $\neq$ student’s data.

Wrong answers you should be able to hear (illustrations, not data):

1. **Adult-filled table / “I’ll just write it neatly for you.”** Miss: the record is theirs. Repair: they write; you ask the stranger question.
2. **Invent-data neat rows / “make the graph pretty.”** Miss: honesty over aesthetics. Repair: stop; label honesty; redesign or use labelled secondary data.
3. **Graph first from memory / phantom points.** Miss: table before graph. Repair: every plotted point appears in a row.
4. **Generated gel / perfect curve / AI observation log filed as looking.** Miss: generated image $\neq$ data. Repair: label fiction; reopen real photo or skip that try.
5. **Aesthetic bullet journal with no data / family code words only.** Miss: stranger reconstruct. Repair: date, question, units, variable names a stranger could read.
6. **Kitchen fizz notebook filed as Chemistry with Lab.** Miss: picture $\neq$ credit. Repair: honesty card; lab-path neighbor for credit path.

Parent warm-up (5–8 min). Take last week’s notebook. Cover the apparatus. Can you reconstruct the trial from the page alone? Note missing units, missing question, neat rows that smell invented. Practice the sentence: “What would a stranger need in your notebook to reconstruct this trial without watching it?” Cut denser CER to claim + notebook pointer + because-the-idea — the pointer only works if the page can be found.

Why stranger-readable beats neat. A portfolio that looks magazine-perfect with blank tables behind it fails the high-school test. An evaluator who asks “what did you measure?” needs a row, not a vibe. NCAA “with lab if offered,” dual-enrollment lab claims, and co-op lab credit all assume a record that can travel. You do not need professional lab-notebook culture in week one. You do need date, question, units, and honest numbers.

America’s Lab Report honesty card (say once). Laboratory experiences interact with the material world — or with data drawn from it. Fake teacher data sets do not count. Kitchen translation: my measurement and labelled secondary are allowed; invent and generated “results” are not. This is a useful study shape, not a promise that every home will see the same result.

Framework densening without a stats course. High-school grain includes tables, scatterplots when the math band supports it, and precision talk. At 15–16,

table + units + “about” language is enough. At 17–18, repeated measures and range talk densify — still not a statistics course. Algebra sits beside physics ideas when ready; it is not a wall that ends the notebook.

Wrong answer seven: “We already know what should happen, so the numbers can wait.” Miss: look and record first. Repair: blank table before the tidy idea; fill from the try; revise the claim if needed.

Wrong answer eight: “The AI lab partner filled my table while I watched a video.” Miss: unaided first on measuring and recording. Repair: close the window; run a short try; student writes the rows.

Composite illustration (labelled illustration, not a reported family). A seventeen-year-old graphs five neat points for “enzyme rate.” The table page is blank. They shrug: “I remembered.” That is invent-data theater. Repair: new short try, table first, graph only from rows, uncertainty crumb from repeats. A sixteen-year-old’s page is messy but dated, with units and a crossed-out claim replaced by a better one pointing at row 3. That is high-school looking.

What you are learning this week as the adult. Stop filling the table. Ask the stranger question and wait. Smell invent-data. Tag data types. Keep kitchen pictures labelled as pictures. Point denser CER at a locatable row. That fluency is enough to teach tomorrow without a lab-methods course.

How to teach it this week

Session shape. Warm-up: stranger test on yesterday’s page → materials for today’s short measurement try → RAMP if needed → frame the question → measure / record with units → table before any graph → talk box → denser CER crumb pointing at a locatable row → exit ticket (repaired header or “every plotted point appears in row ____”).

Exact wording you can say.

- “What would a stranger need in your notebook to reconstruct this trial without watching it?”
- “Where are the units? Where is the question? Where is the date?”
- “Show me the row — not the memory of the row.”
- “Is this your measurement, labelled secondary data, or something we must not file?”

- “You may rewrite the page. You may not invent numbers.”

First try-it. REC-01 Stranger Notebook Test: hand yesterday’s notes to parent or sibling as “stranger”; mark missing units, dates, variable names; rewrite one page without inventing numbers.

How to fade help. At first, sit beside and point at missing units. Then ask only the stranger question. Then leave them alone with a stranger checklist sticky for five minutes. Stop filling cells for them. If the trial was messy, the page should look honest — not magazine-neat.

Age-band moves.

- **15–16:** Scaffold headers (date, question, units); table before graph; operational definition rewrite of fuzzy words (“growth” → “height in cm”); denser CER pointer to a row; uncertainty crumb introduced in plain language (“about ____ / range ____ to ____”); adult present; photo of setup optional.
- **17–18:** More independent stranger repair; repeated measures + spread talk; captioned figure; methods crumb another could repeat; integrate two trials on one claim when ready; still refuse invent-data; still refuse generated results; occasional FRQ-shaped data table stretch labelled as stretch.

When to stop talking. After the stranger question. While they rewrite. When they are mid-count of a measurement. Do not narrate the “right” table into existence.

Refuse this week. Adult-filled tables; invent-data; generated perfect logs; model summary as observation; kitchen-as-chem-credit notebook theater; Young Minds reprint of table→graph scripts as this chapter’s whole identity; professional lab-notebook culture as week-one identity cosplay.

Practice that actually builds learning

Talk box

Opening (locked): “What would a stranger need in your notebook to reconstruct this trial without watching it?”

Follow-ups: 1. Observe: “What do you *measure* — not what you expected?” 2. Record: “What does the table show — with units?” 3. Reason: “Which row supports the claim — and why would that measurement count for this idea?” 4. Check

/ alternative: “Is anything missing that a stranger would need? Could another explanation fit these numbers?” 5. Revise: “Rewrite one page without inventing numbers — you may change your mind about the claim.”

How to wait. Pose the stranger question. Count three to five. Look at the notebook, not at their face. After they speak, wait again. Revoice: “So a stranger would need the units on column B and the date at the top — is that what you’re fixing?” Stuck silence usually means: the question was vague; wait-time was zero; they are hunting a vocabulary word; they think neatness is the goal; they invent rows because the trial was messy; they are bracing for an AP rubric sentence; the materials never landed. Pose, wait, point at the page.

In-home try-its

REC-01 Stranger Notebook Test

- **Time:** 25–40 min
- **Materials:** Yesterday’s notes; sticky “Could a stranger tell what we did?”
- **Safety:** None.
- **The fun:** Parent or sibling plays stranger with apparatus covered.
- **The skill:** One repaired header (date, question, units).
- **Steps:** Stranger reads; marks missing units, dates, variable names; writer rewrites one page; no inventing numbers.
- **Error patterns:** Aesthetic bullet journal with no data; code words only the family knows; adult rewrites for them.

REC-02 Table Before Graph

- **Time:** 30–45 min
- **Materials:** Raw numbers from a try; blank table; blank graph
- **Safety:** None.
- **The fun:** Catching phantom points.
- **The skill:** “Every plotted point appears in row ____.”
- **Steps:** Build table with IV/DV headers and units; plot; check graph cannot invent points not in table.
- **Error patterns:** Graph first from memory; phantom points; changing measure mid-table silently.

REC-03 Uncertainty Crumb

- **Time:** 30–45 min
- **Band:** introduce 15–16; emphasize 17–18

- **Materials:** Repeated measurements of same quantity; rough range or $\pm$ talk
- **Safety:** Per measurement tool.
- **The fun:** Permission to say “about.”
- **The skill:** “About ____ (range ____ to ____).”
- **Steps:** Three quick repeats; report central value + spread in plain language; refuse false precision; refuse inventing $\pm$ to look advanced.
- **Error patterns:** Single measurement treated as exact truth; inventing $\pm$ decoration.

REC-04 Photo of Setup Is Data Context

- **Time:** 20–35 min
- **Materials:** Phone photo of *this* setup (not an AI image); notebook paste or link note
- **Safety:** No photos that compromise privacy of others without consent.
- **The fun:** Caption like a real methods figure.
- **The skill:** Caption: device + what varied.
- **Steps:** Photo; label IV/DV in caption; refuse stock photo or generated lab bench as your setup.
- **Error patterns:** Generated lab bench image; unrelated internet photo; photo replacing numbers.

REC-05 Units and Operational Definition

- **Time:** 25–40 min
- **Materials:** Fuzzy word card (“growth,” “better,” “stronger”) + rewrite as measurable
- **Safety:** Per plan.
- **The fun:** Turning vague words into measurable ones.
- **The skill:** Operational DV sentence.
- **Steps:** Replace fuzzy DV with operational measure; run or plan one trial; keep measure stable across rows.
- **Error patterns:** Keeping “better” as DV; changing measure mid-table silently.

LAB-04 Data Drawn from the Material World

- **Time:** 30–45 min
- **Materials:** Honesty card (interact with material world or data drawn from it; fake sets do not count); one real measurement; one labelled secondary public data snippet
- **Safety:** None beyond paired measurement.
- **The fun:** Sorting allowed vs forbidden data types.

- **The skill:** Tag today's data type in notebook margin.
- **Steps:** Sort: my measurement / labelled secondary / forbidden invent / forbidden generated gel; file only allowed types.
- **Error patterns:** Filing chatbot numbers; "close enough" invented points; generated curve as result.

WRITE-01 Captioned Figure soft

- **Time:** 25–40 min
- **Materials:** One table or graph from this week; caption card
- **Safety:** None.
- **The fun:** Caption that could travel.
- **The skill:** Caption names what was measured and what varied.
- **Steps:** Write caption; check stranger test; revise once.
- **Error patterns:** Caption that restates the claim with no method crumb.

Out-of-home try-its

REC-04 + OUT-02 Park / Yard Transect

- **Time:** 40–70 min outing
- **Materials:** Notebook; meter tape or step count; phone for setup photo; transect card
- **Safety:** Adult present outdoors; no protected-species collecting; wash hands; photo privacy.
- **The fun:** A straight line that becomes a table.
- **The skill:** Photo as context + table with units; photo does not replace numbers.
- **Steps:** Mark transect; measure one named feature with units; photo of setup; table before any graph; stranger sticky at end.
- **Error patterns:** Photos with no numbers; inventing counts to fill a pretty table; wandering with no question.

Museum data-card soft

- **Time:** 45–75 min outing
- **Materials:** Notebook; honesty card for secondary labels
- **Safety:** Adult present; museum rules.
- **The fun:** Copying a museum data display as labelled secondary.
- **The skill:** Tag "secondary — not my measurement"; one question for a future home try.
- **Steps:** Choose one exhibit with quantitative display; copy with source label; refuse filing as own trial.

- **Error patterns:** Copying wall text as personal data.

Library methods crumb

- **Time:** 30–45 min
- **Materials:** One methods paragraph from a textbook or open educational resource; rewrite card
- **Safety:** None.
- **The fun:** Rewriting so another teen could almost repeat.
- **The skill:** Methods crumb another could repeat — without inventing results.
- **Steps:** Read methods; rewrite in kitchen-safe language if possible; list what a home cannot do and would need a lab-path neighbor for.
- **Error patterns:** Inventing results while rewriting methods.

WRITE-03 Methods Crumb Another Could Repeat

- **Band:** both (emphasize 17–18)
- **Time:** 25–40 min
- **Materials:** Yesterday’s try; methods crumb card
- **Safety:** None if writing-only
- **The fun:** Writing so another teen could almost repeat the try.
- **The skill:** Methods crumb another could follow — without inventing results.
- **Steps:** Rewrite procedure in ordinary words; list tools and units; name what a home cannot do and would need a lab-path neighbor for.
- **Error patterns:** Inventing results while rewriting methods; copying a textbook methods paragraph as if it were theirs.

WRITE-05 Error Analysis Soft

- **Band:** 17–18 (introduce 15–16)
- **Time:** 25–40 min
- **Materials:** Two trials with real variation; error sticky
- **Safety:** Per prior try
- **The fun:** Naming “why the numbers moved” without self-blame.
- **The skill:** One ambiguity source + one next design fix.
- **Steps:** Compare trials; name measurement error sources; refuse “bad student” story; refuse inventing a third trial to “clean” results.
- **Error patterns:** Averaging away without discussion; inventing points to tighten the cluster.

AS-04 Invent-Data Refusal Card

- **Band:** both
- **Time:** 20–30 min
- **Materials:** Two sample tables (one honest messy; one suspiciously neat); refusal card
- **Safety:** None
- **The fun:** Detective work on fake neatness.
- **The skill:** Refuse invent-data; say why.
- **Steps:** Compare tables; mark signs of invent (perfect integers, no variation, graph points with no rows); practice the sentence “We stop and redesign rather than invent.”
- **Error patterns:** Praising neatness over honesty; shame spiral that kills the next look.

AS-05 Generated Result Refusal Card

- **Band:** both
- **Time:** 20–30 min
- **Materials:** Sample “gel” or perfect curve labelled fiction; real photo of a home setup
- **Safety:** None
- **The fun:** Spotting the fake result image.
- **The skill:** Generated image $\neq$ data.
- **Steps:** Sort fiction vs real setup photo; label fiction; practice “we reopen a real photo or skip that try.”
- **Error patterns:** Filing AI image as result; treating detectors as judges of a student’s mass reading.

A sample week (illustration)

Monday REC-01 stranger test on last week’s page. Tuesday short measurement try + REC-02 table before graph. Wednesday REC-05 operational definition if fuzzy words appear. Thursday talk box + denser CER pointing at a row. Friday AS-04 or AS-05 refusal card + exit ticket. Once this month: REC-04 + OUT-02 park transect. Lab-path neighbor only if a credit path truly needs glassware — schedule honesty, not guilt.

Parent phrases that help

- “Show me the row.”

- “Where are the units?”
- “You may rewrite. You may not invent.”
- “Is this your measurement or labelled secondary?”
- “What would a stranger still need?”

Parent phrases that hurt

- “I’ll just neat it up for the portfolio.”
- “Make the graph look right.”
- “Ask the chatbot what the numbers should be.”
- “Paste the model summary as what you saw.”
- “We need Chemistry with Lab on the transcript — file the kitchen fizz.”

Blocked / mixed / incorrect example

Blocked (new move): REC-01 only — stranger test + rewrite one page.

Mixed: Same week pair REC-01 with REC-02; add REC-05 when fuzzy DVs appear; add LAB-04 when invent-data temptation appears; add REC-04 + OUT-02 once this month.

Incorrect example to diagnose: Student’s graph shows five neat points; the table is blank; they say “I remembered the numbers.” Miss: table before graph; invent-data. Repair: rebuild table from a new try or label honesty and redesign. Neighbor wrongs: parent rewrites the table “so it’s neat for the portfolio”; chatbot fills a blank data table; generated gel taped into the notebook; kitchen fizz log titled “Chemistry with Lab”; model summary pasted as “what I observed.”

For the student

Your notebook is not only a diary. It is a record a stranger should almost reconstruct without watching the trial.

A stranger-readable page usually has: date; question; materials crumb; what you did (enough that another person could try); a table with units; what you claim — pointing at a row; what you are unsure of. Fancy handwriting is optional. Invented neat numbers are not allowed.

Tiny worked example. Question: Does ice melt faster in room light or in shade on this counter? Table:

Trial	Condition	Time to melt (min)
1	light	42
2	shade	61
3	light	45

Caption: “Three trials on the kitchen counter; start mass ~20 g ice cubes; room ~22 °C (thermometer).” Claim crumb: “Ice melted faster in light than shade in these trials — see times in the table — consistent with more energy transfer in light.” Limitation: “Counter drafts may differ; only three trials.” Uncertainty crumb: “Times are $\pm$ about 1 min (phone stopwatch, human start/stop).”

Try 1. Hand your last page to a parent or sibling as stranger. Rewrite one missing piece — date, units, or question — without inventing numbers.

Try 2. Build a table before any graph from a short measurement try. Check: every plotted point appears in a row.

Explain it back. Tell someone what a stranger would need on your page that is not there yet.

Challenge. Three quick repeats of the same measurement; write “about ____ (range ____ to ____).” Skip inventing a $\pm$ to look advanced.

You may rewrite. You may change your claim when the table disagrees with your expectation. You may not invent rows. A generated picture is not your result. A model paragraph is not your observation. Messy honest beats neat fake.

At 15–16, headers and units may need scaffolding — ask for the checklist sticky. At 17–18, add spread talk and a methods crumb another could repeat — still without inventing results. Either way, unaided first on measuring and recording when that is the lesson.

A second worked crumb (physics vehicle). Question: How does release height change the roll distance of a toy car on this ramp? Table headers: Trial | Release height (cm) | Roll distance (cm). Three trials at each of two heights. Caption names the track, the car, and the meter stick. Claim points at the table. Limitation: carpet friction may change. Leave out a third height you did not run.

A third worked crumb (biology vehicle). Question: Do these bean seedlings differ in height after five days under the window vs under the shelf? Measure in cm. Photograph the setup as context. Tag “my measurement.” Refuse a generated

plant photo as your result. Claim points at rows. Limitation: window heat and light are confounded — note that honestly.

What success feels like for you. You can hand a page to someone who was not there and watch them retell the trial. You can say “I do not know yet” when the table is thin. You can refuse a pretty fake. That is high-school science looking.

If it isn’t clicking

1. Pages stay private / no units / no question.

Next move: Stranger test with apparatus covered. Fix only the header today. Celebrate one repaired date-question-units block. If they freeze, you write the header template blanks once; they fill the blanks next try.

2. Invent-data neat rows or graph phantoms.

Next move: Stop. Label honesty. Rebuild from a new try or use labelled secondary data. Do not “fix the graph.” Run AS-04 refusal card once. If shame spikes, name the value: honesty over neatness.

3. Adult-filled tables or chatbot logs filed as looking.

Next move: Parent puts the pen down. Student writes. Tool may prepare *you* after the try — not fill their table during the attempt. Delete generated “results.” Reopen a real photo or skip that try.

Slow down when expectation still melds with numbers. Go ahead when a stranger can reconstruct the trial from the page. Get a human tutor when record-keeping anxiety turns every hour into a fight — no shame. Correct invent-data firmly without crushing the look: the look is still welcome; the fake rows are not. “Never correct the adolescent” is not this book’s rule.

4. They write beautiful reflections with no table.

Next move: Require one table before any paragraph. Caption comes after numbers. Reflection without a row is English, not this hour’s science record.

5. They refuse to rewrite because “it’s already done.”

Next move: Stranger sticky is the audience. Rewrite is craft, not punishment. Keep the old page; add a dated repair page stapled behind.

Tools, including AI

Optional helpers for you, the adult. Keep this short. Point back to the Science Hour AI box.

You may ask a tool, on your account, to explain tables/units/uncertainty *to you* from a named page; to draft a blank table template with the key held by you; to give you a labelled SCRIPT after the try for stranger-test questions; to suggest revision questions after *their* caption or CER draft. Unaided first on measuring and recording. SCRIPT after the try.

You may not invent a data table, generate a gel or micrograph as their result, paste a model summary as the observation, write their lab report, photo-to-key a blank table, or park an unsupervised chatbot as their only partner during the attempt. COPPA does not bind ages 15–18; you still host — in the room at 15–16; co-hold with AP / Common App integrity at 17–18. Bastani is OFF-AGE for science hour — one caution in the Science Hour chapter.

What “done enough” looks like

Before you move on:

- ☐ A stranger can reconstruct the latest trial from the page without watching (date, question, units, table, claim pointer).
- ☐ Table exists before any graph; every plotted point appears in a row.
- ☐ Fuzzy DV rewritten as an operational measure at least once this week.
- ☐ Data types tagged: my measurement / labelled secondary — not invent, not generated result.
- ☐ Uncertainty crumb attempted in plain language (15–16 introduced; 17–18 expected more often).
- ☐ Parent stopped filling the table for them; stranger question asked with wait.
- ☐ Placement by skill, not birthday. Neat portfolio pages are not the same as honest records.
- ☐ Refusal cards practiced once if invent-data or generated-result temptations appeared.
- ☐ One out-of-home or photo-context try filed with numbers, not photo alone.

Done enough is showable two ways (oral stranger reconstruct + repaired page) and still holds after a night. Not a percentile. Not Emerging Adults Science I. Revisit

next Tuesday's page with a fresh stranger sticky — the habit lives in the Hour rhythm and the dated notebook, not in a ninth teaching chapter.

Band cue. Prefer 15–16 scaffolds if headers still collapse without you. Prefer 17–18 edges if they already stranger-repair alone and can talk range. Birthday does not decide.

More in-home practice detail

REC-02 deep notes. Before anyone reaches for graph paper, the table must exist. Headers name the independent variable and dependent variable in ordinary words plus units. If the student plots from memory, stop the graph. Rebuild the table from a new short try if needed. Phantom points are invent-data's cousin. Exit sentence: "Every plotted point appears in row ____."

REC-03 deep notes. Uncertainty is not a decoration. Three quick repeats of the same quantity teach "about" language. At 15–16, "about 12 cm (roughly 11–13)" is enough. At 17–18, ask what the spread might mean for the claim. Refuse a single measurement treated as exact truth. Refuse inventing a $\pm$ to look advanced. False precision ("12.000 cm" on a kitchen ruler) is another honesty fail.

REC-05 deep notes. Fuzzy words hide bad measurement. "Growth," "better," "stronger," "healthier" must become operational: height in cm, time in s, mass in g, count per transect. If the measure changes mid-table, the stranger cannot tell what happened. Freeze the operational definition for the week unless you redesign on purpose and label the redesign.

LAB-04 deep notes. Sort cards on the table: my measurement; labelled secondary (museum display, public dataset, textbook figure with honesty tag); forbidden invent; forbidden generated gel/curve. Only the first two may enter the notebook as evidence. Chatbot numbers are invent with better manners. "Close enough" invented points are still invent.

More out-of-home practice detail

Park transect honesty. The photo of the tape on the grass is context. The counts or lengths are the data. A beautiful photo essay with no table fails this chapter. Adult present. No protected-species collecting. Wash hands. Soft entry only.

Museum secondary label. Copying a quantitative museum display is allowed if

tagged secondary. Filing museum numbers as “my trial” is not. One question for a future home try keeps the looking spine alive.

Lab-path neighbor notebook join. When a supervised bench session happens, the home notebook still carries the question, the plan, and the claim pointer afterward. Write where the measurement happened. Do not pretend the kitchen produced electrophoresis.

Week-plan honesty for notebooks

1. One stranger repair.
2. One short measurement try with table before graph.
3. One operational-definition rewrite if fuzzy words appear.
4. One talk box + denser CER pointing at a row.
5. One refusal card (invent or generated) if temptation appeared.
6. One OUT photo-context + numbers this month.

That plan is smaller than a lab-manual year. It is the honest lesson plan this chapter promises.

Connection forward

Chapter 3 will redesign fair tests — change / measure / same / can we tell for sure. Those redesigns need stranger-readable pages or the redesign is theater. Chapter 7 densifies CER warrants further — warrants need locatable rows. Do not skip this chapter’s stranger test to chase a prettier claim paragraph.

Encouragement that is specific

This week you can learn to smell invent-data and to ask the stranger question without filling the silence. Today they can repair one header and point at one row. Messy honest is welcome. Magazine fake is not.

Quick parent checklist before Thursday’s talk box. Cover the apparatus. Read the page aloud as a stranger. Missing date? Missing units? Missing question? Claim with no row pointer? Photo with no numbers? Generated image filed as result? Adult handwriting in the data cells? Fix one fault today. Leave blanks rather than invent numbers to “complete” the page. Then ask the locked opening and wait.

Quick student checklist. Date. Question. Units. Table. Claim pointer. Uncertainty crumb. Honesty tag if secondary. No invented rows. No generated result images. You may rewrite. You may change your mind. You may not fake the world.

Bridge from Chapter 1. Chapter 1 put a system on the table and asked what claim the notebook could support before the tidy idea. Chapter 2 makes sure that notebook can travel. Without stranger-readable rows, denser CER becomes theater. With them, systems looking and fair-test redesign have a place to land.

Closing picture for this chapter. A dated notebook open on the table. Units in the header. A blank table filling from a real try. An uncertainty sticky. A stranger-test card. No generated gel. No adult handwriting in the data cells. That still-life is the high-school record. Teach the stranger page this week. Then let Chapter 3 redesign the fair test on pages that can travel. The denser CER chapters will thank you for every unit you insisted on today.

A stranger-readable notebook is the high-school record that denser CER and fair-test redesign both need.

Chapter 3 — Designing and redesigning fair tests



Figure 5: A kitchen-table still-life from a high three-quarter view: two trial cards labelled Confound and Fair, a sticky that reads “tell for sure?”, a dated notebook open to a blank three-column sticky (Change / Measure / Same), one safe mini-try apparatus set aside, a short redesign sticky ready for a second page. No people. No logos. No readable package branding.

Why this matters

You changed the surface. You also changed the height. You also used a heavier mass. Then you announced that roughness stops the motion — proved.

That announcement is not a character flaw. It is what happens when a try feels busy and the mind grabs the first difference it likes. The hour's job is smaller and kinder: name the one thing you meant to change, name what you measured, name what you kept the same on purpose, and ask — after the try — whether you can tell for sure. If you cannot, redesign once. Keep the messy first page. Add a new dated page for the repair.

Fair test remains a taught procedure at ages 15–18 — denser materials, same rule. Change one thing. Measure one thing. Keep the rest the same. Ask “can we tell for sure?” Redesign after a confound. Accept “insufficient evidence” as a valid outcome. Adolescents this age can name an independent variable and a dependent variable in ordinary language, hold constants on purpose, catch a confound, and redesign without shame. At 15–16 they catch an obvious confound with a prompt and redesign with a coached constant list. At 17–18 they design an unconfounded try more independently, transfer the same rule to new materials, and say when the data are too thin to claim. They do not become fair-minded because a parent bought an AP binder, and control-of-variables does not appear by staring at a pile of ramps alone.

What this idea unlocks is every later claim that points at a trial. A plant that got more light *and* more water cannot teach you about light alone. A conductivity try that also changed probe depth and water temperature cannot teach you about salt alone. A vinegar-and-soda fizz is still a change picture — adult present, authorized pair only — and it is still not a Chemistry credit. One deliberate change, recorded in a dated notebook a stranger could reconstruct, is how looking turns into a claim you can check. Chapter 2 built the stranger-readable notebook. This chapter puts the fair-test rule inside it. Chapter 7 will densify the claim with a warrant. Do not skip the redesign for the sake of a tidy paragraph.

Two refusals sit beside the idea, or the week becomes noise.

Discovery-only is not the program. A useful classroom study of third- and fourth-graders learning to design unconfounded experiments found that children who received clear teaching of the control-of-variables rule produced far more “masters” than children left to unguided discovery on the same materials — and both groups

manipulated the materials. The difference was explanation of the rule. Masters later looked alike on a transfer task that asked them to judge someone else's experiment poster. That study was a classroom trial on ramps, not a kitchen RCT for ages 15–18, and the percentages are not this adolescent's score. This is a useful study, not a promise that every home will see the same result. Age the *shape*: show a confounded design and a fair design on the same question before vocabulary; open a blank table before the race; ask “can we tell for sure?”; then let the student redesign. Do not declare discovery dead. Do not import classroom percentages as this kitchen's score.

Worksheet-only is not the program either. A fair-test sheet with no apparatus on the table is vocabulary without a lookable. Activity mania — ten demos, no record, no “what changed?” — is entertainment. Confirmation bias dressed as science — “prove the textbook claim” by changing three things until the graph looks right — is fraud training. Coverage as the hour — every PE by Friday — is a map mistaken for depth. One try with a named change, a blank table filled from real trials, and one authentic redesign beats all four.

You do not need to be a scientist. You do need to put the materials down, ask what they will change and what they will keep the same, wait, and point back at the notebook when the claim gets ahead of the evidence.

This week you can learn to hear confound pride and to answer it with a redesign, not a scolding lecture. Today the student can catch one confound and redesign once.

For the parent: understand it yourself

Many adults feel rusty on “variables” and laminated scientific-method posters. That is ordinary. Five minutes here, then the warm-up, is enough for tomorrow. The student still does the trying, the recording, and the redesign.

Everyday picture. Two cookies from different batches. One was baked longer. One used a different pan. Someone asks which change made the cookie browner. You cannot tell for sure — two things changed. That kitchen moment is fair test in ordinary clothes. You do not need the word *variable* to feel the problem. At 15–18 you will also use the tool words when they help: independent variable for the one deliberate change, dependent variable for what you measure, constants for what you keep alike. Tool words, not a spelling test with no trial.

Precise picture. Four teen words carry the procedure:

- **Change (IV):** the one thing we decide to make different on purpose.
- **Measure (DV):** what we count, time, weigh, or carefully observe — with units and an operational definition when needed.
- **Same (controls / constants):** everything else we keep alike on purpose.
- **Can we tell for sure?** If two things changed, we cannot blame one. If the data are too thin, “insufficient evidence” is a valid outcome.

A second precise picture: a confounded try next to a clean try on the same question. Same question — does the surface change how far the object travels? Confounded: steep-smooth-short with a light mass against shallow-rough-long with a heavy mass. Clean: same height, same mass, same release method, same start line; only the surface differs. Three trials each surface. Distances with units in a blank table drawn *before* the first release. Ask what a stranger would need to reconstruct the trial and whether you can tell for sure. That hour is the rule with examples, then the student’s redesign. It is not a sermon that discovery is dead. It is not an AP FRQ packet as Tuesday’s identity.

Framework and NGSS high-school progressions treat control of variables, precision, and alternative explanations as *moves* — maps for what looking can include, not a mandate to finish every performance expectation this week. Borrow the move. Leave the PE dump.

Wrong answers you should be able to hear

1. *Confound pride.* “We changed the surface *and* the height *and* the mass — and look, rough stops it!” Hear the pride. Do not crush the look. Ask: “Can we tell for sure it was the surface?” Point at the two other changes. Redesign so only one thing differs. Keep their original page; add a new dated page for the redesign.
2. *Variable vocabulary quiz with no trial.* “Define independent variable” while the apparatus stays in the closet. Hear coverage dressed as science. Put the materials down. Name IV on *this* trial.
3. *Invented neat rows.* The trial was messy; the notebook looks perfect. Hear invent-data. Keep the messy numbers. Redesign if needed. A fluent filled blank from a machine is performance, not the student’s looking.
4. *“Prove the textbook.”* The student (or the packet) treats the try as confirmation theater — change whatever it takes until the expected graph appears.

Hear confirmation bias. Ask what would falsify the claim. Keep inconvenient trials. If evidence is thin, say so.

5. *Kitchen chemistry as Chemistry credit.* Fizz, foam, excitement — then “we did chemistry.” Hear the credit grab. Name it plainly: this is a change picture. Adult measures. Authorized pair only. No sealed bottle. No other mixes. It does not unlock titration or a Chemistry transcript line. Put the work under Science or Physical Science when the work is actually that — or under Chemistry only when supervised investigation honestly belongs there.

A sixth you will also hear: “Just tell me if the design is right.” The student wants the answer key instead of the redesign. Point at the materials and the blank “same” cards. Ask what they would keep the same next time. Do not grab the answer. Do not fill the silence with the explanation.

Five-to-eight-minute parent warm-up

Do this alone with tomorrow’s apparatus — cards for a confounded design and a fair design on the same question, or a safe mini-try — before the lesson.

Minute 1. Set or sketch a deliberately messy try: different height *and* different surface *and* different mass. Say aloud: “Can we tell for sure?” Answer yourself: no.

Minute 2. Reset so only one thing changes. Touch each “same.” Say the change once. Say the measure once, with units.

Minute 3. Draw a blank table with headers: trial #, condition (IV), measurement (DV + units), notes. Leave cells empty.

Minute 4. Practice the locked opening: “What did we change on purpose — what stayed the same — and can we tell for sure?” Count a slow three after you ask. Look at the materials or the cards, not at an imaginary adolescent.

Minute 5–8. Write Change / Measure / Same on three scraps. Put them face down. Tomorrow the student’s words fill them. Decide whether tomorrow is FAIR-01 (confound vs fair side-by-side) or FAIR-02 (name IV, DV, constants before materials) first — both are strong. If notebook habits from Chapter 2 are still thin, keep one stranger-notebook check in the week. Skill, not birthday.

How to teach it this week

Science Hour stays the five beats you already know from the front of the book: open / system or question + RAMP if needed; short look or prior-idea card; one try / measure / record; talk box + denser CER crumb; exit ticket. This week the plan and try beats own the named change and the redesign. Total often ~30–50 minutes. Stop while a look remains.

Warm-up looking (3–7 min). Put the materials or the two design cards in view. Cover any worksheet title that already says “hypothesis proved.” Ask what they notice about the setup — before any vocabulary sentence. Wait a slow three (classroom-origin wait; use the move, not a kitchen coefficient).

Plan the fair test (4–8 min). Name change / measure / same. Draw the blank table *before* materials move for the race. At 15–16, co-build the “same” list and gate start until cards are filled. At 17–18, the student names IV/DV/constants more independently; you still gate safety and RAMP. Adult present for heat, electricity, outdoor water, chemicals, glassware, and any kitchen chemistry picture.

Try / measure / record (15–25 min). Student runs the trials. You do not grab the notebook. Messy real numbers beat invented neat ones. Two or three trials per condition at 15–16; more rows, uncertainty crumb, and a short methods sentence a stranger could follow at 17–18 when the habit holds. If a confound appears mid-try, stop the claim — do not “fix” by inventing rows.

Talk + denser CER crumb (5–10 min). Claim that answers the question. Evidence that points at a row. One “because” that names a scientific idea already on the table this week — a light warrant, not a lecture. Point at “can we tell for sure?” Name one limitation or alternative if the data allow. Chapter 7 will densify; this week the redesign owns the hour.

Exit ticket (2–5 min). Name IV/DV/same for *this* trial; or “confound was ____ / fair redesign changes only ”; or “*insufficient evidence* — *need* before claiming ____.” Diagnostic wrong noted by you for tomorrow — not a graded performance.

Exact wording you can say

- “What did we change on purpose — what stayed the same — and can we tell for sure?”
- “What are we measuring — in what units?”
- “What else was different — what would we redesign?”

- “You may change your mind after the redesign.”
- “Fill the blank table from what you measured — not from what you hoped.”
- “Insufficient evidence is allowed. What would you need next?”

Age-band moves: 15–16 / 17–18

15–16. Co-build the “same” list; 2–3 trial rows; oral “can we tell for sure?”; adult checks safety and gates start until Change / Measure / Same cards are filled; denser CER oral or short write with one warrant phrase and one limitation *or* alternative prompted; still refuse full lab-report theater as every hour.

17–18. Student names IV/DV/constants; redesigns a confounded try more independently; transfers the same rule to new materials (FAIR-06); holds multiple trials without secretly changing procedure; says “insufficient evidence” without inventing points; short methods sentence another student could almost follow; still kitchen-scale or lab-path when needed; still refuse AP FRQ as every Thursday. If fair-test habits are weak, stay on 15–16 FAIR longer. Skill, not birthday.

Parent learns this week. Show a confounded design and a fair design on the same question before vocabulary. Ask “can we tell for sure?” and wait.

Student tries today. Catch one confound and redesign once.

First try-it. FAIR-01 Confound vs Fair Side-by-Side, or FAIR-02 Name IV, DV, Constants before materials. Fade help across the week: co-name same list → they name while you watch → they design → redesign once when confounded → transfer to new materials at 17–18.

When to stop talking. When you are performing the scientific-method poster while their blank table is empty. One question. Stop. Look at the materials or the notebook if the silence is hard.

This-week sketch (illustration, not a script law)

Day	Focus	Card
Mon	Confound vs fair side-by-side, or IV/DV/constants gate	FAIR-01 or FAIR-02
Wed	Redesign after confound, or multiple trials same design	FAIR-03 or FAIR-05

Day	Focus	Card
Fri	Insufficient evidence + exit, or transfer new materials	FAIR-04 or FAIR-06
Optional OUT	Stream / puddle clarity soft — one named change	OUT-03

Three to five Science Hours plus one OUT is a full week. One deep hour beats five manic demos.

Practice that actually builds learning

Named try-its below carry **time, materials, safety, the fun, the skill**. Library, walk, museum, kitchen, yard, and lab-path neighbor *are* the practice — they do not replace the fair-test redesign move.

Talk box

Opening (locked): “What did we change on purpose — what stayed the same — and can we tell for sure?”

Follow-ups:

1. What are we measuring — what do you *see* or *time* or *weigh*?
2. What does the notebook / table show for each condition?
3. How do you know from *this* trial — can we tell for sure it was the change we named?
4. What else was different — what would we redesign — what else could explain these numbers?
5. You may change your mind after the redesign. Try another look. Insufficient evidence is allowed.

How to wait. After you ask, a slow three is a convention, not a sacrament (elementary science classroom origin). After they stop, wait again. If they are mid-measure or mid-claim, do not cut them off. Look at the materials, the table, or the notebook, not at the adolescent, if the silence is hard.

Stuck silence usually means: the question was vague; wait-time was zero; they are hunting a vocabulary word because you asked name-first; they are guessing what you want; the materials never landed; they offered a book-only guess; they think science means “repeat the parent’s explanation”; they invent neat rows because the trial was messy; they are bracing for an AP rubric sentence. Pose, wait, and point back at the notebook — not fill the silence with the right vocabulary, and not turn the table into a fight.

In-home try-its (FAIR bank)

FAIR-01 Confound vs Fair Side-by-Side

- **Band:** both
- **Time:** 35–50 min
- **Materials:** Same question; Card A confounded design; Card B fair design (paper or safe mini-try); notebook
- **Safety:** Prefer paper + one safe try; adult present for any apparatus
- **The fun:** Spotting the trick next to a clean design feels like detective work with real materials.
- **The skill:** Predict which design can “tell for sure”; mark extra variables on A; run B if safe or redesign A on paper.
- **Steps:** Pose one question. Show A and B. Mark confounds on A. Fill Change / Measure / Same for B. Blank table before any run. Talk box. Exit: “We can / cannot tell for sure because ____.”
- **Error patterns:** “More variables = more scientific”; skipping the teach of the rule; inventing results for B without running it.

FAIR-02 Name IV, DV, Constants

- **Band:** both
- **Time:** 30–45 min
- **Materials:** Question card; three-column sticky; planned safe try; notebook
- **Safety:** Per try; adult gates start until sticky is filled when hazards are present
- **The fun:** Cards make the plan visible before the mess — then the try lands clean.
- **The skill:** Fill IV / DV / constants *before* materials move; adult checks; then try.
- **Exit ticket:** Three-column sticky photographed or copied into the notebook.

- **Error patterns:** Constants list empty; IV that is actually a pile of changes; starting early “just to see.”

FAIR-03 Redesign After Confound Caught

- **Band:** both
- **Time:** 35–50 min
- **Materials:** Yesterday’s confounded notebook page; blank redesign page; optional second try materials
- **Safety:** Per redesign; do not shame-spiral into unauthorized mixes
- **The fun:** Repairing a broken design is satisfying — the second page is progress, not failure.
- **The skill:** Identify confound; redesign; optional second try; compare claims carefully without deleting the first page.
- **Exit ticket:** Old confound named + new constant list.
- **Error patterns:** Shame spiral; keeping old claim without redesign; inventing neat rows to “fix” the first page.

FAIR-04 “Insufficient Evidence” Is a Valid Outcome

- **Band:** both
- **Time:** 30–45 min
- **Materials:** Sparse data set (two points only) or a thin notebook page from a prior try; CER crumb card
- **Safety:** None if using prior data
- **The fun:** Saying “not enough yet” feels like intellectual honesty — rare and powerful.
- **The skill:** Attempt a claim; conclude insufficient; name what additional data would be needed; refuse inventing points to finish.
- **Exit ticket:** “Need ___ before claiming ___.”
- **Error patterns:** Forcing a strong claim; inventing points; filing a model summary as the missing data.

FAIR-05 Multiple Trials, Same Fair Design

- **Band:** both
- **Time:** 35–50 min
- **Materials:** Fair design card; space for three trials; notebook table
- **Safety:** Per materials
- **The fun:** Watching variation appear across honest repeats teaches that science is not one lucky run.

- **The skill:** Repeat the same fair design; table the variation; talk about range without secretly changing the IV mid-way.
- **Exit ticket:** Trial range + one claim with caution.
- **Error patterns:** Changing procedure mid-way “to help”; dropping the inconvenient trial; smoothing numbers to look professional.

FAIR-06 Transfer: New Materials, Same Rule

- **Band:** 17–18 (stretch 15–16)
- **Time:** 35–50 min
- **Materials:** New safe phenomenon (e.g. paper helicopter after a prior ramp or sink try); design sketch paper
- **Safety:** Adult check gate before run
- **The fun:** Owning the design on new materials feels like real agency.
- **The skill:** Learner designs a fair test alone after a short rule review; adult checks before run. Age the transfer *shape* from classroom studies — do not claim equal sample sizes or kitchen percentages.
- **Exit ticket:** Design sketch approved or revised.
- **Error patterns:** Copying prior constants blindly when irrelevant; skipping the adult check; treating transfer as a race.

Out-of-home try-it

OUT-03 Stream or Puddle Clarity Soft

- **Band:** both
- **Time:** 35–50 min on site
- **Materials:** Clear bottle; optional DIY turbidity sense; notebook; adult
- **Safety:** Shore-based default; adult present; never enter unsafe water; no storm-drain “tests”; no unknown reagents; wash hands; local rules
- **The fun:** Edge looking is real-world science without a scavenger packet.
- **The skill:** Observe; compare two sites if safe with *one* named change (e.g. upstream vs downstream edge, or sunny vs shady puddle edge); systems note of watershed soft; refuse chemical dumping tests.
- **Exit ticket:** Site A vs B observation + what changed on purpose + boundary crumb.
- **Error patterns:** Wading floodwater; inventing clarity numbers; changing three site features at once and claiming one cause; scavenger worksheet dump.

Blocked for a new move / mixed for when to use it

Blocked (one new move): FAIR-02 or FAIR-01 alone until the student can name change + same + measure without hunting your face for the “right” word. Then one redesign (FAIR-03).

Mixed (when the move holds): Pair FAIR-05 with a stranger-can-read check from Chapter 2; or FAIR-04 with a denser CER crumb that ends in “insufficient”; or Friday FAIR-06 at 17–18 with a short warrant phrase. Pair OUT-03 in the same week when the home fair test is steady.

One incorrect example to diagnose

Illustration (composite, not a reported family): A sixteen-year-old runs two plant setups. One gets a sunny window *and* extra water *and* a bigger pot. The other sits in a closet with less water in a small pot. The notebook announces: “Light makes plants grow — proved.” Rows look neat. One plant species differs. A chat window offered “typical growth numbers” that somehow match the table.

What you hear: Confound pride + invent-neat risk + confirmation theater + generated numbers as data.

Next move: “Can we tell for sure it was the light?” Wait. Point at water and pot and species. Redesign with FAIR-03: same water, same pot size, same starting health; only light exposure differs. Keep the original page; add a new dated page. Trash the chat numbers kindly. Do not paste a generated growth chart as “our” data. Do not file the hour as Chemistry credit or as a brand title on a transcript.

Exit crumb shapes

- “Change: . **Measure:** . Same: , , ____.”
- “Can we tell for sure? ____ because ____.”
- “Confound was . **Fair redesign changes only** .”
- “Insufficient evidence — need ____ before claiming ____.”
- Sticky claim + one evidence row number + one caution.

Sibling and mixed-band notes

If two adolescents share the hour, give them the same phenomenon and parallel jobs when bands differ: one fills Same cards while the other spots the confound

on a scripted setup; then swap. Do not turn the table into a race for who “wins” science. Kindness is part of safety. A younger sibling from *Science for Young Minds* age may watch and help with Same cards; they do not own denser CER warrants as a quiz. This book ages up — one pointer to the earlier book, then teach 15–18 fair-test redesign. *Science for Homeschooling* holds survey years and transcript architecture; one pointer, then teach this week’s redesign.

Dose and safety (week grain)

Three to five Science Hours plus one OUT is enough. Multi-day plant logs can run beside shorter trials; they do not require a 180-day calendar. Safety spine from the Science Hour still holds: adult present for heat, electricity, outdoor water, chemicals, glassware; RAMP before the try; authorized materials only; no unmarked bottles; no bleach mixes; no drain cleaners; no alcohol flames; no sealed pressurized fizz bottles; living things — no harm, return, wash hands; mold cultivation refused by default; home vertebrate dissection refused as default. A vinegar-and-soda fizz remains a change picture, not a Chemistry credit. Regulated chemicals, burners, and electrophoresis belong on a lab-path neighbor, not in a default home bank.

What “fair” does not mean this week

Fair does not mean “the student guessed the parent’s preferred answer.” Fair does not mean “every trial matched.” Fair does not mean “we used science words.” Fair does not mean “we proved the textbook.” Fair means one deliberate change, a real record, an honest answer to “can we tell for sure?”, and a redesign when you cannot. Disagreement between two honest trials is data. Deleting the unpopular trial is not. Inventing neat rows is not. Filing a generated image as the result is not.

If Chapter 1 still needs systems-before-tidy-idea, or Chapter 2 still needs stranger-readable notebooks, those moves are not leftovers — they are the floor under this chapter. Place by skill. A path through high-school fair-test redesign is the promise. A diploma is not. A percentile is not. An AP score is not the only path that counts.

Confirmation bias (“prove the textbook”)

A packet that says “prove that ____” trains confirmation theater. Prefer questions that could come out otherwise. Prefer redesign when the first try cannot tell for sure. Prefer “insufficient evidence” over inventing the expected slope. If an AP-style stem appears at 17–18, label it occasional stretch — not Tuesday’s identity. Control-of-variables teaching ages the *shape* of clear instruction with materials; it does not license importing classroom percentages as this adolescent’s score, and it does not declare discovery dead.

America’s Lab Report grain (labelled school-origin)

Integrated looking — clear outcome, sequenced with talk, reflection — beats isolated lab-day theater. Borrow the design principles. Do not crown a kitchen franchise. One fair redesign with talk beats five demos with no notebook.

For the student

Fair test means you change **one** thing on purpose, you measure what happens, and you keep everything else the same on purpose. Then you ask: can we tell for sure? If you cannot, you redesign once. Messy first pages stay. New pages get new dates.

The change is sometimes called the **independent variable** — the thing you decide to make different. What you measure is sometimes called the **dependent variable**. The things you keep the same are **controls** or **constants**. Those are tool words. What matters is the try on the table and the numbers in your notebook.

At 15–18 the bar rises a little from middle grades: a stranger should be able to reconstruct your trial from the notebook; “insufficient evidence” is a brave answer; inventing neat rows is not looking; a chat window’s “typical results” are not your data.

Tiny worked example

Question: Does the ramp surface change how far the object travels?

Change (IV): surface — towel vs foil.

Measure (DV): distance from the bottom of the ramp, in centimeters.

Same: same mass, same ramp height, same start line, same release (no push), same floor.

Table (drawn before the race):

Trial	Surface	Distance (cm)	Notes
1	towel		
2	towel		
3	foil		

You fill the empty cells from what you measure. Messy real numbers beat invented neat ones. If you also changed the height, you cannot blame the surface — redesign. If you only have two messy points and a big gap, say insufficient evidence and name what you need next.

Try 1

Pick FAIR-01 or FAIR-02. Fill Change / Measure / Same cards before materials move. Run at least two trials per condition. Point at one row when you say what happened. Answer the locked question out loud.

Try 2

Take a confounded page (yours or a scripted Card A). Catch the confound. Redesign once on a new dated page (FAIR-03). Optional: run the redesign. Keep both pages.

Explain it back

In your own words: What did we change on purpose — what stayed the same — and can we tell for sure? Point at the notebook while you talk.

Challenge

Design a fair test for a *new* safe question (paper helicopter, dissolving time with adult-controlled temperature, insulation wrap). Get an adult check before you run.

At 17–18, try FAIR-06 transfer without copying last week’s constants blindly.

If it isn’t clicking

Diagnostic 1 — Confound pride that will not budge.

They keep changing two things and calling it “more scientific.”

Next move: Paper-only FAIR-01. Mark extra variables in red. No materials until they can say “we cannot tell for sure because ____.” Then one fair mini-try.

Diagnostic 2 — Empty constants list / IV that is a pile.

They name a change that is really three changes.

Next move: FAIR-02 sticky gate. Adult refuses start until three real constants are named. Practice on yesterday’s apparatus without running.

Diagnostic 3 — Invent-neat or force-a-claim.

Rows look too perfect, or they invent points to finish a CER.

Next move: FAIR-04 with a deliberately sparse table. Practice the sentence “Need ____ before claiming ____.” Keep messy real data. No chat numbers. No generated charts.

When to slow down. If Chapter 2 stranger-notebook habits are weak, repair those first for a few hours. Fair test without a readable record becomes theater.

When to go ahead. When they catch a confound unaided and redesign once with a constant list that would survive a stranger’s eye, move toward multiple trials (FAIR-05) and transfer (FAIR-06). Mix last week’s redesign into Friday’s exit.

When to get a human tutor. If wait-time never happens, if every hour becomes a fight, or if safety gates keep failing, a co-op lab mentor or a trusted science teacher for a few sessions can model the redesign talk. A chatbot is not a tutor for inventing the missing rows.

Correct a wrong reason without crushing the look. “Never correct the adolescent” is not this book’s rule. Shame is not the rule either. Point at the materials. Ask the locked question. Redesign.

Tools, including AI

Point back to the Science Hour AI box. Keep this short.

You may, on your account: ask a tool to explain control-of-variables *to you* from a named page or from today's Card A / Card B; generate an extra isomorphic practice design with the answer key held by you; ask for a labelled SCRIPT after the try (words for *you* to say); ask for revision questions after *their* redesign draft; diagnose a design they already produced (crop to the paper, not their face).

You may not: invent an observation or data table and file it as theirs; ask a tool to “fix” a confounded table; generate a gel, micrograph, or growth chart as the result; park an unsupervised chatbot as their only partner during the attempt; write their lab report or CER for them; detector-grade their “can we tell for sure?” sentence.

Unaided first on looking, measuring, and recording. SCRIPT after the try. At 15–16, still in the room. At 17–18, co-hold and keep AP / Common App integrity — revision questions after *their* draft remain allowed; “write my lab report” does not. A fluent filled blank from a machine is performance, not the student's fair test.

What “done enough” looks like

Before you move on from this chapter's focus, you should be able to check most of this list — by skill, not by birthday.

- ☐ Student names Change (IV), Measure (DV), and at least three Same (constants) for *this* trial before materials race.
- ☐ Blank table exists before the first measurement; cells fill from real trials.
- ☐ Student answers “can we tell for sure?” with a reason that points at the design or the notebook.
- ☐ At least one confound has been caught and redesigned on a new dated page (original page kept).
- ☐ “Insufficient evidence” has been practiced once without inventing points.
- ☐ At 15–16: denser CER crumb with one warrant phrase and one limitation or alternative prompted.
- ☐ At 17–18: multiple trials without mid-run procedure drift; optional transfer design (FAIR-06) adult-checked before run.
- ☐ No invent-data neat rows; no generated image filed as result; kitchen picture not filed as Chemistry credit.
- ☐ One OUT soft (OUT-03 or similar) invited in the same week or the next — claim returns with locatable evidence.
- ☐ Exit ticket done; one diagnostic wrong tagged for tomorrow without per-

centile identity.

A “grade 11 Biology workbook” is a publisher’s scope, not a legal grade, and not a transcript line. Fair-test redesign lives inside Biology, Chemistry, Physics, Earth Science, Environmental Science, or Science when the work is actually that — never “Emerging Adults Science I,” never a brand title as the credit.

Done enough is showable two ways and holds after a night: they can redesign a scripted confound on paper *and* run one fair mini-try with a stranger-readable table. What still needs practice gets next Tuesday — mix last week’s confound into a new materials transfer when ready. Life of the habit is the session rhythm and the file you keep, not a ninth teaching chapter.

You changed one thing on purpose. You measured. You kept the rest the same — or you admitted you did not, and you redesigned. That is fair test at 15–18. That is enough for this week.

Chapter 4 — Systems looking (cells, energy, matter)



Figure 6: A kitchen-table still-life from a high three-quarter view: a clear jar with a drawn boundary line on paper beneath it, arrow stickies for inputs and outputs, a yellow sticky labelled “leaves out,” a simple body-subsystem card, a dated notebook open to a blank systems sketch. No people. No logos. No readable package branding.

Why this matters

The diagram looks finished. Labels are neat. Someone announces that this is the cell — or the energy flow — or the matter cycle — as if the poster were the world.

That announcement is not a character flaw. It is what happens when a picture feels complete and the mind treats the picture as the thing. The hour's job is smaller and kinder: draw a boundary; name what is inside and outside; mark inputs and outputs; say what the model leaves out; ask how a change at the boundary or inside would matter. Cells, energy, and matter show up here as *system objects* you can look at this week — not as a Biology or Chemistry survey dump. Chapters 5 and 6 carry domain vehicles. This chapter owns the systems move.

Systems looking is how crosscutting ideas become a weekly practice without becoming a laminated slogan. Adolescents ages 15–18 can draw a boundary with help, name one input and one output, and say one thing the model leaves out. At 15–16 the boundary is scaffolded; feedback appears soft. At 17–18 they revise a model against data, name what the model leaves out without coaching, and ask how a scale shift would change the question. They do not become systems thinkers because a parent bought a wall poster of “everything is a system,” and useful models do not appear by copying organelle lists with no phenomenon on the table.

What this idea unlocks is every later explanation that can survive a second look. A cell diagram that never meets a question about inputs and outputs stays art. An energy arrow sketch that never meets a lamp, a plant, or a motion try stays decoration. A food-web craft that never marks which links were observed stays a worksheet biome. One owned diagram — boundary, arrows, “leaves out” sticky — beside a notebook page is how explanation stays honest at high school.

Two refusals sit beside the idea, or the week becomes noise.

“Everything is a system” without a diagram the learner owns is not the program. The slogan feels deep and teaches nothing you can check. Activity mania — five models, no talk about what they leave out — is entertainment. Coverage as the hour — every organelle, every trophic level, every energy form by Friday — is a map mistaken for depth. Model-as-truth is not the program either. “The model is the real system” collapses the useful gap between representation and world. A generated “cell under the microscope” filed as Figure 1 is not the student's observation. A model summary from a screen is not today's look.

You do not need to be a scientist. You do need to put a system on the table, ask

where the boundary is and what the model leaves out, wait, and point back at the notebook when the picture gets ahead of the evidence.

This week you can learn to ask for the boundary before the vocabulary list. Today the student can sketch one system, label one input and one output, and name one thing left out.

A third refusal belongs in the same breath: coverage as systems week. Ten labelled diagrams with no phenomenon on the table teach handwriting. One jar beside a blank page, or one body-subsystem card beside a pulse count with consent and hygiene, or one energy-arrow sketch beside a lamp they turned on, teaches the practice. Depth is the hour. The map of every crosscutting concept can wait on the shelf.

For the parent: understand it yourself

Many adults remember systems as a poster word or as a middle-school food-web craft. That is ordinary. Five minutes here, then the warm-up, is enough for tomorrow. The student still draws the boundary and names the limit.

Everyday picture. A subway map. It shows connections. It leaves out street trees, exact walking times, and the smell of the platform. Nobody calls the map a lie because it leaves those out — unless someone treats the map as the city. That gap is the systems habit in ordinary clothes.

Precise picture. In high-school science looking, a **system** is a set of parts and interactions you choose to treat together for a question. A **system model** is a representation — diagram, physical build, or mathematical-light sketch — that shows those parts and flows on purpose. Framework teaching materials treat systems and system models, energy and matter, structure and function, and scale as crosscutting moves meant to be *integrated*, not as three separate quiz lists. *Taking Science to School* notes that useful models need instruction — they are not a creativity elective with no science object. Borrow the moves. Leave the PE dump.

Five kitchen moves carry the practice:

- **Boundary:** What is inside this system for *this* question — and what is outside?
- **Parts and interactions:** What pieces matter, and how do they affect each other?

- **Inputs / outputs:** What matter or energy crosses the boundary — in which direction?
- **Feedback (soft):** When a change inside feeds back to amplify or stabilize — careful, plain grain; no medical advice.
- **Leaves out:** What does this model simplify, hide, or refuse to claim — and when would that omission change a prediction?

At 15–16, boundary + one input + one output + one “leaves out” sentence is enough. At 17–18, add feedback soft, scale shift, and revise once when data disagree. Still refuse AP-scale modeling reports as the weekly default. Cells, energy, and matter are *objects* for the move this week — not a year of Biochemistry.

A second precise picture: a closed jar with soil and a seedling. Boundary drawn around the jar. Inputs: light energy, maybe water you add. Outputs: heat, maybe water vapor. “Leaves out” sticky: soil microbes not drawn; CO₂ exchange not measured; this is not a proof of full photosynthesis biochemistry. That hour is systems looking. It is not Chapter 5’s Biology vehicle week — though the same jar may return there.

Wrong answers you should be able to hear

1. *Slogan without a line.* “Everything is a system!” No boundary drawn. Hear empty depth. Ask: “Where is the boundary for *this* question?” Require a line before vocabulary.
2. *Model as decoration.* Beautiful cell craft; no inputs/outputs; no “leaves out”; no link to a question. Hear craft without science looking. Require the sticky before the fridge photo.
3. *Generated cell / gel / micrograph as observation.* An image tool produces a “cell under the microscope” or a fake gel. It lands as Figure 1. Hear generated image $\neq$ data. Label a schematic if you use one, then put it away before the look — or skip. Real prepared slide, printed micrograph from a book, or soft alternative. Never file a generated result as the student’s observation.
4. *Model summary as the observation.* A chatbot paragraph describes what “usually happens” in a cell or an ecosystem; that paragraph is filed as today’s looking. Hear model-summary-as-observation. Trash it kindly. Blank page. Eyes on the jar, the produce, or the lamp. Then build the diagram *after* the look and name a limit.

5. “*The model is the truth.*” Student defends the drawing against the thermometer, the mass change, or the leaf observation. Hear representation collapsed into world. Say: “Data can win. What would we revise once?” Keep both pages — prediction and result.

A sixth you will also hear: “Just tell me what to draw.” Point at the phenomenon. Ask what a stranger would need to see in the model to understand *this* question. Do not grab the pencil and finish their thinking.

A seventh, quieter miss: coverage as systems week — ten labelled diagrams with no phenomenon on the table. Hear the map replacing the hour. One jar, one body-subsystem card, or one energy-arrow sketch beside something they can point to teaches the practice. Depth is the hour.

Five-to-eight-minute parent warm-up

Do this alone with tomorrow’s lookable — a jar, a lamp, a body-subsystem card, or a grocery produce item — before the lesson.

Minute 1. Sketch a quick boundary around the object. List two things inside and two outside.

Minute 2. Add one input arrow and one output arrow. Label matter or energy in plain words.

Minute 3. Write one “leaves out” sticky: “This leaves out , ***which matters if*** .” Place it on the sketch before you sit down with the student.

Minute 4. Practice the locked opening: “Where is the boundary of this system — and what does this model leave out?” Count a slow three. Look at the sketch, not at an imaginary adolescent.

Minute 5–8. Decide SYS-01 (boundary first) or SYS-02 (inputs and outputs) as the first try. If fair-test habits from Chapter 3 are still thin, keep one fair test in the week and let the system diagram serve that trial — do not abandon the notebook spine for craft week. If you are heading toward Biology next, keep today’s diagram reclaimable as a vehicle, not as a finished year.

How to teach it this week

Science Hour stays the five beats: open / system or question + RAMP if needed; short look or prior-idea card; one try / measure / record *or* systems probe; talk box + denser CER crumb; exit ticket. This week the open and try beats can own a systems diagram — or a diagram beside a short trial. Total often ~30–50 minutes. Stop while a look remains.

Warm-up looking (3–7 min). Phenomenon visible first when looking is the point — jar, lamp, leaf, produce, printed watershed map. Cover captions that already explain the model. Ask what they notice. Wait a slow three (classroom-origin wait; use the move, not a kitchen coefficient).

Frame the system (4–8 min). Draw or reveal a blank boundary. At 15–16, co-draw the line and list inside/outside together. At 17–18, the student draws; you ask what the model leaves out. Refuse “the universe” as the default boundary. Adult present for heat, electricity, outdoor water, chemicals, glassware, and living-specimen work.

Try / probe / record (15–25 min). Student adds arrows, measures one flow if the try allows (temperature change, mass, growth notice, light on/off), or runs a soft structure–function probe. You do not grab the pencil for the “right” organelle set. Messy owned diagrams beat copied poster perfection. Pair with a short fair test when the question needs it — Chapter 3 still holds.

Talk + denser CER crumb (5–10 min). Claim about what is happening in the system. Evidence that points at the diagram *or* a notebook row. One warrant phrase naming a scientific idea already on the table (energy transfer, matter conservation as weighing honesty, structure–function). Name what the model leaves out. Chapter 7 densifies; this week the boundary and the limit own the hour.

Exit ticket (2–5 min). Boundary sentence + one input + one output; or “leaves out, *which matters if* ”; or scale A answers ___ / scale B answers ___. Diagnostic wrong noted by you for tomorrow — not a graded performance.

Exact wording you can say

- “Where is the boundary of this system — and what does this model leave out?”
- “What is inside — what is outside — for *this* question?”
- “What crosses the boundary — in or out — matter or energy?”

- “What would change if we moved the boundary?”
- “What does this model leave out — and when would that matter?”
- “You may revise the diagram after another look.”

Age-band moves: 15–16 / 17–18

15–16. Scaffolded boundary; one input and one output labelled; one “leaves out” sentence prompted; feedback introduced soft if ready; denser CER oral or short write with warrant crumb; still refuse full systems-essay theater as every hour.

17–18. More independent system model; name what the model leaves out without a prompt list; feedback soft with stabilizing vs amplifying careful language; scale shift; revise once when data disagree; still kitchen-scale; still refuse AP modeling FRQ as weekly spine. If boundary habits are weak, stay on 15–16 SYS longer. Skill, not birthday.

Parent learns this week. Ask for the boundary before the vocabulary list.

Student tries today. Sketch one system, label one input and one output, name one thing left out.

First try-it. SYS-01 Boundary First, then SYS-02 Inputs and Outputs. Fade help: co-draw → they draw while you watch → they name leaves-out → scale shift or structure–function at week’s end.

When to stop talking. When you are narrating every arrow while their page is blank. One question. Stop. Look at the jar or the diagram if the silence is hard.

This-week sketch (illustration, not a script law)

Day	Focus	Card
Mon	Boundary first on jar or body-subsystem card	SYS-01
Wed	Inputs/outputs arrows + leaves-out sticky	SYS-02 + SYS-04
Fri	Scale shift or structure–function; exit	SYS-05 or SYS-06
Optional OUT	Grocery produce structure–function	OUT-04
Neighbor week	Watershed / water-in-the-system soft	EARTH-02

Three to five Science Hours plus one OUT is a full week. One owned diagram beats ten poster copies.

Practice that actually builds learning

Named try-its below carry **time, materials, safety, the fun, the skill**. Library, walk, museum, kitchen, yard, grocery, and lab-path neighbor *are* the practice — they do not replace the systems-looking move.

Talk box

Opening (locked): “Where is the boundary of this system — and what does this model leave out?”

Follow-ups:

1. What do you *see* inside the boundary — what is outside?
2. What does the notebook / diagram show for inputs and outputs?
3. How do you know from *this* model or trial — what warrant ties the arrows to the idea?
4. What else could be crossing the boundary — can we tell for sure — what does the model leave out?
5. You may revise the diagram. Try another look. Move the boundary once and say what changes.

How to wait. After you ask, a slow three is a convention, not a sacrament (elementary science classroom origin). After they stop, wait again. If they are mid-draw or mid-claim, do not cut them off. Look at the materials, the diagram, or the notebook, not at the adolescent, if the silence is hard.

Stuck silence usually means: the question was vague; wait-time was zero; they are hunting a vocabulary word because you asked name-first; they are guessing what you want; the materials never landed; they offered a book-only guess; they think science means “repeat the parent’s explanation”; they think looking means “say what the screen already told me”; they are bracing for an AP rubric sentence. Pose, wait, and point back at the diagram — not fill the silence with the right organelle list, and not turn the table into a fight.

In-home try-its (SYS bank)

SYS-01 Boundary First

- **Band:** both

- **Time:** 30–45 min
- **Materials:** Phenomenon (jar garden, aquarium photo, house vent, watershed map print); blank paper; notebook
- **Safety:** Observation only unless a paired try is approved; adult present for living specimens
- **The fun:** Drawing the line turns a familiar object into a question you can own.
- **The skill:** Draw boundary; list inside/outside; revise after talk; refuse “the universe” as default.
- **Steps:** Phenomenon visible. Locked opening. Student draws. Talk. Exit: boundary sentence + two outside items.
- **Error patterns:** No line drawn; everything inside; copying a textbook diagram without a question.

SYS-02 Inputs and Outputs Arrows

- **Band:** both
- **Time:** 30–45 min
- **Materials:** System diagram from SYS-01 or new; arrow stickies; notebook
- **Safety:** None for diagram; per any paired measurement
- **The fun:** Arrows make invisible flows feel visible — then honesty about what you did not measure.
- **The skill:** Add energy/matter arrows; label direction; ask what is conserved vs transformed in plain words (honesty about model limits).
- **Exit ticket:** Two labelled arrows.
- **Error patterns:** Arrows with no labels; perpetual-motion vibes; claiming measured CO₂ from a jar you never instrumented.

SYS-03 Feedback Soft

- **Band:** 17–18 (introduce 15–16)
- **Time:** 35–50 min
- **Materials:** Thermostat analogy card; body-system or other plain feedback example; notebook
- **Safety:** Diagram only; no medical advice; no diagnosing family members
- **The fun:** Spotting a loop feels like seeing the hidden gear in a machine.
- **The skill:** Identify a change that feeds back; sketch loop; mark stabilizing vs amplifying carefully.
- **Exit ticket:** Loop sketch with one sentence.
- **Error patterns:** Every loop called “balance”; health diagnosis from a dia-

gram; climate-as-policy sermon as the hour.

SYS-04 What the Model Leaves Out

- **Band:** both
- **Time:** 30–45 min
- **Materials:** Simple model (food-web card, cell-as-factory metaphor card labelled *metaphor*); notebook
- **Safety:** None
- **The fun:** Naming omissions makes the student the editor of the model, not its victim.
- **The skill:** List three omissions; ask which omission would change a prediction; revise model note.
- **Exit ticket:** “Leaves out , *which matters if* .”
- **Error patterns:** Treating model as the thing; mocking models as “just lies”; refusing all models as useless.

SYS-05 Scale Shift

- **Band:** both
- **Time:** 30–45 min
- **Materials:** Same phenomenon at two scales (leaf ↔ canopy; molecule picture ↔ beaker — picture honesty); notebook
- **Safety:** Pictures OK; no unauthorized chemistry
- **The fun:** Switching scale feels like zooming a camera — different questions come into focus.
- **The skill:** Name which questions each scale answers; refuse forcing one scale’s answer onto the other.
- **Exit ticket:** Scale A answers ; *scale B answers* .
- **Error patterns:** “Atoms explain everything today”; ignoring macro measurement; filing a molecular animation as today’s observation.

SYS-06 Structure–Function Probe

- **Band:** both
- **Time:** 30–45 min
- **Materials:** One structure (leaf stomata print, bird-bone image, tool hinge); optional magnifier + real leaf; notebook
- **Safety:** Magnifier; living no-harm; wash hands
- **The fun:** Guessing function from structure, then asking what evidence would be needed, feels like real inquiry.

- **The skill:** Propose function; name needed evidence; optional observe real leaf; refuse just-so sermons.
- **Exit ticket:** Structure + hypothesized function + needed evidence.
- **Error patterns:** Just-so stories with no test; teleology sermon; inventing micrograph “evidence.”

Out-of-home try-its

OUT-04 Grocery Produce Structure–Function

- **Band:** both
- **Time:** 30–45 min
- **Materials:** Produce; notebook; adult
- **Safety:** Food hygiene; knives adult-controlled if any cutting; venue rules
- **The fun:** The produce aisle becomes a lab without glassware.
- **The skill:** Structure observation; hypothesized function; what evidence would be needed beyond the aisle.
- **Exit ticket:** Structure + function guess + needed evidence.
- **Error patterns:** Eating as the only method; unsupervised knife work; scavenger worksheet dump.

EARTH-02 Water in the System (neighbor week)

- **Band:** both
- **Time:** 35–50 min
- **Materials:** Local watershed map print or walk; cups for safe infiltration demo optional; notebook
- **Safety:** Outdoor adult; water hygiene; no storm-drain chemical dumps
- **The fun:** Naming where your water comes from and goes turns a map into a system you live inside.
- **The skill:** Boundary watershed; inputs/outputs; human-use note without culture-war dump.
- **Exit ticket:** Watershed boundary + one flow.
- **Error patterns:** Worksheet packet scavenger; inventing stream data; policy sermon as the hour.

Blocked for a new move / mixed for when to use it

Blocked (one new move): SYS-01 alone until a boundary line and two outside items exist without hunting your face. Then SYS-02 arrows. Then SYS-04 leaves-out sticky.

Mixed (when the move holds): Pair SYS-04 with a Chapter 3 fair test on the same phenomenon; or SYS-05 with a denser CER crumb; or Friday SYS-06 with OUT-04 the same week. Pair EARTH-02 as a neighbor week when water systems fit the season.

One incorrect example to diagnose

Illustration (composite, not a reported family): A seventeen-year-old prints a colourful cell poster from a chat tool, labels every organelle from a list, and files it as “lab: observed animal cell.” No boundary question. No inputs/outputs. No “leaves out.” The notebook title says Biology. A parent is proud of the neatness.

What you hear: Generated image as observation + model-as-decoration + coverage pride + transcript brand risk if the title becomes a product name.

Next move: “Where is the boundary of this system — and what does this model leave out?” Wait. Trash the filing of the generated image as observation kindly — keep it only if labelled *schematic, not my observation*, then put it away. SYS-01 on a real jar or a printed micrograph from a book with a caption written *after* looking. Add inputs/outputs. Add leaves-out. Put the work under Biology only when the work is actually Biology looking — never a brand title as the credit line.

Exit crumb shapes

- “Boundary: . **Outside:** , ____.”
- “Input: . **Output:** .”
- “Leaves out , **which matters if** .”
- “Scale A answers ; **scale B answers** .”
- Sticky claim + arrow to diagram feature + one caution.

Sibling and mixed-band notes

If two adolescents share the hour, give them the same phenomenon and parallel jobs when bands differ: one draws the boundary while the other lists leaves-out

candidates; then swap. Do not turn the table into a race for the prettiest poster. Kindness is part of safety. A younger sibling from *Science for Young Minds* age may help with inside/outside stickies; they do not own denser warrants as a quiz. This book ages up — one pointer to the earlier book, then teach 15–18 systems looking. *Science for Homeschooling* holds survey years; one pointer, then teach this week's boundary.

Dose and safety (week grain)

Three to five Science Hours plus one OUT is enough. Safety spine from the Science Hour still holds: adult present for heat, electricity, outdoor water, chemicals, glassware, living specimens; RAMP before the try; no unmarked bottles; no bleach mixes; living things — no harm, return, wash hands; mold cultivation refused by default; home vertebrate dissection refused as default. Kitchen pictures stay pictures. Generated gels stay fiction.

What systems looking does not mean this week

Systems looking does not mean “everything is connected, so any answer works.” Systems looking does not mean “copy the poster.” Systems looking does not mean “atoms explain every question today.” Systems looking means an owned boundary, named flows, honesty about what the model leaves out, and a claim that can point at the diagram or the notebook. Depth is the hour. The map of every crosscutting concept can wait on the shelf.

If Chapter 3 fair-test redesign is still thin, keep one FAIR card in the week. Systems without a checkable claim becomes art class. Place by skill. A path through high-school systems looking is the promise. A diploma is not. A percentile is not. An AP score is not the only path that counts.

Cells, energy, matter — as system *objects* this week (not a survey)

Keep the domain soft. The point is the systems move.

Cells as a system object. A cell diagram is allowed when it answers a boundary question: what is inside this membrane for *this* question, what crosses it, what the cartoon leaves out (organelles not to scale; no claim that the drawing is a micrograph you took). Pair with a printed secondary image or a soft prepared-slide look

if you have a lab-path neighbor — never a generated “my micrograph.” Chapter 5 will vehicle living systems more fully.

Energy as a system object. A lamp, a hand warmer, a plant on a sill, a moving cart — sketch where energy enters and leaves the boundary you chose. Plain words: light, heat, motion. Refuse “energy is used up” as the final claim without another look; hear force-as-fuel cousins and repair with another measurement, not a scolding lecture. Chapter 6 will vehicle Physics more fully.

Matter as a system object. A closed weighing try (adult-gated), a dissolving notice, a condensation on a jar lid — mark matter arrows with honesty about what you measured. Conservation language stays tied to the notebook, not to a poster slogan. Kitchen fizz remains a change picture, not Chemistry credit.

One object per day is enough. Three posters in one hour is coverage mania.

This-week dose honesty

If you only have thirty minutes: RAMP if needed + boundary sketch + one arrow + leaves-out sticky + exit sentence. That is a real Science Hour. Lab-path neighbors for microscopy or regulated techniques are scheduled honesty, not guilt. America’s Lab Report’s design grain still travels: clear outcome, sequence with talk, reflect — labelled school-origin, not a kitchen RCT promise.

If Chapter 1 still needs “system before tidy idea,” keep one prior-idea card soft (cells-as-tiny-mouths, energy-as-fuel) and repair with another look + named idea just-in-time. Do not scold. Do not equation-punish.

For the student

Systems looking means you choose a boundary for a question, you name what is inside and outside, you mark what crosses the boundary, and you say what your model leaves out. Then you ask whether the notebook agrees.

A **system** is the set of parts and interactions you are treating together for *this* question. A **model** is a picture or build that shows those parts and flows on purpose. Models are useful because they simplify. Models are honest when you name the simplification.

At 15–18 the bar rises from middle grades: the diagram is yours, not a colouring sheet; “leaves out” is required, not optional; a generated cell picture is not your observation; a chat summary is not today’s look.

Tiny worked example

Phenomenon: A closed jar with a small plant on a sunny sill.

Boundary: The jar (glass + lid + air + soil + plant inside).

Outside: The room, the sun, you.

Input: Light energy from the sun (and water if you open the lid to add it).

Output: Heat to the room; water vapor if you measure condensation — say so only if you saw it.

Leaves out: Soil microbes not drawn; exact gases not measured; this jar is not a proof of the full photosynthesis equation.

Claim crumb: Light energy enters the jar system; the plant is part of how matter and energy are transformed inside — evidence: growth notice / condensation / temperature crumb from *this* notebook — warrant: energy transfer / matter in systems — limitation: we did not measure gases.

Try 1

Do SYS-01 on a jar, a lamp, or a body-subsystem card. Draw the boundary. List two outside items. Answer the locked question out loud.

Try 2

Add SYS-02 arrows and a SYS-04 leaves-out sticky. Point at one arrow when you talk. Optional: OUT-04 at the grocery with an adult — structure, guessed function, needed evidence.

Explain it back

In your own words: Where is the boundary — what does this model leave out — and which notebook evidence makes you say what is happening? Point at the diagram while you talk.

Challenge

Take the same phenomenon at two scales (SYS-05). Write which questions each scale can answer. At 17–18, add a soft feedback loop (SYS-03) without turning it into medical advice.

If it isn't clicking

Diagnostic 1 — Slogan, no line.

They say “everything is a system” but will not draw a boundary.

Next move: Paper-only SYS-01. No vocabulary until a line and two outside items exist. Then one input arrow.

Diagnostic 2 — Decoration / copy-poster.

Beautiful labels; no question; no leaves-out.

Next move: SYS-04 first. Three omissions required before any photo. Put the pretty poster away until the sticky exists.

Diagnostic 3 — Generated image or model summary as observation.

Chat cell / gel / paragraph filed as today's look.

Next move: Kind refuse. Label fiction. Blank page. Eyes on a real object or a printed secondary image captioned after looking. Then rebuild the diagram. House rule: generated image $\neq$ data.

When to slow down. If Chapter 2 notebook habits or Chapter 3 fair-test redesign are weak, repair those for a few hours. Systems without a record or a checkable claim becomes craft.

When to go ahead. When they draw a boundary unaided, name leaves-out, and revise once when data disagree, move toward feedback soft and scale shift. Mix last week's diagram into Chapter 5's Biology vehicle.

When to get a human tutor. If every hour becomes a fight over “the right diagram,” or if safety gates keep failing on living specimens, a co-op mentor can model the boundary talk. A chatbot is not a tutor for inventing the observation.

Correct a wrong reason without crushing the look. Point at the jar. Ask the locked question. Revise the sticky.

Tools, including AI

Point back to the Science Hour AI box. Keep this short.

You may, on your account: ask a tool to explain systems and system models *to you* from a named Framework page or from today's jar/card; generate an extra isomorphic boundary practice with the key held by you; ask for a labelled SCRIPT after the try; ask for revision questions after *their* diagram draft; diagnose a diagram they already produced (crop to the paper).

You may not: invent an observation; generate a gel, micrograph, or sky photo as the result; put a model summary on the table as the observation; park an unsupervised chatbot as their only partner during the attempt; write their systems CER for them; detector-grade their "leaves out" sentence.

Unaided first on looking and diagramming. SCRIPT after the try. At 15–16, still in the room. At 17–18, co-hold and keep AP / Common App integrity — revision questions after *their* draft remain allowed; "write my lab report" does not. A fluent filled blank from a machine is performance, not the student's systems looking.

What "done enough" looks like

Before you move on from this chapter's focus, you should be able to check most of this list — by skill, not by birthday.

- ☐ Student draws a boundary for *this* question and names at least two things outside.
- ☐ At least one input and one output are labelled (matter or energy in plain words).
- ☐ Student answers the locked opening with a "leaves out" sentence that could change a prediction.
- ☐ Diagram is the student's (or clearly revised by them) — not an unmarked generated image filed as observation.
- ☐ At 15–16: denser CER crumb with one warrant phrase and one limitation or alternative prompted.
- ☐ At 17–18: scale shift or feedback soft completed once; model revised once when data disagree.
- ☐ No invent-data neat flows; no generated gel/micrograph as result; kitchen picture not filed as Chemistry credit.

- ☐ One OUT (OUT-04 or EARTH-02 neighbor) invited in the same week or the next — claim returns with locatable evidence.
- ☐ Exit ticket done; one diagnostic wrong tagged for tomorrow without percentile identity.

A “grade 11 Biology workbook” is a publisher’s scope, not a legal grade, and not a transcript line. Systems looking lives inside Biology, Chemistry, Physics, Earth Science, Environmental Science, or Science when the work is actually that — never “Emerging Adults Science I,” never a brand title as the credit.

Done enough is showable two ways and holds after a night: they can redraw a boundary and leaves-out sticky from memory *and* talk one input/output from the notebook. What still needs practice gets next Tuesday — mix last week’s system into Chapter 5’s living-system vehicle when ready. Life of the habit is the session rhythm and the file you keep, not a ninth teaching chapter.

You drew a boundary. You named a flow. You said what the model leaves out. That is systems looking at 15–18. That is enough for this week.

Chapter 5 — Biology as Hour looking (not a year dump)



Figure 7: A kitchen-table still-life from a high three-quarter view: a plant with a simple inputs–outputs card, a dated notebook open to a claim pointing at a row, a sticky that reads “not a year dump,” a soft body-subsystem card set aside. No dissection tray as default. No people. No logos. No readable package branding.

Why this matters

The binder says Biology. Unit lists stretch to the horizon: cells, tissues, organs, kingdoms, cycles, genetics, evolution, ecology — finish by Friday. The notebook stays thin. The adolescent learns that Biology means racing titles.

That itch is ordinary. It is not the hour. Biology topics at ages 15–18 are *vehicles* for systems looking and denser claim-with-evidence — not an encyclopedia year as the weekly spine. Body as interacting systems (not medical school). Photosynthesis as inputs and outputs you can point at. Trait variation in a sample you measured. One ecosystem question in a yard or park. DNA → protein as a map claim on paper (not a home wet lab). Dissection optional, never required. One living-system question this week. Boundary. Notebook evidence. Claim that points at the page. Stop.

What this idea unlocks is Biology that can survive a stranger’s eye. A vocabulary parade with no lookable teaches short-term matching. A scavenger worksheet at the zoo with no question teaches tourism. A generated gel filed as “my electrophoresis result” teaches fraud. One owned try — systems boundary on a living system, evidence locatable in *this* notebook, a warrant that names a scientific idea already on the table — is how high-school Biology looking stays honest. Chapter 4 built the systems move. Chapter 3 built fair-test redesign. Chapter 7 will densify CER. This chapter puts living systems on those rails without dumping a year.

Two refusals sit beside the idea, or the week becomes noise.

Coverage of every kingdom is not the program. Framework and NGSS high-school life-science families are a map ceiling — texture for what looking *can* include — not a mandate to finish every performance expectation this month. Assessment boundaries in public frameworks often refuse specific cell-type laundry lists and full biochemistry of protein synthesis as required assessment grain; borrow that honesty. Depth is the hour. *Science for Homeschooling* holds survey-year jobs for Biology as a transcript architecture problem; one pointer, then teach this week’s living-system looking. Do not reprint that book’s TOC as this chapter.

Dissection-as-identity is not the program either. Dissection is optional, never required. Home vertebrate dissection is refused as default. Soft alternatives — models, labelled simulations, museum specimens, organ-relationship diagrams — count as systems looking when the notebook owns the claim. Lab-path neighbor benches exist for supervised work when a family chooses that path with RAMP

and host rules. Curiosity is not a permit for unsupervised cutting.

A third refusal belongs in the same breath: Biology as culture-war pamphlet. Evolution and related public-map ideas appear only as the public map places them — one sentence naming a live debate when load-bearing for the idea, then look and measure. The hour is not a sermon from the left or the right. Trait variation you measured is allowed. Just-so stories with no evidence are not. Climate-as-policy theater is not this chapter's job; Earth soft neighbors handle water systems without a pamphlet.

Prior ideas are the mind at rest. Hear plants-eat-through-roots. Hear cells-as-tiny-mouths. Hear "DNA is a tiny person." Repair with another look and a named idea just-in-time. Do not scold. Do not replace looking with a lecture about how wrong they were.

You do not need to be a biologist. You do need one living system on the table (or in the yard), a blank notebook page, and one question you have not already filled with the explanation.

This week you can learn to pick one living-system question instead of a chapter list. Today the student can run one Biology vehicle try with a systems boundary and one notebook claim pointer.

For the parent: understand it yourself

Many adults remember Biology as a vocabulary binder or a dissection day that felt like "real science." That is ordinary. Five minutes here, then the warm-up, is enough for tomorrow. The student still looks, measures, and claims.

Everyday picture. A houseplant on a sill. Someone asks what is happening. A year-dump answer lists organelles, light reactions, dark reactions, stomata names, and three textbook paragraphs. An Hour answer draws a boundary around plant + pot + air in view, marks light in and growth/water notices out, points at a notebook row from a light/dark soft compare if you ran one, and names what the model leaves out (gases not measured; full biochemistry not claimed). Same plant. Different job.

Precise picture. Biology as Hour looking means: choose a living-system vehicle; put a systems boundary on it; gather evidence a stranger can locate in the notebook; write or say denser CER with a warrant that names a scientific idea

(energy/matter in ecosystems, structure–function, variation, information flow as map); name a limitation or alternative. PFI 2016 texture among homeschooled students in grades 9–12: biology showed up for **29%** that year and **66%** ever in that table — a neighbor census, not a mandate for your kitchen. This is useful survey texture, not a promise that every home will see the same result. You may still run photosynthesis I/O this month. You are not failing if this week is variation in leaf samples and an ecosystem one-question walk.

Five vehicle cards carry the bank (BIO-01...06). You pick **one** for the week — not six.

- **BIO-01 Body as interacting systems** — two subsystems, one interaction; refuse diagnosing family members.
- **BIO-02 Photosynthesis inputs–outputs** — arrows + fair-ish light compare if safe; refuse claiming full mechanism from one jar.
- **BIO-03 Trait variation in a sample** — measure, graph, talk selection *potential* without a just-so story.
- **BIO-04 Ecosystem one question** — yard/park plot; one ecological question; refuse scavenger dump.
- **BIO-05 DNA → protein claim soft** — paper evidence cards; refuse generated gel; lab-path if family wants electrophoresis.
- **BIO-06 Optional dissection honesty / alternative** — choose path; systems learning goal either way.

Wrong answers you should be able to hear

1. *Kingdom coverage mania*. “We have to finish cells, ecology, and genetics this month.” No notebook from one try. Hear the map replacing the hour. Say: “One living-system question this week. Boundary. Claim from the notebook. The map waits.”
2. *Cells-as-tiny-mouths unrepaired — or over-repaired*. Prior idea sits, or a scolding lecture replaces looking. Hear prior idea as mind at rest. Another look + named idea just-in-time. Caption what they can point to before the organelle parade.
3. *Generated gel / micrograph as result*. An image tool produces a “my gel” or “my cheek cell photo.” It lands in the portfolio as lab. Hear generated image $\neq$ data. Paper map for BIO-05. Real slide or printed secondary micrograph captioned after looking. Lab-path for real electrophoresis. House rule: fiction stays labelled fiction.

4. *Kitchen DNA extraction as molecular Biology credit.* Strawberry goo in a bag feels exciting — then “we did genetics lab.” Hear the credit grab. Name it: DNA extraction picture soft, if you run it with adult and food-safe materials, is a structure notice — not PCR, not sequencing, not a “With Lab” genetics claim by itself. Notebook honesty tag required.
5. *Required dissection culture / unsupervised home vertebrate work.* “Real Biology means cutting.” Hear identity theater. Optional never required. Soft alternatives count. Lab-path only for real dissection with PPE and supervision. Home vertebrate dissection refused as default.

A sixth you will also hear: “Just tell me the AP Biology answer.” The student wants the CED unit as Tuesday’s identity. Point at the living system and the blank page. Ask the locked opening. Occasional FRQ-shaped stretch at 17–18 is an edge, not the weekly spine. There is no rule that AP Biology *is* the Science Hour.

A seventh: model summary as the observation — a chatbot paragraph on photosynthesis filed as today’s look. Trash kindly. Eyes on the plant. Then diagram.

Five-to-eight-minute parent warm-up

Do this alone with tomorrow’s living lookable — plant, body-subsystem card, leaf sample bag, or evidence-card set — before the lesson.

Minute 1. Pick **one** BIO card for the week. Put the every-kingdom binder away for this hour.

Minute 2. Sketch a systems boundary on the lookable. Add one input and one output. Write one leaves-out sticky.

Minute 3. Practice the locked opening: “What is happening in this living system — and which notebook evidence makes you say that?” Count a slow three. Look at the plant or the card, not at an imaginary adolescent.

Minute 4. RAMP if needed: living no-harm, return, wash hands; adult present for outdoor water, lamps, cutting tools; no mold cultivation; dissection path honesty if that card is in play.

Minute 5–8. Decide BIO-02 or BIO-01 as the first try if systems habits from Chapter 4 are steady; if notebooks are thin, keep one REC stranger-check from Chapter 2 in the week. Write one denser CER crumb you hope to hear — claim + row pointer + because-the-idea — then put your sample answer away so you do not dictate it.

How to teach it this week

Science Hour stays the five beats: open / living system or question + RAMP if needed; short look or prior-idea card; one try / measure / record; talk box + denser CER; exit ticket. This week the vehicle is Biology. Total often ~30–50 minutes. Stop while a look remains.

Warm-up looking (3–7 min). Living system visible first — plant, plot photo from yesterday’s walk, body-subsystem card, leaf samples. Cover captions that already explain everything. Ask what they notice. Wait a slow three.

Frame the living system (4–8 min). Boundary from Chapter 4. Name today’s question in ordinary words. At 15–16, co-build boundary and evidence plan. At 17–18, more independent system model and multi-trial compare when ready. Adult present for lamps, outdoor work, any cutting, any kitchen DNA picture, any lab-path plan.

Try / measure / record (15–25 min). One BIO try. Blank table or observation log before the race. Messy real notices beat invented neat growth numbers. Secondary data allowed when labelled secondary (BIO-02 honesty; BIO-05 evidence cards). Photo of setup is context, not a substitute for numbers.

Talk + denser CER (5–10 min). Locked opening. Claim about the living system. Evidence that points at a notebook cell. Warrant that names an idea (energy/matter, structure–function, variation, information flow as map). One limitation *or* alternative at 15–16; both when ready at 17–18. Chapter 7 densifies further; this week the living-system pointer owns the hour.

Exit ticket (2–5 min). “Living system: . **Evidence row:** . Leaves out / limitation: ____.” Or interaction sentence (BIO-01). Or inputs/outputs + evidence tag mine/secondary (BIO-02). Diagnostic wrong tagged for tomorrow.

Exact wording you can say

- “What is happening in this living system — and which notebook evidence makes you say that?”
- “Where is the boundary — what crosses it?”
- “What do you *see* or *measure* — what does the notebook show?”
- “Why would that measurement count for *this* idea?”
- “What does this model leave out — what else could explain these notices?”
- “You may change your mind after another look. Insufficient evidence is

allowed.”

Age-band moves: 15–16 / 17–18

15–16. Scaffolded boundary on the living system; stranger-readable notebook; denser CER with warrant; one limitation *or* alternative prompted; BIO vehicle as *this week’s* identity; adult present; AP labelled only if family uses the map as edge.

17–18. More independent living-system model; multi-trial or multi-sample compare; alternative explanations *and* limitations; BIO-05 paper map careful; occasional lab-path neighbor for real techniques; occasional FRQ-shaped stretch labelled stretch — still not AP as weekly spine. If systems or fair-test habits are weak, stay on Chapter 3–4 moves longer inside a soft BIO vehicle. Skill, not birthday.

Parent learns this week. Pick one living-system question for the week, not a chapter list.

Student tries today. One BIO vehicle try with systems boundary + one notebook claim pointer.

First try-it. BIO-02 Photosynthesis Inputs–Outputs, or BIO-01 Body as Interacting Systems. Fade help: co-boundary → they boundary while you watch → denser CER oral then short write → OUT ecosystem question when home try is steady.

When to stop talking. When you are performing the unit list while their plant sits unmeasured. One question. Stop. Look at the living system or the notebook if the silence is hard.

This-week sketch (illustration, not a script law)

Day	Focus	Card
Mon	Boundary + one BIO vehicle start	BIO-01 or BIO-02
Wed	Measure / record + denser CER crumb	Same vehicle continue or BIO-03
Fri	Exit + diagnostic; optional BIO-06 honesty	Exit menu
Optional OUT	Ecosystem one question / zoo soft after notebook	BIO-04 + OUT-02

Day	Focus	Card
Stretch 17–18	DNA→protein paper map; refuse generated gel	BIO-05

Three to five Science Hours plus one OUT is a full week. One living-system question beats a kingdom scavenger.

Practice that actually builds learning

Named try-its below carry **time, materials, safety, the fun, the skill**. Library, walk, museum, zoo, kitchen, yard, and lab-path neighbor *are* the practice — they do not replace systems-and-claim looking on a living system.

Talk box

Opening (locked): “What is happening in this living system — and which notebook evidence makes you say that?”

Follow-ups:

1. What do you *see* or *measure* in this living system?
2. What does the notebook / table show — which row or notice?
3. How do you know from *this* — what warrant ties the evidence to the idea?
4. What else could explain these notices — what does the model leave out — can we tell for sure?
5. You may change your mind after another look. Redesign once if the try was confounded. Insufficient evidence is allowed.

How to wait. After you ask, a slow three is a convention, not a sacrament (elementary science classroom origin). After they stop, wait again. If they are mid-measure or mid-claim, do not cut them off. Look at the plant, the plot, the card, or the notebook, not at the adolescent, if the silence is hard.

Stuck silence usually means: the question was vague; wait-time was zero; they are hunting a vocabulary word because you asked name-first; they are guessing what you want; the living system never landed; they offered a book-only guess;

they think Biology means “repeat the parent’s explanation”; they invent neat growth numbers because the trial was messy; they are bracing for an AP rubric sentence. Pose, wait, and point back at the notebook — not fill the silence with the right kingdom list, and not turn the table into a fight.

In-home try-its (BIO bank)

BIO-01 Body as Interacting Systems (Not Medical School)

- **Band:** both
- **Time:** 35–50 min
- **Materials:** Two-system card (e.g. respiratory–circulatory) plain diagram; notebook; optional pulse count with consent and hygiene
- **Safety:** Diagram default; optional pulse with consent, hygiene, no diagnosing family; no medical advice
- **The fun:** Seeing two systems talk to each other feels like discovering a hidden handshake.
- **The skill:** Boundary each subsystem; name one interaction; refuse organ-list memorization as the whole hour.
- **Steps:** Cards down. Boundary each. Interaction sentence. Talk box. Exit: interaction sentence pointing at the card.
- **Error patterns:** Organ list only; medical advice; diagnosing relatives from a diagram.

BIO-02 Photosynthesis Inputs–Outputs Picture

- **Band:** both
- **Time:** 35–50 min (multi-day soft OK)
- **Materials:** Plant + light/dark setup honesty; or labelled secondary data if home try weak; arrow stickies; notebook
- **Safety:** Plants only; adult for lamps/cords; no sealed dangerous gas collection; water away from outlets
- **The fun:** Watching a plant answer slowly turns patience into data — or honesty about secondary evidence.
- **The skill:** Systems arrows for matter/energy; fair-ish compare light conditions if safe; CER; refuse claiming full biochem mechanism from one jar; tag evidence mine / secondary.
- **Exit ticket:** Inputs/outputs + evidence tag (mine / secondary).
- **Error patterns:** “Plants eat soil” unrepaired; inventing O₂ numbers; filing

a chat summary as observation; sealed risky gas setups.

BIO-03 Trait Variation in a Sample

- **Band:** both
- **Time:** 30–45 min
- **Materials:** Leaves, beans, or public class-height secondary set labelled secondary; ruler; notebook; graph paper
- **Safety:** Living no-harm; wash hands; allergy check
- **The fun:** A pile of “same” leaves becomes a spread — variation becomes visible.
- **The skill:** Measure variation; graph; talk selection *potential* without forcing a just-so story; refuse inventing measures.
- **Exit ticket:** Range + one claim about variation with a row pointer.
- **Error patterns:** “Variation means anything survives”; inventing measures; culture-war sermon as the hour.

BIO-05 DNA → Protein Claim Soft (Map, Not Wet Lab)

- **Band:** 17–18 (careful 15–16)
- **Time:** 30–45 min
- **Materials:** Framework/NGSS-style explanation task on paper; evidence cards; honesty: no home PCR/gel
- **Safety:** Paper only at home default; lab-path if family wants electrophoresis
- **The fun:** Building an explanation from cards feels like detective work without fake gels.
- **The skill:** Construct explanation from provided evidence cards; **refuse generated gel as result**; schedule OUT lab-path neighbor if electrophoresis is desired.
- **Exit ticket:** Explanation with evidence cards cited.
- **Error patterns:** Filing AI gel; kitchen “DNA extraction” as molecular Biology credit; inventing band patterns.

BIO-06 Optional Dissection Honesty / Alternative

- **Band:** both
- **Time:** 20–40 min
- **Materials:** Honesty card: dissection optional never required; alternative: model, simulation labelled sim, museum specimen, organ-relationship diagram

- **Safety:** Lab-path only for real dissection; PPE; host rules; home vertebrate dissection refused as default
- **The fun:** Choosing a path with integrity feels like adult agency — learning still happens either way.
- **The skill:** Choose path; if dissecting via co-op/lab-path, RAMP + supervision; else systems diagram of organ relationships with a named learning goal.
- **Exit ticket:** Path chosen + one systems learning goal.
- **Error patterns:** Required dissection culture; unsupervised home vertebrate work; treating refusal as “not real Biology.”

Out-of-home try-its

BIO-04 Ecosystem One Question (with OUT-02)

- **Band:** both
- **Time:** 35–50 min
- **Materials:** Yard/park plot or soft transect; one ecological question; notebook; adult
- **Safety:** Outdoor adult; weather; hygiene; leave-no-trace; no protected-species harm; tick awareness as relevant
- **The fun:** A hoop or transect turns a familiar yard into a study plot with one real question.
- **The skill:** Systems boundary of plot; observe; claim with evidence; refuse scavenger worksheet dump.
- **Exit ticket:** Question + claim + one observation with location.
- **Error patterns:** Listing twenty species with no question; inventing counts; aimless walk called science.

Zoo / aquarium soft (outing grain)

- **Band:** both
- **Time:** visit-dependent; bring Hour grain home
- **Materials:** Notebook; one exhibit chosen; adult
- **Safety:** Venue rules; adult present
- **The fun:** One exhibit looked at as a system beats a stamp-card race.
- **The skill:** Boundary of displayed system; three observations; CER crumb; refuse whole-venue scavenger dump. Outing rows motivate (zoo/aquarium soft texture in national outing tables) — they do not replace the notebook

claim.

- **Exit ticket:** Exhibit name + living-system claim + evidence note.
- **Error patterns:** Worksheet packet racing; photos without claims; inventing animal “data” from memory at home.

Blocked for a new move / mixed for when to use it

Blocked (one new move): BIO-01 or BIO-02 alone with Chapter 4 boundary until the student can point at notebook evidence when they claim. Then denser CER crumb. Then one OUT.

Mixed (when the move holds): Pair BIO-03 with a Chapter 3 fair-test redesign if measurement was confounded; pair BIO-05 with AS gel-refusal honesty; pair BIO-04 the same week as a steady home vehicle; Friday BIO-06 honesty when dissection pressure appears.

One incorrect example to diagnose

Illustration (composite, not a reported family): An eighteen-year-old “finishes” genetics week by pasting a generated electrophoresis image into the notebook, captioned “my DNA results.” No evidence cards. No lab-path. A chat window wrote the CER. The transcript sticky says a brand title. Parent is relieved the unit is “done.”

What you hear: Generated gel as result + write-my-lab-report + coverage mania + brand-as-credit risk.

Next move: Kind refuse. Label the image fiction and remove it from “my results.” Run BIO-05 on paper evidence cards. Locked opening. Warrant from cards cited. If the family wants real electrophoresis, plan OUT-06 lab-path with RAMP — skip any garage gel. Put work under Biology when the work is Biology looking — never a brand as the credit line. “With Lab” remains a claim that needs supervised investigation evidence.

Exit crumb shapes

- “Living system: . **Evidence:** row/notice . Because (idea): ____.”
- “Inputs: . **Outputs:** . Tag: mine / secondary.”
- “Variation range: . **Claim:** .”

- “Question: . **Claim:** . One observation: ____.”
- “Path (dissect / alternative): . **Systems goal:** .”

Sibling and mixed-band notes

If two adolescents share the hour, same living system, parallel jobs when bands differ: one owns boundary while the other owns evidence pointers; then swap. Do not race for who “knows more kingdoms.” Kindness is part of safety. A younger sibling from *Science for Young Minds* age may help count leaf samples; they do not own denser DNA-map warrants as a quiz. This book ages up — one pointer to the earlier book, then teach 15–18 Biology as Hour looking. *Science for Homeschooling* holds Biology survey-year jobs; one pointer, then teach this week’s vehicle.

Dose and safety (week grain)

Three to five Science Hours plus one OUT is enough. Multi-day plant logs can run beside shorter talks; they do not require a 180-day calendar. Safety spine still holds: adult present for heat, electricity, outdoor water, chemicals, glassware, living specimens, cutting tools; RAMP before the try; living things — no harm, return, wash hands; mold cultivation refused by default; home vertebrate dissection refused as default; no unmarked bottles; no unauthorized mixes. Kitchen DNA pictures stay pictures. Generated gels stay fiction. Lab-path neighbors for regulated techniques are scheduled honesty, not guilt.

What Biology Hour looking does not mean this week

It does not mean every kingdom. It does not mean AP Biology as Tuesday. It does not mean dissection as identity. It does not mean a culture-war pamphlet. It does not mean inventing growth numbers so the graph looks right. It means one living system, a boundary, locatable evidence, a warrant, and honesty about limits. Depth is the hour. The map waits on the shelf.

If systems looking (Chapter 4) or fair-test redesign (Chapter 3) is still thin, keep those moves inside the BIO vehicle — do not abandon the spine for coverage. Place by skill. A path through high-school Biology looking is the promise. A diploma is not. A percentile is not. An AP score is not the only path that counts.

Coverage itch vs one-question depth

The coverage itch will return midweek. Treat it as a diagnostic, not as a moral failure. When the itch says “add mitosis, add meiosis, add five kingdoms,” answer with the week’s one question on the whiteboard or sticky: *What is happening in this living system — and which notebook evidence makes you say that?* If the sticky is full and the notebook is empty, the itch won. Put the binder away for twenty minutes. Finish the claim pointer.

Soft Earth neighbor (same spine)

If the week’s living system is a plot or stream edge, EARTH-02 water-in-the-system can sit as a neighbor day without becoming a second survey. Boundary the watershed soft. One flow. No culture-war dump. Return to the BIO claim. Outing tables that mention zoo or aquarium visits are motivation texture — then notebook — not a substitute for the claim.

For the student

Biology as Hour looking means you study a **living system** this week — not every topic in the binder. You draw a boundary. You gather evidence in your notebook. You claim what is happening and point at the page. You name what you did not measure.

Tool words help when they earn their keep: **system, input, output, variation, structure–function, evidence, warrant, limitation**. Tool words are not a matching test with no organism in view.

At 15–18 the bar rises: a stranger should find your evidence; “plants eat soil” gets another look, not a shame lecture; a generated gel is not your result; a chat CER is not your claim; dissection is optional, never a loyalty test.

Tiny worked example

Living system: A bean plant on a sill (boundary: plant + pot + nearby air you are treating together).

Question: What inputs and outputs can we name — and what evidence do we have?

Look: Light on vs cloth-covered soft compare (adult lamp safety), or honest secondary data tagged secondary if the home try is weak.

Notebook: Date; setup sketch; notices or measurements; tag mine / secondary.

Claim crumb: Light energy is an input to this plant system; growth/appearance notices differ by light condition — evidence: rows 1–3 — warrant: energy/matter in living systems — limitation: we did not measure gases; full photosynthesis chemistry not claimed.

Try 1

Pick BIO-01 or BIO-02. Draw the boundary. Fill one input and one output. Answer the locked question out loud while pointing at a notebook row or notice.

Try 2

Do BIO-03 (variation) or BIO-04 (ecosystem one question outdoors with an adult). Graph or tally from *your* counts. Say one limitation. Optional at 17–18: BIO-05 paper map — refuse any generated gel.

Explain it back

In your own words: What is happening in this living system — and which notebook evidence makes you say that? Point at the page while you talk.

Challenge

Plan next week's vehicle: same living system, new question — or new system, same systems+claim moves. At 17–18, write one falsifier: "This claim would be weaker if ____."

If it isn't clicking

Diagnostic 1 — Coverage mania.

They (or you) keep adding kingdoms instead of finishing one claim.

Next move: Put the binder away. One BIO card. Locked opening. Exit ticket before any new topic.

Diagnostic 2 — Book-only / chat-only Biology.

Fluent paragraphs; no locatable evidence from a try.

Next move: BIO-02 or BIO-04 with a blank table first. Delete unlocatable sentences. Evidence must point at a cell.

Diagnostic 3 — Generated result or kitchen-as-credit.

Fake gel, invent-neat growth, or strawberry goo filed as genetics lab credit.

Next move: Honesty card. Fiction labelled fiction. BIO-05 paper path or soft extraction tagged *picture, not molecular credit*. Redesign the portfolio page.

When to slow down. If Chapter 4 boundary or Chapter 3 redesign is weak, repair those inside a gentle BIO-01 diagram week. Living systems without a boundary become vocabulary theater.

When to go ahead. When they point at notebook evidence without hunting your face, and can name one limitation, move toward BIO-03/04 and careful BIO-05. Mix last week's plant into Friday's denser CER.

When to get a human tutor. If dissection pressure is causing harm, if outdoor safety keeps failing, or if every hour becomes a culture-war fight, a co-op Biology mentor or lab-path host can help. A chatbot is not a tutor for inventing the gel.

Correct a wrong reason without crushing the look. Point at the plant. Ask the locked question. Keep the messy page.

Tools, including AI

Point back to the Science Hour AI box. Keep this short.

You may, on your account: ask a tool to explain a named Biology idea *to you* from a named lesson page or today's apparatus (plant, subsystem card, evidence cards); generate extra isomorphic practice with the key held by you; ask for a labelled SCRIPT after the try; ask for revision questions after *their* CER draft; diagnose work they already produced (crop to the paper).

You may not: invent an observation or growth table; generate a gel, micrograph, or "cheek cell photo" as their result; put a model summary on the table as the observation; write their lab report or CER; park an unsupervised chatbot as their only partner during the attempt; coach live-exam or application fraud.

Unaided first on looking, measuring, and recording. SCRIPT after the try. At 15–16, still in the room. At 17–18, co-hold and keep AP / Common App integrity — revision questions after *their* draft remain allowed; “write my lab report” / “write my Common App essay” does not. Bastani et al. (2025) remains **off-age for science hour** (high-school math trial) — one caution, then teach. A fluent filled blank from a machine is performance, not the student’s Biology looking.

What “done enough” looks like

Before you move on from this chapter’s focus, you should be able to check most of this list — by skill, not by birthday.

- ☐ One living-system vehicle completed with a drawn boundary and at least one input/output or interaction named.
- ☐ Notebook evidence is locatable (row, notice, or tagged secondary cards) — not invent-neat, not chat-only.
- ☐ Student answers the locked opening while pointing at the notebook.
- ☐ Denser CER crumb includes a warrant phrase naming a scientific idea; 15–16 has limitation *or* alternative; 17–18 moving toward both.
- ☐ Generated gel/micrograph refused as result; kitchen DNA picture not filed as molecular credit.
- ☐ Dissection treated as optional never required; alternative path has a systems learning goal if chosen.
- ☐ One OUT (BIO-04 / zoo soft / lab-path) invited in the same week or the next when ready.
- ☐ Work titled Biology (or Science) when accurate — never a brand; “With Lab” only with supervised investigation evidence.
- ☐ Exit ticket done; one diagnostic wrong tagged for tomorrow without percentile identity.

A “grade 11 Biology workbook” is a publisher’s scope, not a legal grade, and not a transcript line. Biology Hour looking lives under **Biology** or **Science** when the work is actually that — never “Emerging Adults Science I,” never a product title as the credit.

Done enough is showable two ways and holds after a night: they can retell the living-system claim with a finger on the page *and* name one thing the model left out. What still needs practice gets next Tuesday — mix last week’s vehicle into

Chapter 6's Chem/Phys hour or Chapter 7's denser CER when ready. Life of the habit is the session rhythm and the file you keep, not a ninth teaching chapter.

You looked at a living system. You pointed at the notebook. You did not dump a year. That is Biology as Hour looking at 15–18. That is enough for this week.

Chapter 6 — Chemistry and Physics as Hour looking



Figure 8: A RAMP card beside splash goggles, a kitchen honesty card labelled not Chemistry credit, a change-of-motion card with a small ramp and ball, and a dated notebook titled Chemistry or Physics. Still-life. No people. No brand logos.

Why this matters

What changed in the matter or the motion — and how do we know safely from this trial?

That is not a request for a vinegar volcano filed as Chemistry with Lab. It is not a wall of algebra that keeps Physics out of the kitchen until calculus arrives. It is not a binder titled simply “AP Physics” — College Board names Physics 1, Physics 2, and Physics C; there is no course titled only “AP Physics.” It is the question that turns a change you can stop, a mass you can weigh, or a ball that slows on a table into this week’s vehicle for systems looking and a denser claim from the notebook.

Chemistry and Physics share one looking chapter in this book because both live under the same locks: safety first, algebra as a tool beside the idea when ready, kitchen pictures stay pictures, and AP sits as an optional edge. They are not the same subject. Salt dissolving and a cart on a ramp ask different questions. They share the same Science Hour spine: put a system on the table, look before the tidy name, measure, record, claim with a warrant, name what you still cannot tell — and stop if you cannot minimize the risk.

If your family used *Science for Young Minds*, you already practiced fair tests, CER light, and one-phenomenon depth in physical science. This chapter ages that habit up. At 15–16 the exit is a RAMP card completed, one Chem or Phys vehicle try, and a denser CER crumb that points at the table. At 17–18 it stretches toward multi-trial comparison, uncertainty talk, mole-as-amount meaning, slope-as-rate, and an occasional lab-path neighbor when the try needs real glassware — still not a survey dump of every reaction or every force law, and still not AP as Tuesday’s script. *Science for Homeschooling* owns the grades 1–12 survey and transcript architecture. One pointer, then teach 15–18 looking. *Math for Emerging Adults* owns algebra as representation; here algebra sits beside the motion or the amount when the student is ready. One pointer, then teach science looking.

What this idea unlocks is honest physical-science looking at home without pretending the sink is a secondary lab. ACS secondary safety language asks Recognize, Assess, Minimize, Prepare — RAMP — before heat or chemicals.¹ NSTA and related school-lab guidance keep an adult physically present for the whole experiment; at home you are that adult.² America’s Lab Report asks for lab work

¹ACS secondary / high-school safety language: Recognize, Assess, Minimize, Prepare (RAMP) before heat or chemicals. Access date 17 September 2026.

²NSTA and related school-lab guidance: an adult physically present for the whole experiment;

sequenced with idea and discussion, not an isolated “lab day” that never talks.³ Framework and NGSS high-school maps already expect models, precision, and alternative explanations — as moves, not as a franchise to cover.⁴ That is a useful study grain, not a promise that every home will see the same result. Then teach.

Among homeschooled ninth-through-twelfth-graders in 2016, chemistry or physics was taught that year to about 22 percent, and ever taught to about 41 percent.⁵ Many high-school science years have been reading years. A kitchen that never measures is not “behind” because it skipped a brand. A kitchen that measures once a week with a RAMP card and a stranger-readable notebook is already doing the looking move this book owns.

You do not need to be a chemist or a physicist. You do need to hear force-as-fuel, kitchen-as-Chemistry-credit, unsupervised “they’re old enough,” algebra-as-wall, invent-data neat rows, a generated titration curve filed as the student’s result, and AP-as-weekly-spine — and to ask the locked question, then wait. Hearing those wrong turns is teaching. Filling the silence with an equation lecture is not.

This week you can learn to complete a RAMP card before any heat or chemical try, say the kitchen honesty sentence out loud, and ask change-of-motion instead of force-as-fuel. Today the student can run one Chem or Phys vehicle try with RAMP done and leave one notebook claim that points at a row.

Picture two Fridays. In one, a dramatic fizz sits in a photo album labelled “Chemistry finished,” with no RAMP, no mass table, and a transcript line that claims Lab. In the other, a small planned reaction or a ramp trial has a RAMP card, goggles when splash risk is real, a table with units, a claim with a warrant, and an honesty tag: picture — or lab-path neighbor planned for next month. Both rooms feel busy. Only one taught looking you can defend to a stranger.

at home the parent is that adult. Access date 17 September 2026.

³National Research Council, *America’s Lab Report* (2006): integrate laboratory experiences with instruction and discussion; isolated “lab day” theater is not the effective pattern reviewed there.

⁴NRC *A Framework for K–12 Science Education* (2012) and NGSS (2013) high-school maps: models, precision, and alternative explanations as *moves*, not a franchise to cover.

⁵Cui and Hanson, NCES 2020-001 (PFI 2016), grades 9–12 *that year*: chemistry or physics about 22%; *ever* among 9–12 about 41%. Do not mash middle-grades cells into this band.

For the parent: understand it yourself

Many adults remember chemistry as a memorized list of elements and a fear of the word *mole*. Many remember physics as “the class after you finished algebra.” Rust on both is normal. It is not a character flaw. Five to eight minutes of this section, then the warm-up, is enough for tomorrow. The student still measures.

Everyday picture — Chemistry. Three adult-approved household solids sit in labelled dishes: salt, sugar, baking soda. No tasting. No mixing beyond the plan. The student records color, grain, whether each dissolves in a small measured water volume you approve. Names come *after* properties. Later in the week, a tiny vinegar-and-soda fizz in an open cup (or a sealed-bag contrast for conservation weighing) runs only after RAMP. On the table sits a card: *Kitchen change-of-matter picture* $\neq$ *Chemistry credit*. That honesty is part of the lesson.

Everyday picture — Physics. A ball rolls across a table and slows. You ask what changed in the motion. If they say “it ran out of force,” you do not scold. You put another look on the table: same ball, smoother path, or a gentle push after it slows — and name the idea just-in-time: forces change motion; they do not ride inside the ball like fuel.⁶ A stopwatch, a metre stick or tape, a simple table, and later a slope sentence turn the look into rate talk. Algebra sits beside the graph when ready. A qualitative path is still physics looking when the idea is clear and the numbers are honest.

Precise picture. *Chemistry as Hour vehicle* means properties before names; a reaction you can stop; conservation as weighing honesty (open vs closed systems); concentration sense with food-safe dilution, not stock acids; mole as “amount of substance” meaning before a drill packet; and a lab-path neighbor planner when glassware, burners, or regulated chemicals are needed. *Physics as Hour vehicle* means change-of-motion (not force-as-fuel); energy transfer storyboard with thermal honesty; wave patterns without lasers in the default bank; circuits with battery packs only or skip to a labelled simulation / OUT; graph slope as rate. Both vehicles use the twin spines from earlier chapters: systems boundary and denser CER from *this* notebook.

Safety is not optional at fifteen. Turning 15 or 17 does not unlock unsupervised mixing. Adult present for heat, electricity beyond toys, outdoor water, chemicals,

⁶Force-as-fuel prior idea: forces change motion; they do not ride inside the object like fuel — *Taking Science to School* / Framework grain labelled for home. Limit line: useful study shape, not a promise every home sees the same result.

glassware, and any kitchen chemistry picture. RAMP before the try. No unmarked bottles. No bleach mixes. No drain cleaners. No alcohol flames. No sealed pressurized fizz bottles scaled for drama. No lasers in the default bank. Living things: care, return, wash hands; mold cultivation refused by default; home vertebrate dissection refused as default. Regulated chemicals, Bunsen-style burners, and electrophoresis belong on a lab-path neighbor, not in a default home bank.^{7 8}

Algebra as tool, not wall. When the student can read a table and a graph, slope-as-rate and simple proportional talk earn a place beside the idea. When they cannot yet, keep the qualitative path and the notebook honest. Do not make the Science Hour a graphing unit with no system on the table. Do not dump calculus as a gate for ordinary change-of-motion looking. AP Physics 1 is algebra-based; Physics C is calculus-based — both are College Board vendor edges, not this week’s required identity.⁹

Wrong answers you should be able to hear

1. *Force-as-fuel.* “The ball stopped because it ran out of force / energy fuel.” Repair: another look; name that forces change motion; ask what was different between trials; point at the table. Do not equation-punish.
2. *Kitchen-as-Chemistry-credit.* “We did a volcano, so it’s Chemistry with Lab.” Repair: honesty card; list what a supervised secondary path would add; plan CHEM-05 / OUT-06 if credit-path lab skills are a real family goal.
3. *Unsupervised “they’re old enough.”* Learner alone with heat, glass, or mixing. Repair: stop; adult present for the entire try; RAMP or skip.
4. *Algebra-as-wall / bare “AP Physics” mash.* “We can’t do physics until Pre-calculus” or transcript line “AP Physics.” Repair: qualitative path now; algebra beside the idea when ready; title **Physics** or **Physics with Lab**; name Physics 1 / 2 / C only as exam edges if they sit them.
5. *Invent-data / generated curve as result / coverage hour / AP packet as every Friday.* Neat rows that never happened; AI titration curve filed as theirs;

⁷ACS secondary / high-school safety language: Recognize, Assess, Minimize, Prepare (RAMP) before heat or chemicals. Access date 17 September 2026.

⁸NSTA and related school-lab guidance: an adult physically present for the whole experiment; at home the parent is that adult. Access date 17 September 2026.

⁹College Board AP Physics naming: Physics 1 / 2 (algebra-based) and Physics C (calculus-based); there is no course titled simply “AP Physics.” Vendor edges, not this week’s required identity. Access date 17 September 2026.

vocabulary march with no try; FRQ every session. Repair: stop; honesty; redesign or labelled secondary data; one vehicle try; occasional WRITE-06 stretch only when denser CER is stable — point back to the Science Hour AI box.

A sixth: *name-first vocabulary dump* — “define molarity” before any property or dilution look. Repair: properties or dilution series first; names just-in-time.

What “With Lab” would need that a picture lacks (say once). Supervised investigation that actually happened; dated notebook with question, method, data, claim; adult present for higher-hazard work; often glassware controls and assessment of lab skills a stranger could recognize. America’s Lab Report does not convert a baking-soda picture into Chemistry credit.¹⁰ PhET or a vendor note that experiments are “encouraged but not mandatory” is a teaching feature or publisher copy — not an automatic lab credit for every reader of a transcript. Keep the three stacks separate: lawful (your state’s map), safe (RAMP + adult), readable to a stranger (title + evidence).

Five-to-eight-minute parent warm-up

Do this alone, with tomorrow’s apparatus.

Minute 1. Decide Chem or Phys for this week’s vehicle. One is enough.

Minute 2. Complete a RAMP card for the planned try — or circle skip / redesign / lab-path neighbor. If you cannot Minimize, you do not run.

Minute 3. Write the kitchen honesty sentence if Chem is on the table: “This is a picture, not Chemistry credit.” Put the card where they can see it.

Minute 4. Practice the locked opening aloud. Practice one change-of-motion sentence without force-as-fuel, or one conservation sentence about open vs closed.

Minute 5. Cut denser CER to claim + notebook pointer + because-the-idea. Save multi-trial synthesis for later.

Minute 6. Decide band exit: 15–16 scaffolded RAMP + one try + oral CER crumb; 17–18 more independent design check before run + uncertainty crumb or slope sentence.

¹⁰National Research Council, *America’s Lab Report* (2006): integrate laboratory experiences with instruction and discussion; isolated “lab day” theater is not the effective pattern reviewed there.

Minute 7. Lay out goggles if splash/heat/glass risk is real. Clear the food surface if non-food chemicals will touch it — or keep the try food-safe and labelled.

Minute 8. Put the model answer away. You are ready. They measure.

How to teach it this week

The Science Hour chapter holds the full session shape. Here is the same five beats scaled to Chem or Phys as this week's vehicle. Keep thirty to fifty minutes. If a day only holds thirty: RAMP (if needed) + one measurement or one conservation / motion look + exit ticket.

1. Open / system or question + RAMP (3–7 min). Name today's outcome in ordinary words: "By the end you can say what changed in the matter (or the motion) and point at evidence from this trial — safely." If heat, chemicals, glass, or electricity beyond toys: finish RAMP before materials leave the cupboard. Adult present for the whole try.

2. Short look or prior-idea card (3–8 min). What do you already think will happen? Hear force-as-fuel or "mass vanishes" without scolding. Do not dump the textbook answer yet. Optional: one labelled secondary figure with honesty card — not your data.

3. One try / measure / record (15–25 min). One Chem or Phys card — not five stations. Record in the notebook a stranger could almost read. Table before graph. No invent-data to make the graph pretty.

4. Talk box + denser CER (5–10 min). Locked opening. Wait. Point at the row. Warrant: why would that measurement count for *this* idea? One limitation or alternative when the band is ready.

5. Exit ticket (2–5 min). Spoken CER crumb, RAMP hazard named, open-vs-closed sentence, slope sentence, or honesty tag (picture / lab-path). Done-enough is right, or wrong-with-a-reason you can use tomorrow.

Band 15–16. Adult scaffolds RAMP and IV/DV. One fair-ish compare or one focused measurement. Denser CER with warrant; one limitation or alternative prompted. Kitchen pictures stay small volume. Circuits: battery kit or skip. AP labelled only if the family already chose that edge — not this week's spine.

Band 17–18. Learner fills more of the RAMP and design before you check the

gate. Multi-trial comparison; uncertainty crumb; mole-as-amount one calculation with meaning; slope-as-rate tied to claim; occasional OUT-06 lab-path neighbor when home cannot host. Still refuse AP as weekly spine. Still refuse invent-data.

Exact wording you can say

- “Before we open anything — RAMP. What could go wrong, and how do we make it smaller?”
- “What will you change on purpose? What will you measure? What stays the same?”
- “What changed in the matter or the motion — and how do we know safely from this trial?”
- “Point at the row. Why does that number count for the idea we named?”
- “This week is a kitchen picture — not Chemistry credit. If we need a supervised bench later, we plan the neighbor.”
- “You may change your mind when we look again.”

When to stop talking. After the locked question, wait. If they are mid-measure, do not narrate the result. If the silence is hard, look at the table or the RAMP card, not at their face. Struggle before rescue: ask, wait, hint (a question or a named idea), then model. Do not grab the answer. Do not paste a machine’s observation as theirs.

Fade help. Week one you may co-fill RAMP. Week two they fill Recognize and Assess; you check Minimize. By a stable month they run the card and you only gate the go/skip decision for higher-hazard tries.

A sample Chem week (hypothetical composite). Mon: SAFE-03 honesty + SAFE-01 RAMP for a planned tiny fizz. Tue: CHEM-01 properties before names. Wed: CHEM-02 small reaction you can stop or skip. Thu: CHEM-03 conservation weighing if volumes stay tiny; denser CER. Fri: exit ticket + honesty tag in the notebook; if the family wants real titration skills later, start CHEM-05 planner. Refuse titling the week “AP Chemistry complete.”

A sample Phys week (hypothetical composite). Mon: prior-idea card for force-as-fuel without scolding. Tue: PHYS-01 change-of-motion with table. Wed: PHYS-05 slope as rate from Tuesday’s numbers. Thu: PHYS-02 energy storyboard or PHYS-04 battery circuit. Fri: talk box + CER crumb; optional wave look Saturday. Algebra sits beside Wednesday’s graph only after the table exists.

Dose honesty. School chem and physics blocks run long with fume hoods and specialists. A parent hour is not a failed block. One named vehicle try done well beats a rushed medley of demos. Lab-path neighbors are scheduled honesty, not guilt about the kitchen.

Practice that actually builds learning

Pick one named try-it per Science Hour. Do not assign the whole bank. Map from memo 02: CHEM-01...06, PHYS-01...05, SAFE as needed, OUT-06 when the neighbor is real.

Talk box (locked)

Opening question: “What changed in the matter or the motion — and how do we know safely from this trial?”

Follow-ups (3–5):

1. Observe: “What do you *see* / *measure* — not what you hoped?”
2. Record: “What does the notebook / table show? Units?”
3. Reason: “How do you know from *this* trial? What is the warrant — why would that measurement count for this idea?”
4. Check / alternative: “What else was different? Can we tell for sure? What else could explain these numbers?”
5. Revise: “You may change your mind. Try another look — or redesign once.”

How to wait. After you ask, count a slow three (classroom-origin wait from Rowe’s elementary science tapes; Stahl’s think-time convention — use the pause; do not claim a kitchen RCT).¹¹ After they stop, wait again. If they are mid-claim, do not cut them off. Look at the materials or the notebook if the silence is hard.

Stuck silence usually means: the question was vague; wait-time was zero; they are hunting a vocabulary word because you asked name-first; they are guessing what you want; materials never landed; they offered a book-only guess; they invent neat rows because the trial was messy; they are bracing for an AP rubric sentence.

¹¹Rowe 1972 wait-time (elementary *science* classroom origin); Stahl think-time convention — use the pause; do not claim a kitchen RCT.

Pose, wait, point back at the notebook — do not fill the silence with the right vocabulary.

In-home try-its

SAFE-03 — Kitchen picture honesty card

Time: 20–30 min. *Materials:* Honesty card (*Kitchen change-of-matter picture* $\neq$ *Chemistry credit* / $\neq$ *secondary lab path*); one food-safe demo description if you will run anything. *Safety:* Food-safe only if a demo runs; adult present. *The fun:* Saying the honest sentence out loud removes the shame and the inflation at once. *The skill:* Path honesty before the fizz. *Steps:* Source the card; list what a transcript Chemistry path would need that this picture lacks; decide picture vs lab-path neighbor for this week. *Exit:* “This week is picture / lab-path because ____.”

CHEM-01 — Properties before names

Time: 30–45 min. *Materials:* Adult-approved household substances (e.g. salt, sugar, baking soda — no unauthorized mixing); observation table; goggles if dust/splash risk. *Safety:* RAMP mandatory. No tasting. Adult present. Food/chem separation rules. *The fun:* Sorting by what you can see and measure before the textbook names arrive. *The skill:* Properties $\rightarrow$ optional names. *Steps:* Record properties; sort; names only after; refuse tasting and secret mixing. *Exit:* Three properties + “I did not mix beyond plan.”

CHEM-02 — Reaction you can stop (picture)

Time: 35–50 min. *Materials:* Food-safe planned reaction (e.g. vinegar/baking soda, **small volume**) OR skip to lab-path; stop plan; goggles; honesty card. *Safety:* Lowest volume; ventilation; adult present entire time; stop on cue. *The fun:* A change you planned and can end. *The skill:* Predict $\rightarrow$ run small $\rightarrow$ record $\rightarrow$ CER + honesty tag. *Steps:* RAMP; predict; run; stop; CER; tag picture $\neq$ credit. *Exit:* Claim + honesty tag.

CHEM-03 — Conservation as weighing honesty

Time: 35–50 min. *Materials:* Closed vs open contrast with safe fizz in sealed bag vs open cup — adult-approved tiny volumes; scale. *Safety:* Bag pressure caution — tiny volumes; goggles; adult present. No sealed pressurized drama bottles. *The fun:* Watching mass “disappear” in the open cup and staying put when the system is closed. *The skill:* Systems boundary + conservation reasoning crumb. *Steps:* Mass before/after; talk where mass went if open; refuse magic

vanishing and invent-mass. *Exit*: Open vs closed result + reasoning crumb.

CHEM-04 — Concentration / dilution sense (no stock acids)

Band: 17–18 (careful 15–16). *Time*: 30–45 min. *Materials*: Drink-mix or food coloring dilution series; measuring tools. *Safety*: Food-safe only; adult present; no lab acids brought home. *The fun*: Seeing “more dilute” as a series you made. *The skill*: Operational concentration sense. *Exit*: Order cups dilute→concentrated with evidence.

CHEM-06 — Mole as an amount (meaning before drill)

Band: 17–18. *Time*: 30–45 min. *Materials*: Counting analogy; one labelled calculation; optional dry-rice weighing honesty. *Safety*: Paper / dry food. *The fun*: Amount-of-substance as a meaning, not a punishment worksheet. *The skill*: Mole means ____; one calculated amount. *Refuse*: Twenty identical drills as the Hour. *Exit*: Meaning sentence + calculated amount.

PHYS-01 — Change-of-motion card

Time: 35–50 min. *Materials*: Cart/ball; ramp; stopwatch or phone; force-as-fuel misconception sticky. *Safety*: Clear path; no heavy falling objects on feet. *The fun*: Catching the “ran out of force” story with another look. *The skill*: Force changes motion; evidence from the trial. *Steps*: Predict; measure; repair force-as-fuel if it appears; optional fair surface compare. *Exit*: “Force changed ____ ; evidence ____.”

PHYS-02 — Energy transfer storyboard

Time: 30–45 min. *Materials*: Pendulum, rubber-band launch, or warm-from-rubbing safe try. *Safety*: Eye protection if projectiles; soft projectiles only. *The fun*: Drawing where the energy went — including thermal honesty. *The skill*: Systems boundary + transfer story, not “used up.” *Exit*: Storyboard arrows.

PHYS-04 — Circuit with household-safe limits

Time: 35–50 min. *Materials*: Battery pack kit OR skip to labelled simulation / OUT; bulb or LED kit. *Safety*: Batteries only at home default; adult present; stop if hot; refuse wall-outlet hacks. *The fun*: Brightness that matches a prediction. *The skill*: Diagram + brightness claim with evidence. *Exit*: Diagram + claim.

PHYS-05 — Graph slope as rate

Time: 30–45 min. *Materials*: Position–time or speed table from PHYS-01. *Safety*: None beyond prior try. *The fun*: Slope as a sentence about the motion, not a naked formula. *The skill*: Math as tool beside the idea. *Refuse*: Inventing a smooth curve. *Exit*: Slope sentence tied to motion.

Out-of-home try-its

CHEM-05 + OUT-06 — Lab-path neighbor planner and bench session

Planner time: 25–40 min at home. *Bench time:* host-dependent (often 60–120 min — still bring Hour grain home). *Materials:* Planner card (community college / co-op / supervised maker chem night); skills list; host rules; prefilled RAMP; notebook intention card. *Safety:* Host rules supersede home defaults; adult/guardian as required by site; ACS ceiling mindset — not a DIY hood. *The fun:* Real glassware when home cannot host — honestly labelled. *The skill:* Decide what home cannot host; CER from *your* measurements; do not auto-title the visit “finished AP Chemistry.” *Exit:* Date/plan + notebook intention; after the visit: outcome + own data rows + site tag. If you only watched a demo, do not file the host’s numbers as yours.

PHYS-03 — Wave pattern look (safe outdoor or home)

Time: 30–45 min. *Materials:* Slinky, water tray, or tone app + honesty about model limits; optional outdoor water-ripple look with adult. *Safety:* No lasers in default bank; water tray wipe-up; outdoor adult. *The fun:* A pattern you can make and describe. *The skill:* Pattern description + one measurement crumb. *Exit:* Pattern + crumb.

Blocked, mixed, and one incorrect example

Blocked (new move). First Chem week: SAFE-03 then CHEM-01. First Phys week: PHYS-01 with the force-as-fuel sticky visible. Do not mix mole drill with a first conservation try on the same day.

Mixed (when the move is stable). Conservation weighing + denser CER; change-of-motion + slope-as-rate; honesty card + lab-path planner in the same week.

Incorrect example to diagnose (hypothetical composite, not a reported family). A sixteen-year-old runs a large vinegar volcano, invents three neat mass rows “because the scale was annoying,” files a phone photo of a perfect internet gel as “my result,” and the parent writes Chemistry with Lab on a draft transcript. Repair: stop; SAFE-03 + AS invent-data / generated-result cards (ch08); redesign small or skip; title **Chemistry** only if the year’s work was chemistry — **with Lab** only when supervised investigation evidence exists.

Library, walk, museum

A museum exhibit on energy or materials can feed PHYS-02 or a systems boundary (OUT-01). A library hour with a trade book on motion can prepare PHYS-01 — then the try still happens with a ball on your floor. Outings motivate. They do not replace the measure-and-claim move.

For the student

Chemistry and Physics in this book are not a dare to mix unknown bottles. They are ways of looking at matter and motion with a plan, a notebook, and an adult in the room when heat or chemicals are involved.

What the idea is. Something changed — in the stuff, or in how something moved. You measured. You wrote it down. You say what you claim, point at your numbers, and say why those numbers count for the idea. You also say how you kept the try safe — or why you skipped and planned a better place to try.

Tiny worked example (illustration). You weigh a bag with a tiny planned fizz sealed inside: 52.4 g before, 52.4 g after. Same try in an open cup: mass drops. Claim: in the closed bag, mass stayed the same under these conditions; in the open cup, some matter left as gas we did not catch. Warrant: if mass is conserved in a closed system, the closed bag should hold steady; the open cup's drop fits matter leaving the system boundary. Limit: cheap kitchen scale; tiny volumes; not a proof of atoms from one bag alone.

Try 1. With your adult, complete a RAMP card for a food-safe property look or a ball-and-ramp look. Run the try. Fill three rows. No inventing.

Try 2. Write a denser CER: claim; evidence with row numbers; because-the-idea (warrant); one thing you still cannot tell.

Explain it back. In your own words: What changed in the matter or the motion — and how do you know safely from this trial?

Challenge. Catch one force-as-fuel sentence in your own first draft and repair it with another look — or redesign a Chem picture that was too big for drama into one you can stop.

If it isn't clicking

Diagnostic 1 — Fear of chemicals or “I’m bad at physics.”

Next move: Start with SAFE-03 honesty and PHYS-01 or CHEM-01 with zero mixing beyond looking. Keep volumes tiny. Celebrate a complete RAMP card as real work. Place by skill, not birthday — a fifteen-year-old consolidating fair-test notes may need more Young Minds—band practice before mole talk.

Diagnostic 2 — Force-as-fuel or vanishing-mass story will not budge.

Next move: Another look, not a lecture. Side-by-side trials. Name the idea in one sentence after the look. If equations make them freeze, stay qualitative this week.

Diagnostic 3 — Invent-data, generated curve, or kitchen-as-credit inflation.

Next move: Stop the portfolio fiction. Honesty cards. Redesign or labelled secondary data. Separate picture weeks from lab-path weeks in the records language. If the urge is strong, use ch08 invent-data and gel-refusal objects on Friday.

When to slow down. RAMP incomplete; PPE missing; learner alone with heat; algebra panic swallowing the system. Slow or skip. Safety first.

When to go ahead. Stranger-readable table, warrant that names an idea, honesty tag stable — then dilution sense, slope-as-rate, or lab-path planner.

When to get a human tutor. Persistent unsafe improvisation; deep algebra wall that blocks every physics look even after qualitative path; family needs supervised wet skills for a real Chemistry path and no neighbor is planned. A tutor or co-op bench is help, not a failure.

Correct a wrong reason without crushing the look. “Never correct the adolescent” is not this book’s rule. Silence in the face of invent-data is not kindness.

Tools, including AI

Point back to the Science Hour AI box. Short version for this chapter:

You may, on your account, after the student has tried (or before, for your prep): ask a tool to explain conservation or Newton’s first *to you* from a named page; generate isomorphic blank tables for a *new* try with the key held by you; get a labelled SCRIPT for *you* to say after the try; ask revision questions after *their* CER draft — not a rewrite; diagnose work already on paper (crop to paper; no

face).

You may not: invent a mass table; generate a titration curve or gel as their result; put a model summary on the table as the observation; write their lab report; park an unsupervised chat as their only partner during the attempt; photo-to-key an FRQ packet; coach live-exam cheating.

Bastani's high-school math chatbot study is a useful caution about fluency fooling practice — and it is off-age for science hour. One sentence, then teach looking.¹² Algebra tools and graphing apps may sit beside PHYS-05 after the student built the table by hand once. Simulations (labelled sim) can prepare a circuit week when batteries are unavailable — they do not silently paint Physics with Lab green for every stranger who reads a transcript.

What “done enough” looks like

Before you move on from this chapter's vehicle weeks, you should be able to tick most of these by skill — not by birthday.

15–16

- ☐ Completes a RAMP card for a planned heat/chemical/glass try — or correctly chooses skip / lab-path.
- ☐ Runs one Chem *or* Phys vehicle try with adult present and a stranger-readable table.
- ☐ Claims with evidence pointer + because-the-idea warrant; names one limitation *or* alternative when prompted.
- ☐ Uses the kitchen honesty sentence when the try was a picture.
- ☐ Repairs force-as-fuel or vanishing-mass with another look at least once.

17–18

- ☐ Fills more of RAMP and design independently; adult still gates higher-hazard go/skip.
- ☐ Multi-trial or uncertainty crumb on at least one Phys or Chem try.
- ☐ Slope-as-rate or mole-as-amount meaning used beside a real table — not drill-only.

¹²Bastani et al. high-school math chatbot study: fluency can fool practice — **OFF-AGE for science hour**. One sentence, then teach looking. Access date 17 September 2026.

- ☐ Lab-path neighbor planned or completed when home cannot host — CER from own measurements.
- ☐ Refuses invent-data and generated-result fiction in the portfolio.

Place by skill. A seventeen-year-old who still invents neat rows needs honesty and redesign, not an AP packet. A fifteen-year-old who already keeps a stranger notebook and repairs force-as-fuel may run 17–18 edges carefully.

Life of the habit (here, not a ninth chapter). Revisit next Tuesday's system: what changed in matter or motion last week? Mix last week's fair test with this week's vehicle. Name this week's Chem or Phys question in one sentence. Stop while a look remains. A diploma is not this checklist. An AP score is not the only path that counts.

Ready for ch07. When the notebook has locatable numbers from a Chem or Phys try, the next chapter densens the talk and the writing: claim, evidence, warrant, limitation, alternative — oral then written. Keep the RAMP habit. Keep the honesty card. The vehicle was this week's matter or motion. The claim is how the looking travels.

One more Phys honesty. Force-as-fuel is not a character flaw and not finished at fourteen. *Taking Science to School* notes that Newtonian construction is by no means obvious even to high school or college students who have had introductory mechanics.¹³ When it appears, put another look on the table and name the idea just-in-time. Equation punishment is not repair. Coverage of every force law is not this week's job. Change-of-motion looking is.

¹³Force-as-fuel prior idea: forces change motion; they do not ride inside the object like fuel — *Taking Science to School* / Framework grain labelled for home. Limit line: useful study shape, not a promise every home sees the same result.

Chapter 7 — Talking and writing lab claims



Figure 9: A denser CER three-box card with a warrant line and a falsify sticky, beside a dated notebook open to a data table and a pencil. Still-life. No people. No brand logos.

Why this matters

What do you claim — which evidence from the notebook supports it — and what warrant ties them to the idea?

That is not a timed Advanced Placement free-response every Thursday. It is not a debate-club win. It is not a fluent paragraph a machine could have written with no trial on the table. It is the question that turns a stranger-readable notebook into a sentence another person can check. A claim without evidence is a vibe. Evidence without a claim is a caption. Reasoning that only restates the claim is a shrug in fancy clothes. A warrant that never names a scientific idea is a pile of numbers hoping to mean something. A claim with no limitation pretends one trial finished the question.

If your family used *Science for Young Minds*, you already practiced CER light: claim, point at the notebook, a short because. This chapter ages that habit up. Keep “points at the notebook.” Raise the warrant (why would *that* measurement count for *this* idea?), the limitation (what this dataset cannot tell), and the alternative explanation (what else could explain these numbers?). At 15–16 the exit is oral CER then a short written paragraph with warrant and one limitation *or* alternative. At 17–18 it grows toward multi-sentence reasoning, competing claims on the same data, falsify prompts, soft error analysis, and occasional multi-trial synthesis — still not weekly AP as identity. *English for Emerging Adults* holds sentence craft. *Critical Thinking for Emerging Adults* holds judgment on ordinary present stakes. *History for Emerging Adults* holds sourced claims about founding documents. One pointer each, then teach science: a spoken or written claim about *this trial’s* material world, with the notebook in view.

What this idea unlocks is the explanation frame Ready, Set, SCIENCE! and IQWST-shaped materials put in teacher language: claim; evidence from the investigation; reasoning that links evidence to claim through a scientific idea.¹⁴ Framework high-school argument progressions already expect alternative explanations and limits of the data — as moves, not as a packet franchise.¹⁵ America’s Lab Report asks for ongoing student reflection and discussion sequenced with

¹⁴Claim–Evidence–Reasoning denser grain (IQWST / McNeill & Krajcik teacher language labelled for home): claim; evidence from *this* investigation; reasoning that links evidence to claim through a scientific idea (warrant).

¹⁵NRC *Framework* (2012) high-school argument progressions: alternative explanations and limits of the data as moves, not a packet franchise.

the look — not a silent procedure and a grade.¹⁶ Rowe’s wait-time work began in elementary *science* classrooms; extending the pause after a question and after an answer changes discourse, including evidence–inference talk. Copy the pause. Label the classroom origin. Do not invent a kitchen discussion RCT.¹⁷ That is a useful study grain, not a promise that every home will see the same result. Then teach.

Willingham’s knowledge constraint travels carefully: CER is a move inside *this* investigation, not a portable “scientist identity” minted by one worksheet.¹⁸ Knowledge first — the system and the tiny fair test — before multi-investigation synthesis of ecosystems in week one of age fifteen. Coverage is a map. Depth is the hour.

PFI 2016 found scientific inquiry or experiments taught that year to only about 25 percent of homeschooled ninth-through-twelfth-graders — while biology that year sat near 29 percent and chemistry or physics near 22 percent.¹⁹ Many high-school science years have been reading years. A denser CER from a real table is how inquiry becomes more than a checkbox. It does not require a fume hood. It does require a notebook and a wait.

You do not need to be a science writer. You do need to hear a claim with no row, a row with no claim, a warrant that only restates the claim, a chatbot CER with no trial, a model summary filed as the observation, invent-data to make the warrant pretty, and AP FRQ as every Thursday — and to ask the locked question, then wait. Hearing those wrong turns is teaching. Filling the silence with your own perfect paragraph is not.

This week you can learn to model one warrant stem aloud (“This measurement counts because ____”), press for a locatable row, and wait after “what else could explain these numbers?” Today the student can speak a denser CER, then write a short paragraph with one limitation named.

¹⁶National Research Council, *America’s Lab Report* (2006): ongoing student reflection and discussion sequenced with the look — not a silent procedure and a grade.

¹⁷Rowe 1972 wait-time began in elementary *science* classrooms; extending wait before and after an answer changes discourse, including evidence–inference talk. Copy the pause; label classroom origin; do not invent a kitchen discussion RCT.

¹⁸Willingham knowledge constraint travels carefully: CER is a move inside *this* investigation, not a portable “scientist identity” minted by one worksheet.

¹⁹Cui and Hanson, NCES 2020-001, grades 9–12 *that year*: scientific inquiry or experiments about **25%**; biology about **29%**; chemistry or physics about **22%**. Many high-school science years have been reading years — quote the high-school cells; do not mash middle-grades rows.

Picture two Fridays. In one, a tidy paragraph could have come from any review book — or from a window — and no one can find the numbers in the notebook. In the other, a paragraph starts two cells, names the idea in the warrant, admits the scale's limit, and offers one rival explanation that the next trial could test. Both pages look like writing. Only one is lab looking on paper.

For the parent: understand it yourself

Many adults remember science writing as “copy the conclusion from the lab manual,” as a graded lab report they never understood, or as no writing at all — only talk that drifted into a lecture. Rust on essay formulas is normal. It is not a character flaw. Five to eight minutes of this section, then the warm-up, is enough for tomorrow. The student still writes the blanks.

Everyday picture. Yesterday's table is open. Three numbers are enough. You ask: “What do you claim — which evidence from the notebook supports it — and what warrant ties them to the idea?” You wait. The student says, “I claim blue light yielded a higher bubble rate than green under these conditions, because rows 2 and 3 show means 18 and 7 bubbles per two minutes. This counts because chlorophyll absorbs blue more readily than green — so more bubbles fit that idea if other conditions stayed the same. Limit: we did not measure filter transmission with a meter.” They point. If they say “because photosynthesis” with no row, you send them back: “Which evidence from the notebook?” That pointing is the move.

Precise picture. A *claim* here is a sentence about the material world that answers this week's question and could be wrong. *Evidence* is numbers, observations, or labelled secondary data the learner did not invent — and another person can locate in the notebook. A *warrant* (the denser piece of reasoning) ties evidence to claim through a scientific idea: why *this* measurement counts for *that* claim. A *limitation* is one honest sentence about what this dataset cannot tell. An *alternative explanation* is another story the same numbers might fit — prompted, then owned. At 15–16 the exit is oral then written: claim; locatable evidence; warrant; one limitation *or* alternative. At 17–18 add competing claims on the same data, falsify prompts, soft error analysis, and occasional synthesis across linked trials — still not a Document-Based-Question mash and not AP every week.

Talk is not a luxury before writing. Pose one authentic question about the evidence. Wait. Revoice without stealing the claim: “So you're saying rate rose because

temperature rose — is that what columns B and C show?” Point at the notebook. Recitation (“define osmosis”) may warm up for two minutes. It is not the talk box.

Warrant in one kitchen sentence. The warrant is the bridge: *why these numbers count as evidence for this idea*. “Temperature was higher and rate was higher” is evidence talk. “Higher temperature increases collision frequency in this enzyme picture, so a higher rate fits the idea if volume and concentration stayed the same” is warrant talk. You do not need university prose. You need the idea named and tied to the row.

Limitation vs alternative (keep separate). Limitation: what the dataset cannot tell (scale precision; $n=2$; filter transmission unmeasured). Alternative: another explanation the same numbers might fit (volume also changed; light distance differed). At 15–16 prompt one. At 17–18 ask for both when the week can hold them. Insufficient evidence remains valid — Framework and fair-test chapters already licensed that honesty.

Wrong answers you should be able to hear

1. *Claim with no evidence / vibe evidence.* “It worked” / “everyone knows.” Repair: “Where in the data?” Highlight and arrow to a cell. Delete unlocatable phrases.
2. *Evidence with no claim.* A perfect table and then “so that’s the data.” Repair: “What do you claim *about the material world* from this trial?” One sentence.
3. *Warrant that only restates the claim / idea dump with no evidence.* “This supports my claim because my claim is true” / a paragraph of textbook with no numbers. Repair: “Why does *that row* count for *that claim*?” Circle the idea words; if none, add. If no rows, return to the table.
4. *Chatbot CER / model summary as observation / write-my-lab-report.* Fluent encyclopedia voice; summary filed as looking; tool rewrote the report. Repair: close the window; student writes from *this* notebook; tool only after a real draft, on your account, as revision questions — not a rewrite. Point back to the Science Hour AI box.
5. *AP FRQ as every Thursday / debate-club winning / insufficient evidence refused.* Rubric language with no own data; vibe winner; inventing points to finish a strong claim. Repair: AS-06 AP-as-map card; “what else could explain these numbers?”; FAIR-04 “insufficient evidence” is valid; occasional WRITE-06 stretch labelled *practice, not spine*.

A sixth: *quote dump from the textbook* — three copied definitions and no sentence of their own tied to the trial. Repair: sentence 1 is the claim about *this* trial; then evidence; then warrant; then limit.

Five-to-eight-minute parent warm-up

Do this alone, with yesterday's data (or three numbers cut from it).

Minute 1. Cut the table to three numbers you can point at. Put the rest aside for now.

Minute 2. Write one sample warrant aloud: "This measurement counts because ____." Put it in your pocket. You will not read it first.

Minute 3. Star one limitation the dataset cannot tell. Star one alternative explanation you could prompt.

Minute 4. Write one revision question that targets evidence or warrant, not polish: "Where is the claim? Point to the evidence. Why does that row count?"

Minute 5. Plan the wait after the locked opening. Count three aloud once, now, so you remember. Plan the second wait after they answer.

Minute 6. Decide the band exit: oral then paragraph with warrant + one limit/alternative (15–16) or competing claims / falsify / multi-trial soft (17–18). Do not assign CER-07 synthesis before a stable three-box exists.

Minute 7. If two learners will sit, plan one uptake prompt: "Add one idea to what ____ said, tied to a *different* row."

Minute 8. Put the model warrant away. You are ready. They speak, then write.

How to teach it this week

The Science Hour chapter holds the full session shape. Here is the same five beats scaled to denser CER talk and a short written claim. Keep thirty to fifty minutes. If a day only holds thirty, open the notebook, one talk-box turn with wait, and a paragraph exit.

1. Open / notebook on the table (3–7 min). Name today's outcome: "By the end you can claim something about this trial, point at evidence, and say why that

evidence counts for the idea.” No new demo required if yesterday’s table is enough. If a new try is planned, RAMP first when needed.

2. Short look at the record (3–8 min). Table before graph. Units visible. Operational DV clear. Optional: highlight two cells that could become evidence. Do not write their claim for them.

3. One build (15–25 min). Three-box CER, or competing claims, or oral-then-written — one focus. Not a packet of ten stems. Record in the notebook.

4. Talk box (5–10 min). Locked opening. Wait. Evidence press. Warrant press. Alternative or limit. Revoice without upgrading into the “right” AP sentence.

5. Exit ticket (2–5 min). Written CER crumb, circled idea phrase, falsifier sentence, or “insufficient — need ____.” Done-enough is right, or wrong-with-a-reason usable tomorrow.

Band 15–16. Scaffold the three boxes. Prompt one limitation *or* one alternative — not both as a burden on day one. Oral before written most days. Adult models one warrant stem once, then fades.

Band 17–18. Multi-sentence reasoning; competing claims; falsify; soft error analysis; occasional multi-trial synthesis or labelled FRQ-shaped stretch — still not weekly spine. Integrate evidence across linked trials when two notebook pages already exist.

Exact wording you can say

- “What do you claim — which evidence from the notebook supports it — and what warrant ties them to the idea?”
- “Where in the data? Draw an arrow to the cell.”
- “Why would that measurement count for *this* idea — not only repeat the claim?”
- “What else could explain these numbers?”
- “What can’t this dataset tell us?”
- “If we only had Trial 1, what would we wrongly conclude?”
- “You may change your mind when we look again.”
- “Insufficient evidence is allowed. What would you need next?”

When to stop talking. After the locked question, wait. After they answer, wait again before evaluating. If they are mid-warrant, do not finish the sentence for them. Look at the notebook if the silence is hard. Struggle before rescue: ask,

wait, hint (a question or a named idea), then model one stem. Do not grab the answer. Do not paste a machine's CER as theirs.

Fade help. Week one: co-fill Evidence box from highlighted cells. Week two: they fill Claim and Evidence; you prompt Warrant with “because the idea ____.” Week three: they draft oral CER alone; you only press alternatives. By a stable month, written paragraph after oral is routine.

A sample claim week (hypothetical composite). Mon: CER-01 three-box from last week's Chem or Bio table. Tue: CER-02 evidence must be locatable (highlighter arrows). Wed: CER-03 reasoning names the idea + TALK-01 one question, three seconds. Thu: CER-06 oral then WRITE-02 paragraph. Fri: CER-04 competing claims or CER-05 falsify; exit ticket. Optional Saturday: museum one-exhibit CER (OUT-01). Refuse FRQ dump as the week's identity.

Dose honesty. One denser CER from real numbers beats five empty stems. If the table is thin, FAIR-04 / “need ____ before claiming ____” is the scientific move — not invent-data.

Uptake moves (keep on a sticky). Evidence press: “Where in the data?” Systems press: “Inside or outside the boundary?” Fair-test press: “Can we tell for sure?” Revision press: “What would you change in the design?” Honesty press: “Is this your measurement or a labelled secondary set?” Warrant press: “Why does that row count for this idea?” Limitation press: “What can't we tell yet?” Alternative press: “What else could explain these numbers?” Use one press per turn. Do not stack seven questions before they answer the first.

Sibling or co-op note. If two learners share the hour, post-response wait so each speaker is heard. Whose turn? One uptake prompt: “Add one idea to what ____ said, tied to a different row.” Refuse cold public quiz of strangers. Refuse turning disagreement into contempt.

What not to do this week. Do not assign a CER worksheet with no apparatus and no notebook. Do not mash Wineburg document sourcing as if it were lab CER — history owns founding pieces; this chapter owns *this trial's* data. Do not make multi-trial synthesis weekly. Do not fill silence with the AP rubric sentence.

Practice that actually builds learning

Pick one named try-it per Science Hour. Map from memo 02: CER-01...07, TALK-01...04 and TALK-06, WRITE-01...03 and WRITE-05...06. Pair lightly — do not assign the whole menu.

Talk box (locked)

Opening question: “What do you claim — which evidence from the notebook supports it — and what warrant ties them to the idea?”

Follow-ups (3–5):

1. Observe: “What do you *see / measure* in the table — not what the book said would happen?”
2. Record: “What does the notebook show? Can a stranger find that cell?”
3. Reason / warrant: “How do you know from *this*? What idea makes that row count as evidence?”
4. Check / alternative / limit: “What else could explain these numbers? What can’t this dataset tell us? Can we tell for sure?”
5. Revise: “You may change your mind. Try another look — or redesign once — or call insufficient.”

How to wait. Pose one question. Count three to five silently (Rowe wait-time; Stahl think-time — classroom-origin; use the pause).²⁰ After the learner speaks, wait again before evaluating. Revoice tentatively. Point at the notebook. Do not mash Rowe and Stahl as a kitchen RCT.

Stuck silence usually means: the question was vague; wait-time was zero; they are hunting a vocabulary word; they are guessing what you want; the materials or table never landed; they offered a book-only guess; they think science means “repeat the parent’s explanation”; they invent neat rows because the trial was messy; they are bracing for an AP rubric sentence. Pose, wait, point back at the notebook — do not fill the silence with the right vocabulary or the rubric sentence.

²⁰Rowe 1972 wait-time began in elementary *science* classrooms; extending wait before and after an answer changes discourse, including evidence–inference talk. Copy the pause; label classroom origin; do not invent a kitchen discussion RCT.

In-home try-its**CER-01 — Three-box build**

Time: 30–45 min. *Materials:* Notebook page with Claim / Evidence / Reasoning boxes; one completed table. *Safety:* None. *The fun:* Watching a vague “it worked” become three honest boxes. *The skill:* Claim + locatable evidence + reasoning that names an idea. *Steps:* Fill claim; cite evidence rows; write reasoning; refuse evidence-free claim. *Exit:* Complete three-box.

CER-02 — Evidence must be locatable

Time: 25–40 min. *Materials:* CER draft; highlighter. *Safety:* None. *The fun:* Detective arrows from phrase to cell. *The skill:* Delete unlocatable “everyone knows.” *Exit:* Two arrows to cells.

CER-03 — Reasoning names the idea

Time: 30–45 min. *Materials:* Idea bank sticky (energy transfer; selection; conservation of mass as weighing honesty; Newton’s first in plain words; structure–function). *Safety:* None. *The fun:* Circling the idea words so reasoning is more than a restatement. *The skill:* Warrant that ties row to idea. *Exit:* Circled idea phrase.

CER-04 — Competing claims, same data

Time: 35–50 min. *Materials:* One table; two plausible claims. *Safety:* None. *The fun:* Scoring which claim the data support better without inventing a winner. *The skill:* Data decide; insufficient allowed. *Exit:* Winning claim + one deciding row — or “insufficient.”

CER-05 — Falsify prompt

Band: 17–18 (careful 15–16). *Time:* 30–45 min. *Materials:* Learner’s claim; blank “would falsify if ____.” *Safety:* Per any new try. *The fun:* Naming what would change your mind before ego digs in. *The skill:* Falsifier sentence; optional fair test aimed at it. *Exit:* Falsifier sentence.

CER-06 — Oral CER then written

Time: 30–45 min. *Materials:* Talk-box timer; then paper. *Safety:* None. *The fun:* Hearing the claim before polishing it. *The skill:* Speak with wait; then write; compare strength. *Refuse:* Adult dictating the speech. *Exit:* Written CER after oral.

CER-07 — Occasional multi-trial synthesis (not weekly AP)

Band: 17–18. *Time:* 40–50 min. *Materials:* Two or three related notebook pages;

optional AP-style stem **labelled occasional stretch**. *Safety*: None. *The fun*: One claim that honestly spans trials. *The skill*: Synthesis + citation of which trials. *Refuse*: Making this every Thursday. *Exit*: Synthesis claim + trial citations + “practice not spine” sticky if an AP-shaped stem was used.

TALK-01 — One question, three seconds

Time: 20–35 min. *Materials*: Notebook open; timer optional. *Steps*: Adult poses one evidence question; silent count 3–5; learner answers; wait again; no stack of quizlets. *Exit*: Learner restates the question they answered.

TALK-02 — Revoice without stealing

Time: 25–40 min. *Materials*: Prior CER draft. *Steps*: Learner speaks; adult revoices tentatively; learner confirms or repairs; point to data. *Refuse*: Upgrading into the “right” AP sentence. *Exit*: Confirmed claim in learner words.

TALK-03 — Evidence press round

Time: 25–40 min. *Materials*: Two sticky claims. *Steps*: For each, “where in the data?”; discard claim with no cell. *Exit*: Surviving claim + cell ID.

TALK-04 — Systems press round

Time: 25–40 min. *Materials*: System diagram. *Steps*: Questions only about boundary/flows/omissions; wait; revise diagram. *Refuse*: Vocabulary quiz dressed as systems talk. *Exit*: One revised arrow or boundary.

TALK-06 — Disagreement without contempt

Band: 17–18 (careful 15–16). *Time*: 30–45 min. *Materials*: Two CER drafts on same data. *Steps*: Name disagreement location (claim vs evidence vs reasoning); revise; refuse personal attack. *Exit*: Disagreement located + next check.

WRITE-01 — Captioned figure

Time: 25–40 min. *Materials*: Graph or photo of *this* setup. *Steps*: Caption what was measured and what varied; no novel claim required yet. *Refuse*: AI figure caption filed as own; stock photo as your setup. *Exit*: Caption ≤ 3 sentences.

WRITE-02 — CER paragraph

Time: 30–45 min. *Materials*: Three-box notes $\rightarrow$ paragraph. *Steps*: Convert boxes to flowing paragraph; keep evidence locatable; star the evidence phrase. *Exit*: Paragraph with starred evidence.

WRITE-03 — Methods crumb another could repeat

Time: 30–45 min. *Materials*: Yesterday’s try. *Steps*: Write steps so a stranger

could repeat; include what was held constant. *Refuse*: “We did the lab.” *Exit*: Methods crumb + constant list.

WRITE-05 — Error analysis soft

Band: 17–18. *Time*: 30–45 min. *Materials*: Messy data set. *Steps*: Name measurement and design error sources; what next; refuse self-insult as analysis; refuse invent-excuses for invent-data. *Exit*: Two named error sources + one fix.

WRITE-06 — Occasional FRQ-shaped stretch (not weekly spine)

Band: 17–18. *Time*: 40–50 min. *Materials*: One AP-style or textbook FRQ stem **labelled practice**; own data if possible. *Steps*: Answer using evidence; meta-note: assessment practice, not this week’s identity; return next session to SYS/CER try. *Exit*: Response + “practice not spine” sticky.

Out-of-home try-its**OUT-01 + CER — Museum one-exhibit claim**

Time: 40–50 min on site (+ travel). *Materials*: Notebook; one exhibit chosen. *Safety*: Venue rules; adult present. *The fun*: One exhibit, one systems-or-claim look — not a scavenger race. *The skill*: Boundary or CER crumb from observations you wrote down. *Refuse*: Whole-museum worksheet dump. *Exit*: Exhibit name + claim with evidence you recorded.

WRITE-06 at a quiet library table (optional stretch)

Time: 40–50 min. *Materials*: One labelled practice stem; own notebook if the stem allows. *Safety*: None. *The fun*: Timed practice that stays labelled practice. *The skill*: Evidence from your work, not only rubric phrases. *Exit*: Response + sticky: practice not spine. Then next Science Hour returns to a real try.

Blocked, mixed, and one incorrect example

Blocked (new move). First denser-CER week: CER-01 then CER-02. Do not assign competing claims and multi-trial synthesis on day one.

Mixed (when stable). Oral CER + written paragraph same day; evidence press + systems press across two days; captioned figure before CER paragraph.

Incorrect example to diagnose (hypothetical). A seventeen-year-old pastes a chatbot paragraph that never cites their table, invents two neat rows so the warrant “looks scientific,” and the parent files an AP FRQ packet as every Thursday’s

Science Hour. Repair: close the window; CER-02 arrows; AS invent-data refusal (ch08); AS-06 AP-as-map; return Thursday to a real notebook page.

Library, walk, museum

Library and museum motivate and supply secondary figures — labelled secondary, not your data. The claim still points at *this* notebook when the lesson is denser CER. Shared looking does not replace the warrant.

Practice ladder across a month (illustration, not a mandate). Week 1: three-box + locatable evidence. Week 2: warrant names the idea + oral then written. Week 3: limitation or alternative prompted every exit. Week 4: competing claims or falsify once. Then return to a fresh Bio, Chem, or Phys vehicle so the claim move stays attached to looking — not floating as a worksheet genre. America's Lab Report design principles travel here: clear outcome; sequence look with talk; integrate content with process; ongoing reflection.²¹ Recipe-with-no-talk is not the ladder's top rung.

For the student

A lab claim is a sentence about what happened in *your* trial that another person could check. Talking it first makes the writing stronger. Writing it down makes the talk leave a trail.

What the idea is. Claim: what you say is true about the trial. Evidence: the numbers or observations in your notebook — with row numbers a stranger can find. Warrant: why those numbers count for a scientific idea (not “because I say so”). Limitation: what you still cannot tell. Alternative: what else might explain the same numbers.

Tiny worked example (illustration). Claim: In our closed bag, mass stayed the same under these conditions. Evidence: Table row 1 — 52.4 g before and after. Warrant: If mass is conserved when matter cannot leave the system, a closed bag's total mass should hold steady. Limitation: kitchen scale precision; tiny volumes. Alternative: a leak too small to see could still matter on a better scale — next try checks the seal.

²¹National Research Council, *America's Lab Report* (2006): ongoing student reflection and discussion sequenced with the look — not a silent procedure and a grade.

Try 1. Open yesterday’s table. Speak a denser CER with your adult waiting after the question. Point at two cells.

Try 2. Write the same claim as a short paragraph. Star the evidence phrase. Add one limitation *or* one alternative.

Explain it back. What do you claim — which evidence supports it — and what warrant ties them to the idea?

Challenge. Write one falsifier: “My claim would be in trouble if ____.” Optional: redesign a fair test aimed at that falsifier.

Oral checklist (keep in the notebook cover). (1) Claim in one sentence. (2) “Evidence: row ____ shows .” (3) “*This counts because [idea]* .” (4) “Limit / other explanation: ____.” (5) Stop. Let the adult wait. You do not need a speech. You need a trail.

Writing checklist. Star every evidence phrase. Arrow to a cell. Circle the idea words in the warrant. If you cannot circle an idea, add one. If you cannot star evidence, return to the table before you write more adjectives.

If it isn’t clicking

Diagnostic 1 — Blank page / freeze when asked for a warrant.

Next move: Oral only today. Model one warrant stem once. Three numbers only on the table. TALK-01 with a full wait. Do not upgrade their sentence into AP language.

Diagnostic 2 — Fluent paragraph with no locatable evidence — or invent-data to finish.

Next move: CER-02 highlighter arrows. Delete unlocatable phrases. If invent-urge appeared, stop and use honesty / redesign (ch08 AS-04). Wrong-with-a-reason beats pretty fiction.

Diagnostic 3 — Every Thursday became an FRQ packet / chatbot rewrite / debate without a notebook.

Next move: AS-06 card on the fridge. Return to three-box from *their* table. Tool only after a real draft, revision questions only. Disagreement must locate claim vs evidence vs reasoning (TALK-06).

When to slow down. No table yet; warrant still only restates claim; silence filled every time by the adult. Slow. Build Evidence box first.

When to go ahead. Locatable evidence stable; warrant names an idea; oral-then-written routine — then competing claims, falsify, soft error analysis, occasional synthesis.

When to get a human tutor. Persistent inability to point at a row after weeks of practice; writing anxiety that blocks every exit; family wants AP-shaped practice and denser CER is not yet stable — tutor for writing craft, still with the notebook in view.

Correct a wrong reason without crushing the look. “Never correct the adolescent” is not this book’s rule. Silence in the face of invent-data is not kindness.

Tools, including AI

Point back to the Science Hour AI box. Short version for this chapter:

You may, on your account, after the student has tried: ask a tool to explain warrant vs restatement *to you*; generate blank CER cards or isomorphic practice stems with the key held by you; get a labelled SCRIPT for *you* to say after the try; ask revision questions after *their* draft — not a rewrite; diagnose a paragraph already written (crop to paper).

You may not: write their CER or lab report; invent evidence rows; put a model summary on the table as the observation; generate a gel or perfect curve as their result; park unsupervised chat as their only partner during the attempt; photo-to-key an FRQ; detector-grade their sentence; coach live-exam or Common App fraud (“write my lab report” / “write my essay” bans still hold).

Bastani’s math chatbot caution stays off-age for science hour — fluency can fool.²² A fluent filled blank from a machine is performance, not the student’s looking. Keep accounts where you can open them.

²²Bastani et al. math chatbot caution stays **OFF-AGE for science hour** — fluency can fool. Common App / integrity: “write my lab report” / “write my essay” bans still hold. Access date 17 September 2026.

What “done enough” looks like

Before you move on, tick by skill — not birthday. Life-of-the-habit tips live here (and in ch08), not in a ninth teaching chapter.

15–16

- ☐ Speaks a denser CER that points at locatable evidence.
- ☐ Writes a short paragraph with warrant that names an idea (not only a restatement).
- ☐ Names one limitation *or* one alternative when prompted.
- ☐ Survives an evidence-press round without vibe claims.
- ☐ Accepts “insufficient evidence” instead of inventing rows.

17–18

- ☐ Competing claims or falsify prompt completed on own data.
- ☐ Soft error analysis with two named sources + one fix — without self-insult as the whole analysis.
- ☐ Occasional multi-trial synthesis *or* labelled FRQ-shaped stretch — sticky says practice not spine.
- ☐ Revoices a peer’s or sibling’s claim without contempt; locates disagreement in claim / evidence / reasoning.
- ☐ Methods crumb a stranger could repeat, including constants.

Life of the habit. Revisit next Tuesday: mix last week’s fair test into a new CER. Name this week’s system before the tidy idea. Stop while a look remains. A diploma is not this checklist. An AP score is not the only path that counts. Screening a shaky warrant is not an identity label.

Ready for ch08. When oral and written denser CER are routine, short assessments check whether the skill holds on a *fresh* trial, after a night, and two ways — without turning Friday into a percentile personality.

Progress without a percentile. A chart with skill names — locatable evidence, warrant names idea, limitation, alternative, oral-then-written, falsify — and dated notes (“holds on new table; warrant still restates; invent-urge caught and stopped”) tells you Tuesday’s move. A single score on the fridge does not. Screening $\neq$ identity. A shaky warrant means another look and another stem, not “not a science kid.”

Place by skill. A fifteen-year-old with stable warrants may try a careful falsify

prompt. A seventeen-year-old who still cannot point at a row needs CER-02, not an AP packet. The birthday is not the curriculum.

America's Lab Report in one kitchen sentence for this chapter. Clear outcome; look sequenced with idea and talk; integrate content with process; ongoing reflection and discussion.²³ A denser CER after a real try is that grain. An isolated “lab day” with no talk, or a CER worksheet with no apparatus, is not.

²³National Research Council, *America's Lab Report* (2006): ongoing student reflection and discussion sequenced with the look — not a silent procedure and a grade.

Chapter 8 — Short assessments and progress checks



Figure 10: An exit-ticket menu card, an invent-data refusal card, a kitchen honesty card, and a simple skill progress chart with no percentages, beside a dated notebook. Still-life. No people. No brand logos.

Why this matters

What can you show me two ways today — and what still needs practice?

That question is the spirit of kitchen assessment for ages 15–18. Assessment here means a dated investigation notebook, a systems boundary with one flow, a stranger notebook reconstruct, a fair-test redesign, a denser CER with warrant and limitation, an invent-data refusal, a generated-result refusal, a kitchen $\neq$ Chemistry credit honesty check, an exit ticket, one explained miss, and a done-enough checklist by skill. It does not mean a percentile as a personality. It does not mean NAEP. It does not mean a homemade high-stakes battery. It does not mean “not a science kid.” It does not mean an AP score as the only honest path.

Families need two truths at once. First: every Science Hour already assesses. The RAMP card, the table with units, the talk-box claim, the warrant — those are information. Second: a dedicated Friday rhythm keeps the week honest when hope, coverage itch, or a publisher’s quiz would skip the look. Screening a skill is a teaching signal. It is not an identity. Formal evaluation, when a family seeks it for another reason, is a different column. Kitchen checks decide Tuesday’s try.

Wineburg’s century of “kids don’t know” panic stories, built on fact tours, is a useful caution even though that review sat in history: light coverage leaves few traces; more encyclopedia hours are the usual panic, and they still leave few traces.²⁴ This chapter will not panic you into a binder of every PE. National Assessment scores for science exist for schools. They are not a sixteen-year-old’s census, and the federal statistical agency has never published a nationally representative *homeschool* NAEP Science score.²⁵ Passing or missing a state’s reading-and-math sitting does not prove a science year worked. A publisher’s review booklet checks recall inside a scope. It does not license a national percentile.

What this idea unlocks is calm evidence you can hold in a notebook a stranger could read: they can name a system boundary and one flow; they can reconstruct a trial from the record; they can catch a confound and redesign; they can write denser CER with warrant and limitation; they can refuse invent-data and generated gels as results; they can label a kitchen picture as not Chemistry credit. You will know

²⁴Wineburg / historical-coverage caution borrowed carefully: light coverage leaves few traces; more encyclopedia hours are the usual panic, and they still leave few traces. Science depth here = this week’s system + claim.

²⁵NAEP Science is a national sample of *school* students; NCES has not published a nationally representative *homeschool* NAEP Science score. Access date 17 September 2026.

what to reteach Tuesday. You will know when a skill holds after a night. You will know when to grow from a paragraph to a multi-trial stretch — by skill, not birthday.

AP Biology / Chemistry / Physics 1–2 / Physics C / Environmental Science, CLEP Biology / Chemistry, and dual enrollment sit in this chapter as **labelled edges**. They are useful signals when the student and the kitchen are ready. They are never the default kitchen check and never this book’s weekly identity.²⁶ There is no course titled simply “AP Physics.” A full timed FRQ-shaped stretch may appear occasionally for 17–18 when denser CER is stable. It is still not Monday–Friday.

You do not need to be a psychometrician. You need a dated notebook, a pencil, three kitchen skill objects you can rotate, the locked question, and — if an edge is in view — the honesty to label it as an edge.

This week you can learn to run one diagnostic wrong explained and a done-enough checklist on Friday. If an edge is in view, label it as an edge — title the credit **Biology / Chemistry / Physics / Earth Science / Environmental Science / Science**, and record “AP ... exam, score n” as a separate signal. Today the student can show the same skill two ways — oral and written, or two different trials — and name one thing still in practice.

Picture two Fridays. In one, a printout of a score sits on the fridge and no one can say what the student can *do* with a fresh fair-test sticky or a blank CER card. In the other, a chart with skill names — boundary+flow, stranger notebook, redesign confound, denser CER, invent-data refusal, kitchen honesty — has a date and a note: “holds on a new try; warrant still shaky; AP practice labelled practice.” Both rooms feel like they measured something. Only one told you what to put on the table next week.

For the parent: understand it yourself

Many adults remember assessment as a secret test, a red number, and a hallway conversation. Others remember no checks at all — only “we finished the chapter” or “we bought the AP binder.” For a Science Hour, assessment is frequent, short, kind, and useful. Five to eight minutes of this section, then the warm-up, is enough for Friday. The student still shows the skill.

²⁶AP / CLEP / dual enrollment are optional **edges** — useful when ready; never the default kitchen check and never this book’s weekly identity. There is no course titled simply “AP Physics.”

Everyday picture. Friday, about twenty-five to thirty-five minutes inside a Science Hour. You put a *fresh* short try or yesterday’s unused table on the table — not Monday’s answered page. One kitchen object (10–15 minutes). The same skill a second way — oral if the first was written, or a new materials set (5–10 minutes). You ask what still needs practice (2 minutes). You tick two done-enough boxes and write Tuesday’s hold (3 minutes). The student leaves knowing what worked. You leave knowing whether the skill transferred.

Precise picture — four columns

Kitchen check	Optional program review	Optional external edge	State or clinic sitting
What to teach Tuesday	Recall and listening inside a purchased scope	AP / CLEP / dual enrollment when fit	Compliance or documentation in <i>that</i> lane
Systems boundary + one flow; stranger notebook reconstruct; redesign a confound; denser CER with warrant + limitation; invent-data / gel refusal; kitchen $\neq$ credit; exit tickets	Chapter questions, pretests, quizzes when you already use that program	Labelled edge; title stays Biology / Chemistry / Physics / Earth / Environmental / Science; score as separate signal	Reading/math portfolios, commercial batteries, evaluations — not a science NAEP
Parent-run; skill-based; screening $\neq$ identity	Not a national percentile; not a kitchen trial	Never the default weekly spine; CLEP $\neq$ NCAA core	Not replaced by this book; not a proof the science year “worked”

Keep the columns separate until they stick.

What denser kitchen assessment is (memo 03 grain). Age up from *Science for Young Minds*’ dated notebook + fair test + one CER sentence. The honest high-school objects are denser: (1) dated investigation notebook or course folder; (2) named question / method / data / claim; (3) short lab report or multi-sentence CER from the notebook; (4) optional vendor review inside a purchased scope; (5)

optional external edge. “Denser” does not mean every Friday is a college lab report. It means the middle-grades one-sentence CER is no longer the default ceiling. A sixteen-year-old claiming Biology with Lab should be able to show investigations that actually happened. A reading-only year can still be titled Biology if the work was biology reading and assessment — but it should not be titled Biology with Lab.

Kitchen skill objects (rotate; one Friday can hold two if you stay short)

1. **Systems boundary + one flow.** Fresh jar, body-subsystem card, circuit, or watershed sketch. Draw boundary; one input or output arrow; one thing the model leaves out.
2. **Stranger notebook reconstruct.** Hand a recent page to the parent (or a sibling) who did not watch. Can they say what was asked, what was done, what was measured, what was claimed — with units?
3. **Redesign a confound.** Show a confounded design card (or last week’s messy page). Name the confound. Redesign once. “Can we tell for sure?”
4. **Denser CER with warrant + limitation.** Fresh table or short new try. Claim; locatable evidence; warrant; one limitation. Oral then written, or written then explain-back.
5. **Invent-data refusal / generated-result refusal.** Spot a labelled FAKE pretty table or FICTION gel/curve. Practice “insufficient evidence” and the house rule: generated image $\neq$ data.
6. **Kitchen $\neq$ Chemistry credit / AP-as-map.** Honesty card: picture vs lab-path vs course title. Or AP CED snippet labelled College Board map — this week’s spine named SYS/CER/FAIR/CHEM/PHYS, not “AP unit.”

Add crumbs: daily exit tickets (2–5 minutes); one diagnostic wrong explained each Friday; a retest after a night on the sticky skill; a progress chart with skill names, not percentages.

Among homeschooled ninth-through-twelfth-graders in 2016, scientific inquiry or experiments that year sat at about 25 percent; earth sciences about 36 percent; biology about 29 percent; chemistry or physics about 22 percent. Ever taught among 9–12: earth 77 percent; biology 66 percent; inquiry 53 percent; chem/physics 41 percent.²⁷ You are not inventing a subject. You are checking the looking move inside years many families already name — and noticing that inquiry *that year*

²⁷Cui and Hanson, NCES 2020-001: grades 9–12 *that year* biology ~29%; chemistry or physics ~22%. Ever among 9–12: earth 77%; biology 66%; inquiry 53%; chem/physics 41%.

was the thinner neighbor. There is no national study of daily homeschool science minutes. Do not write one into your notebook. Regular investigation sittings, a stranger-readable notebook, and several denser CER pages across a term are an honest dose.

No state in the five-state grain this book uses requires a course titled Emerging Adults Science I. Texas’s leading case names reading, spelling, grammar, math, and good citizenship — not the word science. North Carolina’s test list is English grammar, reading, spelling, and mathematics — not science; the homeschool issues its own diploma. Pennsylvania secondary homes shall include science; biology and chemistry may be included; graduation science three years; the portfolio tests in earlier grades are reading/language arts and mathematics, not science. Virginia lets the parent write the list and show evidence of progress. New York grades 9–12 require science (two units).²⁸ None of that is legal advice. Read your own statute. File the kitchen work under **Biology / Chemistry / Physics / Earth Science / Environmental Science / Science** — Life Science or Physical Science only when the work is actually that. **With Lab** only when supervised investigation actually happened. Never a brand. Never Emerging Adults Science I. Never bare “AP Physics” as the credit line.

Edges, labelled (not defaults)

- **AP** (Biology; Chemistry; Physics 1; Physics 2; Physics C Mechanics; Physics C E&M; Environmental Science): optional external signal. Homeschoolers typically need a participating school’s AP coordinator. Opened fee grain for the 2026–27 cycle runs about **\$99** (U.S./territories/Canada/DoDEA pattern) and **\$129** outside, plus possible local proctoring costs — confirm with the coordinator.²⁹ Safer transcript practice: title **Biology / Chemistry / Physics / Environmental Science**, with “AP ... exam, score n” as a separate line. Tools for learning and labelled practice; not for live exams. College Board 2026 AP Exam Terms: no AI-generated Test answers or submissions.³⁰

²⁸Five-state high-school grain (TX/NC/PA/VA/NY) touches science differently — parent lists, unit requirements, or neither. Not legal advice; read your own statute. Access date 17 September 2026.

²⁹AP / CLEP / dual enrollment are optional **edges** — useful when ready; never the default kitchen check and never this book’s weekly identity. There is no course titled simply “AP Physics.”

³⁰College Board AP Exam Terms (opened 2026 cycle): no AI-generated Test answers or submissions. Tools for learning and labelled practice; not for live exams. Access date 17 September 2026.

- **CLEP** (Biology; Chemistry): optional credit-by-exam edge. Opened register fee pattern about **\$97** plus administration fee — confirm locally.³¹ Each institution sets its own credit policy. CLEP Chemistry’s experimental-chemistry content is exam content about experiments, not a lab year. **Neither is NCAA core.**³²
- **Dual / concurrent enrollment:** state-variant college coursework. When it fits, designate the course on the homeschool transcript with college name; keep the official college transcript. Eligibility and age rules are local. There is no national dual-enrollment right to assume — eligibility and age rules stay local.
- **Enhanced ACT Science:** optional section; not required for the Composite on opened ACT pages. A signal, not a Biology credit.
- **SAT Subject Tests:** discontinued (last international sitting June 2021). One sentence, then stop.³³

Edges sit on top of the kitchen spine. They are not the spine.

NCAA note (if athletics are in view). Science is core. Live Division I public fact-sheet pattern: two years of science, including one year of lab if offered; CLEP not core; worksheet name equals transcript title. “With Lab” is a claim. Virtual labs vs “lab if offered” is silent on opened sheets — treat that as unsettled and point to the NCAA Home School Toolkit rather than a blog rule. Do not tell a parent Division I dropped the lab rule as a settled fact when the live sheet still carries lab language.³⁴

Wrong answers you should be able to hear

1. *Birthday gate.* “You’re only fifteen, so we don’t measure” or “You’re seventeen, so you must do AP packets every Friday.” Repair: run the skill objects at this week’s grain. Adjust length. Place by skill. Label AP as an edge if you choose it.

³¹AP / CLEP / dual enrollment are optional **edges** — useful when ready; never the default kitchen check and never this book’s weekly identity. There is no course titled simply “AP Physics.”

³²CLEP Biology / Chemistry: optional credit-by-exam edges; receiving institution sets credit policy. CLEP Chemistry experimental content is exam content about experiments, not a lab year. **Neither is NCAA core** by itself.

³³SAT Subject Tests discontinued (last international sitting June 2021). One sentence, then stop. Access date 17 September 2026.

³⁴CLEP Biology / Chemistry: optional credit-by-exam edges; receiving institution sets credit policy. CLEP Chemistry experimental content is exam content about experiments, not a lab year. **Neither is NCAA core** by itself.

2. *Percentile identity / NAEP panic.* “You’re a 40th-percentile science student” or a news story becomes an encyclopedia year. Repair: translate to a skill — stranger notebook shaky; warrant still restates; invent-urge appeared. One try, one move.
3. *“Not a science kid.”* A miss filed as a type of person. Repair: screening $\neq$ identity. Shorter try. Clearer RAMP. One claim only. Retest after a night.
4. *Vendor quiz or AP packet as the only measure.* The pretest booklet or a weekly FRQ stands in for looking. Repair: keep the booklet if it helps recall; keep occasional AP-shaped practice labelled *practice*. Add a denser CER on a real table the booklet never saw. Refuse AP as every Friday.
5. *CLEP as a substitute year of Chemistry for NCAA — or Emerging Adults Science I as a credit — or kitchen fizz as Chemistry with Lab.* Repair: CLEP $\neq$ NCAA core; title stranger-readable courses; never brand the credit; honesty card for pictures vs lab path.

A sixth: *no checks — just the next lesson.* Hear abandoned transfer. A skill that only works on Monday’s familiar table is not done-enough.

Five-to-eight-minute parent warm-up

Do this alone, before Friday’s sitting.

Minute 1. Open the dated notebook to a blank progress grid (skill names, not percentages).

Minute 2. Pick one diagnostic wrong you actually expect this month: invent-data neat rows; force-as-fuel; kitchen-as-credit claim; generated gel as result; warrant that only restates; AP packet as every Friday; confound left unchallenged.

Minute 3. Write the repair move in one sentence. Note which bank ID would help Tuesday (FAIR-03, CER-02, SAFE-03, AS-04...).

Minute 4. Practice the locked opening aloud: “What can you show me two ways today — and what still needs practice?”

Minute 5. Choose today’s object: boundary+flow, stranger notebook, redesign, denser CER, invent-data/gel refusal, or honesty/AP-as-map — or a two-ways pair (oral + written on the same skill). If an edge is in view this term, write one line: “Edge = optional; kitchen = spine.”

Minute 6. Print or sketch a done-enough checklist with *skill names*.

Minute 7. Choose a fresh try or a fresh unused table. Transfer dies if Friday reuses Monday's answered page with the answers still in the air.

Minute 8. Put the pencil down. You are ready. They show you two ways.

How to teach it this week

Assessment is not a separate subject titled Emerging Adults Science I. It lives inside Biology / Chemistry / Physics / Earth Science / Environmental Science / Science as short probes. Friday often carries the longer sweep. Daily exit tickets stay tiny. The Science Hour's five beats still hold. The "one try" is the check.

Band 15–16 weekly rhythm

- Daily: 2–5 minute exit ticket matched to the sit (boundary sentence; stranger header; can-we-tell; warrant crumb; RAMP hazard).
- Mid-week: one CER-01 / WRITE-02 page *or* one redesign sticky.
- Friday: one kitchen object on a *fresh* try or table; one diagnostic wrong explained; done-enough checklist; note Tuesday's hold.
- Across a term: several denser CER pages saved; invent-data and gel-refusal cards run at least once. Not a battery every Friday. Not AP as weekly identity.

Band 17–18 weekly rhythm

- Daily exit may be a limitation sentence, alternative explanation, uncertainty crumb, or slope sentence.
- Mid-week: competing claims or falsify when CER is stable.
- Friday: kitchen object on a fresh piece; optional labelled AP-shaped practice *as practice*; done-enough; Tuesday's hold.
- Across a term: multi-trial soft samples; occasional WRITE-06 / CER-07 stretch when paragraphs are stable — still labelled occasional. Optional external edge recorded separately.

Five beats on a check day

1. **Open / fresh materials or fresh table (3–7).** RAMP if a new try needs it. Name the skill object. No claim yet if the object is boundary or stranger reconstruct.

2. **Short look (3–8).** Enough to attempt the object — not a lecture that answers it.
3. **One check try (15–25).** The object is the try. Record. Two ways if time: oral then written, or redesign then CER.
4. **Talk box (5–10).** Locked opening. Wait. What still needs practice?
5. **Exit + diagnostic + done-enough (2–5).** Tick skill boxes. Write Tuesday's hold. Celebrate wrong-with-a-reason usable tomorrow.

Exact wording you can say

- “What can you show me two ways today — and what still needs practice?”
- “Show me on a new table — not Monday's.”
- “Point. Where is the evidence?”
- “Wrong with a reason we can use Tuesday is useful. Fiction rows are not.”
- “This score / this AP stem is a signal — not your identity, and not this week's spine.”
- “Kitchen picture — not Chemistry credit. Lab-path when we need it.”

When to stop talking. After the locked question, wait. Do not narrate the two ways for them. If they freeze, narrow: “Show me the boundary *or* the warrant — pick one first.” Then the second way.

Fade help. Early Fridays you may name which object. Later they choose from a three-item menu. Retest after a night without reteaching the answer.

A sample assessment Friday (hypothetical composite). Fresh conductivity or ramp table the student has not CER'd yet. Object: denser CER with warrant + limitation (oral then written). Diagnostic sticky: warrant-restates tagged Tuesday → CER-03. Done-enough: locatable evidence holds; limitation named; invent-urge absent. Optional: one AS-06 glance if the family has an AP calendar on the wall — spine still named CER, not “AP unit 4.”

Across a term (illustration, not a mandate). Weeks 1–2: exit tickets + boundary or stranger-notebook Fridays. Weeks 3–4: redesign + denser CER Fridays. Week 5: invent-data and gel-refusal if not yet run. Week 6: kitchen $\neq$ credit if Chem pictures happened; AP-as-map if an edge calendar appeared. Then rotate. One OUT check per month when travel fits. Skip a 180-day testing calendar. Skip panic into every performance expectation.

Library / museum as check, not tourism. NCES outing rows show Homeschool families visiting libraries and museums at higher rates than the all-student average

— motivation is real.³⁵ Bring back one claim with locatable evidence. The outing is not the transcript line. The notebook that follows can feed one.

Practice that actually builds learning

Map from memo 02 AS bank plus the skill objects above. Pick one per Friday; rotate across a month.

Talk box (locked)

Opening question: “What can you show me two ways today — and what still needs practice?”

Follow-ups (3–5):

1. Observe: “What do you *see* / *measure* on this fresh try or table?”
2. Record: “What would a stranger need in the notebook to reconstruct this?”
3. Reason: “How do you know from *this*? What is the warrant?”
4. Check / alternative: “Can we tell for sure? What else could explain these numbers? Is this your data or labelled secondary — or fiction we refuse?”
5. Revise / practice: “You may change your mind. What still needs practice — name the skill, not a personality.”

How to wait. Pose. Count three to five. Wait again after the answer (Rowe / Stahl classroom-origin pause — use it; do not claim a kitchen RCT).³⁶ Look at the notebook or the skill card if silence is hard.

Stuck silence usually means: the question was vague; wait-time was zero; they think you want a score speech; Friday reused Monday’s answers; they are bracing for an AP rubric; they fear “not a science kid.” Narrow to one object. Point at materials. Wait.

³⁵NCES outing rows: Homeschool families visit libraries and museums at higher rates than the all-student average — motivation is real (NCES 2024-113 Table A-5 grain: library ~53%; museum/historical site ~43%). Bring back one claim with locatable evidence; the outing is not the transcript by itself.

³⁶Rowe 1972 / Stahl think-time: pose, wait three to five, wait again after the answer — classroom-origin pause; do not claim a kitchen RCT.

In-home try-its

AS-01 — Exit ticket menu

Time: 15–25 min (or 2–5 daily). *Materials:* Menu card (oral CER / boundary sketch / can-we-tell / RAMP hazard / falsifier / warrant crumb). *Safety:* None. *The fun:* Choosing a tiny close that still checks looking. *The skill:* One exit matched to today's sit. *Refuse:* Turning exit into a test packet; public cold quiz. *Exit:* The menu item itself. *Parent note:* Tag the diagnostic error type for Tuesday.

AS-02 — Diagnostic error sticky

Time: 20–30 min. *Materials:* Yesterday exit; sticky types: confound / invent-urge / systems-no-boundary / reasoning-no-idea / force-as-fuel / weather-as-climate / kitchen-as-credit / AP-as-spine. *Steps:* Tag error; plan tomorrow's repair activity from banks. *Refuse:* Moralizing; ignoring the tag. *Exit:* Tag + tomorrow bank ID.

AS-04 — Invent-data refusal card

Time: 20–35 min. *Materials:* Honesty card; sample “pretty” fake table labelled FAKE. *Steps:* Spot invent patterns (too neat; matches hypothesis exactly; no units; phantom points); practice “insufficient evidence”; redesign. *Refuse:* Laughing it off; using FAKE as real later. *Exit:* “If data are thin I will ____.”

AS-05 — Generated gel / result refusal card

Time: 20–35 min. *Materials:* Example AI gel/curve labelled FICTION; Lab Report definition sticky (interact with material world or data drawn from it; fake sets do not count).³⁷ *Steps:* Sort fiction vs real photo of own setup; write house rule; remind BIO-05 / CHEM path — electrophoresis on lab-path neighbor, not as a generated image in the portfolio. *Refuse:* “It's fine if it looks right.” *Exit:* House rule sentence initialed.

AS-06 — AP-as-map not spine card

Band: 17–18 (optional 15–16). *Time:* 25–40 min. *Materials:* AP CED unit list snippet labelled College Board map; family week plan. *Steps:* Circle map uses (if any); schedule at most occasional WRITE-06; keep weekly spine as systems + claim Hour. *Refuse:* Replacing Science Hour with FRQ packs; shame if not AP. *Exit:* This week's spine named (SYS/CER/FAIR/CHEM/PHYS/...) not “AP unit.”

AS-07 — Kitchen ≠ Chemistry credit card

³⁷America's Lab Report definition sticky: interact with the material world or with data drawn from it; invented neat rows and generated gels do not count as the student's result.

Time: 20–30 min. *Materials:* SAFE-03 honesty; transcript/policy note if family keeps records. *Steps:* List what credit path requires; list what pictures teach; update records language. *Refuse:* Inflating transcript; hiding pictures as if shameful. *Exit:* Records sentence: picture / lab-path / course title honesty.

Two-ways drills (core Friday shapes)

- *Boundary two ways:* sketch on jar; then explain-back without looking; or sketch two different systems.
- *Notebook two ways:* stranger reconstruct; then student repairs one missing header.
- *CER two ways:* oral then written on the same fresh table.
- *Fair-test two ways:* mark confound on Card A; redesign on Card B.
- *Honesty two ways:* invent-data refusal + kitchen $\neq$ credit in one sitting if both urges appeared this month.

Out-of-home try-it as a check

OUT check — one claim with locatable evidence

Time: 35–50 min on site (+ travel) or a park transect. *Materials:* Notebook; one question written beforehand. *Safety:* Adult; venue rules; leave-no-trace. *The fun:* Can the looking travel? *The skill:* Bring back one claim with evidence you recorded — not a scavenger packet. *Exit:* Claim + evidence + “still needs practice: ____.” Museum, park, grocery structure–function, or night sky with adult all work when the check is one focused look.

Blocked, mixed, and one incorrect example

Blocked. First assessment month: exit tickets + one object Fridays. Run invent-data and gel-refusal before any AP-shaped stretch.

Mixed. When stable: CER object + honesty card same Friday; stranger notebook + redesign across two Fridays; OUT check once a month.

Incorrect example (hypothetical). A family files weekly AP FRQ scores as the only science record, titles the transcript “AP Physics,” treats a vinegar volcano photo as Chemistry with Lab, and calls a sixteen-year-old “not a science kid” after one thin CER. Repair: AS-06; title **Physics**; AS-07 honesty; screening $\neq$ identity; return Friday to two-ways on a fresh table.

Progress chart (skill names, not percentages)

Skill	Date seen	Holds after a night?	Two ways?	Tuesday hold
Boundary + one flow				
Stranger notebook				
Redesign confound				
Denser CER + warrant				
Limitation / alternative				
Invent-data refusal				
Generated-result refusal				
Kitchen $\neq$ credit honesty				
RAMP before heat/chem				

Done-enough for a skill: showable two ways, holds after a night, wrong-with-a-reason usable when it fails. Not a diploma. Not a percentile.

For the student

Checks are how you and your adult find out what you can *do* — not who you are as a person.

What the idea is. Show a science skill two ways (say it and write it; or do it on a new try). Name what still needs practice. A thin day is information. Invented neat rows are not practice — they are fiction. A generated picture of a gel is not your result.

Tiny worked example (illustration). Friday object: denser CER on a fresh ramp table. Way 1 — oral: “I claim the steeper ramp gave a shorter travel time under these conditions because rows 2–3 show 1.8 s and 1.2 s. This counts if friction and mass stayed the same — forces and motion idea. Limit: phone stopwatch.” Way 2 — written paragraph with the same stars. Still needs practice: naming an alternative (maybe the release height also changed). Tuesday hold: FAIR-02 constants list before the next ramp.

Try 1. Pick one skill from the chart with your adult. Show it two ways on fresh materials.

Try 2. Complete invent-data refusal *or* gel-refusal if you have never run those cards — or if the urge appeared this month.

Explain it back. What can you show two ways today — and what still needs practice?

Challenge. Retest yesterday's sticky skill after a night *without* looking at yesterday's answered page first. Then compare.

If it isn't clicking

Diagnostic 1 — Freeze / “just tell me the score.”

Next move: Narrow to one object. Two-ways on a tiny table. Celebrate wrong-with-a-reason. Remove percentile language from the fridge for a month.

Diagnostic 2 — Skill works only on Monday's familiar try; Friday transfer fails.

Next move: Always use fresh materials or an unused table on check day. Retest after a night. AS-02 tag → matching bank Tuesday.

Diagnostic 3 — Invent-data, gel fiction, kitchen-as-credit, or AP-as-only-measure.

Next move: AS-04 / AS-05 / AS-07 / AS-06 in that order of urgency. Stop filing fiction. Separate edge calendar from weekly spine. Screening $\neq$ identity — still correct the honesty fail without crushing the person.

When to slow down. Anxiety spikes; every Friday feels like a secret exam; edges swallowed the Hour. Slow. Return to exit tickets only for a week.

When to go ahead. Two-ways stable; holds after a night; honesty cards initialed — then occasional FRQ-shaped stretch or external edge planning.

When to get a human tutor. Persistent transfer failure after fresh-try Fridays; writing block that stops every CER exit; family needs documentation for a path this book does not replace (state evaluation, college advising) — tutor or counselor in *that* lane, still with kitchen spine intact.

Correct a wrong reason without crushing the look. Silence in the face of invent-data is not kindness.

Tools, including AI

Point back to the Science Hour AI box. Short version for assessment weeks:

You may, on your account: generate isomorphic blank checks (empty tables, CER cards, confound cards) with the key held by you; ask revision questions after *their* check draft; diagnose work already produced (crop to paper); get a SCRIPT for *you* for the talk-box follow-ups.

You may not: photo-to-key a packet during the check; invent their data; generate a gel as their portfolio result; write their FRQ or lab report; detector-grade their observation; park unsupervised chat as the only partner during the attempt; use AI on a live AP exam; treat a detector score as a science grade.

College Board 2026 AP Exam Terms forbid AI-generated Test submissions.³⁸ Common App fraud examples include misrepresenting AI substantive output as one's own — revision questions after the student's draft remain allowed; “write my lab report” does not. Bastani's math chatbot caution stays off-age for science hour.³⁹

What “done enough” looks like

Life-of-the-habit tips live here (and in ch07), not in a ninth teaching chapter titled “life of the habit.”

15–16

- ☐ Completes exit tickets most Science Hours without turning them into packets.
- ☐ Shows at least three skill objects two ways across a month (boundary, notebook or redesign, denser CER).
- ☐ Explains one diagnostic wrong and names Tuesday's repair bank.
- ☐ Runs invent-data refusal and kitchen $\neq$ credit honesty at least once.
- ☐ Progress chart uses skill names — no percentile identity language.

³⁸College Board AP Exam Terms (opened 2026 cycle): no AI-generated Test answers or submissions. Tools for learning and labelled practice; not for live exams. Access date 17 September 2026.

³⁹Common App fraud examples include misrepresenting AI substantive output as one's own; revision questions after the student's draft remain allowed; “write my lab report” does not. Bastani math-chatbot caution stays **OFF-AGE for science hour**. Access date 17 September 2026.

17–18

- ☐ Adds limitation *and* alternative on denser CER checks when the week holds both.
- ☐ Generated-result refusal initialed; no fiction gels in the portfolio.
- ☐ AS-06 AP-as-map completed if an AP calendar is in view; weekly spine still named as a looking move.
- ☐ Occasional labelled FRQ-shaped stretch only after denser CER is stable.
- ☐ Optional edge (AP/CLEP/DE) recorded as a separate signal; transcript titles stay stranger-readable; With Lab only with investigation evidence.

Life of the habit. Revisit next Tuesday's sticky skill. Mix last week's fair test into Friday's two-ways. Name this week's system before the tidy idea. Stop while a look remains. A diploma is not this checklist. An AP score is not the only path that counts. Screening $\neq$ identity.

Place by skill, last time. A fifteen-year-old who already shows boundary, stranger notebook, and denser CER two ways may run 17–18 edges carefully. A seventeen-year-old who still invents neat rows needs AS-04 and redesign, not shame and not an AP binder as identity. The birthday is not the curriculum. The looking move is.

Ready for records (ch09). When the notebook holds dated investigations with question / method / data / claim and denser CER pages you can show a stranger, you are ready to title the year's work honestly — Biology, Chemistry, Physics, Earth Science, Environmental Science, or Science — never Emerging Adults Science I, never a brand as the credit line, and With Lab only when the investigations actually happened.

Chapter 9 — Records



Figure 11: An open notebook titled Biology / Chemistry / Physics, a dated investigation with question, method, data, claim; a denser CER card with a warrant line; a pencil; a kitchen honesty card labelled not Chemistry credit. Still-life. No diploma seal. No brand. No adolescent.

The science *work* can be as ordinary as a library chapter and a dated notebook, and as serious as any classroom hour. The *credit* is a family claim until a stranger can use it — a college admissions reader, an NCAA Eligibility Center staffer, a dual-enrollment office, a receiving counselor, or the high-school transcript you will someday sign. That stranger will not have sat at your table. They will have a page.

This chapter is how you make that page at ages 15–18. Lawful, safe, and readable to a stranger are three jobs. Keep them in view.

This week you can date one investigation and one denser claim in a notebook so a stranger could almost reconstruct the trial. Today the student tries the page. You write the line, or they write the short lab report.

What you are making

You are making a **transcript line** plus a **dated investigation notebook** (or course folder) of **Biology, Chemistry, Physics, Earth Science, Environmental Science, or Science**, with the question named, plus a **method**, plus **data**, plus a **claim**, plus a denser **claim–evidence–reasoning** paragraph or short lab report from *this* notebook, plus optional publisher review when you use a purchased program, plus optional external edges when they fit. You are not making a national diploma. You are not making Emerging Adults Science I.

When a stranger asks, print those ordinary titles — and **Life Science** or **Physical Science** only when the year’s work was that. Never a brand. Never Exploring Creation with Biology, Discovering Design with Chemistry, OpenStax Biology 2e, Science Unlocked Launch Year X, BJU Biology, or a FlexBook name as the credit line. Never bare “AP Physics” as the transcript title. Never **Emerging Adults Science I**. The dated notebook and the denser kitchen checks live *inside* those titles.

There is no federal homeschool diploma and no national science credit a registrar already files.⁴⁰ Texas, North Carolina, and New York do not issue one. Pennsylvania’s supervisor or approved-organization diploma is a Pennsylvania high-school

⁴⁰No national homeschool diploma: TEA Home Schooling / Alternative Schooling (Texas does not award a homeschool diploma); NC DNPE (the home school issues any diploma); Pennsylvania 24 P.S. § 13-1327.1(d.1); New York 8 NYCRR 100.10 (no local or Regents diploma for home instruction); Virginia list of subjects is a list, not a transcript. Access date: 17 September 2026.

object. Virginia’s list of subjects is a list, not a transcript. A parent-issued diploma can be a real piece of paper. It is not a registrar’s national science credit.

Three readers, if anyone outside the kitchen asks. (1) The **state**, in a thick jurisdiction: IHIP, affidavit, portfolio, evidence of progress — with science samples where the statute named science. (2) A **college admissions** office: transcript, counselor letter (often the parent), optional scores. (3) The **NCAA Eligibility Center**, if athletics are in view: Toolkit packet, Core-Course Worksheets for natural/physical science, proof of graduation. State compliance is not a college transcript. Neither fact is a reason to skip the looking — or to fake a credit.

A family that invents “Emerging Adults Science I, 1.0, A” for a sixteen-year-old has created a slogan. A receiving counselor cannot map it. NCAA will not file it.

As of the 2016 Parent and Family Involvement subject tables, among grades 9–12-equivalent homeschoolers, there is **no overall “science” percent**. Sub-subjects taught *that year*: scientific inquiry or experiments **25 percent**; earth sciences or geology **36 percent**; biology **29 percent**; chemistry or physics **22 percent**. *Ever* among 9–12: earth **77 percent**; biology **66 percent**; inquiry **53 percent**; chemistry or physics **41 percent**.⁴¹ Those are the high-school science rows — not a curriculum poll and not a mandate to finish AP. Inquiry at **25 percent** *that year* is a quiet neighbor: many science years have been reading years. Informal learning does not arrive as “Biology, 1.0, B+.” Name the task, date it, keep a sample, grade on a stated scale if a credit is claimed.

Titles a stranger can read

Print these and only these as high-school names, if a name is needed at all:

Science. **Biology** (or **Biology with Lab** only when supervised investigation actually happened). **Chemistry** (or **Chemistry with Lab** — same claim rule). **Physics** (or **Physics with Lab** — same claim rule). **Earth Science / Environmental Science**. **Life Science** or **Physical Science** (only when the year’s work is that band).

⁴¹Cui and Hanson, NCES 2020-001, Table 9 grades 9–12 *that year*: scientific inquiry or experiments **25%**; earth sciences or geology **36%**; biology **29%**; chemistry or physics **22%**. Table 8 *ever* among 9–12: earth **77%**; biology **66%**; inquiry **53%**; chem/physics **41%**. Do not paste middle-band inquiry 45 / earth 54 / biology 33 / chem-or-physics 16, or History’s social-studies rows, into this band. NCES 2024-113 did not republish subject-taught tables.

Reading / Language Arts / English. Mathematics. History / Social Studies. Art, Music, Physical Education.

Those names travel. The NCAA sample homeschool transcript uses ordinary titles in the same family: Physical Science; Biology with Lab; Chemistry; Physics. The Core-Course Worksheet says the course name on the worksheet should be the same as the title on the transcript.⁴² Pick one title and stay with it.

Never a brand. Never Emerging Adults Science I. The brand, if used at all, sits in a parenthetical: “Biology with Lab (named textbook; sixteen dated investigations; denser CER from the notebook; lab-path neighbor once).” Combining does not mint a new title.

A publisher’s “grade 11 Biology workbook” is a scope, not a legal grade. A year that mixed biology reading, chemistry pictures, and a park transect still splits: **Biology** or **Chemistry** or **Physics** or **Earth Science** or **Environmental Science** or **Science** by the work that actually happened.

Here is an illustration, labelled as such, not a reported family:

17 September 2026. Biology with Lab. Question: how does light change measured leaf color over five days in two treatments? Method: same water volume, same pot size, same window shelf; changed wrap vs open; recorded color scale daily. Data: table in notebook. Claim: wrap slowed the measured green fade in this trial. Warrant: less light reaches the leaf surface under the wrap. Limitation: one plant each, one week. Grade recorded on transcript scale.

That is a record a parent, a Pennsylvania evaluator, a New York quarterly narrative, a college reader, or an NCAA worksheet can actually use. It is not NAEP.

“With Lab” is a claim

Biology with Lab is on NCAA’s sample list. “With Lab” is a claim you can defend.

If you claim lab, keep objects you already produce: a dated notebook (question, method, data, claim); a materials list; a note that eye protection and other gear

⁴²NCAA Eligibility Center, *Home School Toolkit 2025–26*; Core-Course Worksheet. Sample titles include Physical Science; Biology with Lab; Chemistry; Physics. Course name on the worksheet equals title on the transcript. CLEP / credit-by-exam / audited courses are not NCAA core.

were used when ordinary home-lab safety would require them. No opened statute in the five states below requires a bound lab notebook. The notebook is how you defend the claim.

A kitchen picture is a picture. A vinegar-and-soda fizz is a change picture. It is not a Chemistry credit by itself. A year of kitchen trials can be a lab path if investigations happened, hazards were named, and the title is honest. A year that skipped every experiment in a book that “has labs in the chapters” is a reading year. Title it **Biology**. Leave “with Lab” off unless you built investigation some other way you can show.

Simulations can teach a skill. Whether a virtual lab satisfies an athletic “lab if offered” sentence is for the Eligibility Center in the year you file — this book does not invent that answer.⁴³ Integrate looking with discussion (America’s Lab Report’s classroom grain, labelled). Refuse isolated lab-day theater. Kitchen $\neq$ Chemistry credit until the record says otherwise.

The law is a pattern, not one form

U.S. homeschooling is state law. There is no federal science office. Read your current department page and the statute it cites. Five official-page examples show the range. **None of them requires “Emerging Adults Science I.”** Science is sometimes named, sometimes left to the parent’s list, and sometimes neither named nor tested.⁴⁴ This chapter is not legal advice.

Texas. The Agency does not regulate home-school programs. *Leeper*, restated on TEA’s Alternative Schooling page, requires a bona fide written curriculum: reading, spelling, grammar, math, and a course in **good citizenship**. Science is not named as a word. The state does not award a homeschool diploma. For colleges

⁴³Opened NCAA fact sheets, Toolkit, and HSRC pages do not settle whether virtual or simulated labs satisfy “lab if offered.” Confirm with the Eligibility Center in the year you file. Do not treat PhET or a vendor “experiments not mandatory” FAQ as athletic lab credit.

⁴⁴Texas *Leeper* (TEA Alternative Schooling): reading, spelling, grammar, math, good citizenship — science not named. NC DNPE: annual test in English grammar, reading, spelling, mathematics — not science; do not name the school after a curriculum brand. PA 24 P.S. § 13-1327.1: secondary shall include science; biology and chemistry may be included; graduation science three years; 990 secondary hours; no laboratory named in the opened statute. NY 8 NYCRR 100.10: grades 9–12 science two units; unit = 6,480 minutes; 990 hours grades 7–12; Regents lab-evidence is exam-admission. Virginia § 22.1-254.1: parent writes the list; evidence of progress. None requires “Emerging Adults Science I.” Not legal advice.

and NCAA, the parent builds a transcript with stranger-readable titles. Transfer is treated like an unaccredited private school.

North Carolina. Notice of Intent. Nine calendar months. Annual nationally standardized test in **English grammar, reading, spelling, and mathematics** — not science. The home school, not the State, issues any diploma. A five-hour day is a recommendation, not law. Do not name the homeschool after a curriculum brand. Career and College Promise on the DNPE page is **North Carolina** dual enrollment with pathway gates — state-variant, not a national right.

Pennsylvania. Secondary **shall include** science; biology and chemistry *may* be included at the supervisor's discretion. Graduation science is **three years**. The statute does **not** name a laboratory. **990** hours secondary are whole-program hours. Portfolio tests in grades 3, 5, and 8 are reading/language arts and mathematics — not science. A supervisor (or approved-organization) diploma is Pennsylvania's high-school object. The evaluator's experience list may name biology, chemistry, and physics — that describes the evaluator, not a required student Bio–Chem–Physics trio.

Virginia. Notice, a parent-written **list of subjects**, and evidence of progress (fourth stanine, or SAT/ACT/PSAT equivalent, or evaluation / college transcript). Science is not named as required; the parent writes the list. **Biology, Chemistry, Physics, Earth Science, or Environmental Science** is the ordinary word to write.

New York. Letter of intent, IHIP, quarterly reports, annual assessment. Grades **9–12** require **science (two units)**. A unit is 6,480 minutes. **990** hours for grades 7–12. A brand name is a **material**, not a required unit title. Home instruction does not yield a local or Regents diploma. If a Regents examination has a laboratory requirement, the student may be admitted with evidence the lab was met — IHIP, quarterlies, and/or teacher verification. That is an **exam-admission** object, not NCAA and not a national wet-lab law. For NCAA proof of graduation, the Toolkit notes New York (and Hawaii) paths that are not a local diploma — open the Toolkit.

If you live in none of those states, open your department page.

What a short check is

Five objects, not a battery — and a sixth when an edge fits.

1. **A dated investigation notebook.** Date, question named, method, data, claim — under **Biology, Chemistry, Physics, Earth Science, Environmental Science**, or **Science** if a title is needed.
2. **A denser claim from the notebook.** Claim + locatable evidence + reasoning that names the idea (warrant). At 15–16, one limitation *or* one alternative. At 17–18, alternatives *and* limitations when the week asks for them.
3. **A short lab report or multi-sentence CER** that points at *this* table — oral first when that helps, then written. Revised once when you can. Kept in the notebook.
4. **Optional publisher review** when you use a purchased program — to check reading and recall inside a scope. Those tools do not license a national percentile. They generally do not satisfy North Carolina’s annual battery by themselves.
5. **Safety and honesty tags when they matter.** RAMP before heat or chemicals; kitchen picture labelled as picture when that is what it was; lab-path neighbor named when the try needed real glassware.
6. **Optional external edge** — an AP score, a CLEP score, a dual-enrollment grade — labelled as an edge. Edges sit on top of the kitchen spine. They are not the spine.

Screening is not an identity label. A miss on warrant is a teaching signal, not “this adolescent is not a science kid.” Reteach with a shorter try or one claim only.

Bands: **15–16** — system boundary scaffolded; stranger-readable notebook; denser CER with warrant; Bio / Chem / Physics as this week’s vehicle. **17–18** — more independent model revision; multi-trial comparison; optional AP / CLEP / dual-enrollment edge when fit.

What a short check is not

NAEP. A percentile promise. Homeschooling was 3.4 percent of K–12 students in 2022–23 (~1.765 million); the 9th–12th cell was **3.1 percent**. Instruction-at-home figures (5.2 percent overall; 6.6 percent in the high-school band) are a different

bucket.⁴⁵ There is no nationally representative homeschool NAEP Science score and no opened national study of daily homeschool science minutes. SAT Subject Tests were discontinued — last international sittings June 2021.⁴⁶ One sentence. Stop. ACT Science, when taken, is an optional signal (not in the Composite) — not a Biology credit.

Edges: AP, CLEP, and dual enrollment

AP Biology, AP Chemistry, AP Physics 1, AP Physics 2, AP Physics C: Mechanics, AP Physics C: Electricity and Magnetism, AP Environmental Science, CLEP Biology and Chemistry, and dual enrollment are edges — useful when the student and the kitchen are ready. They are not the default year and not a requirement of this book.⁴⁷ There is no course titled simply “AP Physics.”

Safer transcript practice when an AP exam is sat: title the credit **Biology, Chemistry, Physics, or Environmental Science**, and record “AP ... exam, score n” as a separate signal. Homeschoolers typically need a participating school’s AP coordinator; confirm fees locally. Credit is institution-specific.

CLEP may become college credit. It is **not** NCAA core. Audited, CLEP, and credit-by-exam courses are not NCAA-approved core courses. CLEP Chemistry’s experimental-chemistry items are exam content about experiments — not a lab year.

Dual enrollment is a college course taken during high school. Access is local — North Carolina Career and College Promise has pathway gates; New York generally keeps home-instructed students out of the district program; Virginia accepts a college transcript as one evidence-of-progress form. Map the course to **Biology**,

⁴⁵NCES 2024-113: 3.4% homeschooled 2022–23 (~1,765,000); 9th–12th **3.1%**. Instruction-at-home 5.2% / 6.6% (9–12) is a different bucket. No nationally representative homeschool NAEP Science score. Library curriculum source 2016 grades 9–12: **58%** (Table 6). Homeschool past-month visits 2022–23: library **53%**; museum/historical site **43%**; zoo/aquarium **28%** (Table A-5).

⁴⁶College Board, 19 January 2021: SAT Subject Tests discontinued; last international sittings May–June 2021.

⁴⁷College Board AP Central pages for AP Biology, AP Chemistry, AP Physics 1 / 2 / C, AP Environmental Science (accessed 17 September 2026): credit institution-specific; there is no course titled simply “AP Physics.” CLEP Biology / Chemistry on College Board topic list; ACE recommendations on exam pages; each institution sets policy. NCAA Toolkit: CLEP / credit-by-exam / audited courses are not NCAA core. Dual enrollment is state-variant; designate college name on the transcript. Confirm current AP/CLEP fees locally — snapshot tables change.

Chemistry, or **Physics**, with the college named. NCAA wants dual-enrollment designated on the homeschool transcript plus a separate official college transcript. A student who only “CLEPs out” without course lines may look thin to admissions — and NCAA will not count CLEP as core. Edges sit on top of the kitchen spine.

NCAA, if athletics are in view

If Division I or Division II sports might be in the picture, science planning starts in ninth grade. **Science is a core area** (natural/physical science).⁴⁸

Division I asks for **sixteen** NCAA-approved core-course credits from the start of ninth grade, including **two years of science, including one year of lab if offered** on the live public fact sheet. One extra core year may be English, math, *or science*. Ten of the sixteen, including seven in English, math, or natural/physical science, must be finished before the seventh semester — the 10/7 rule. Minimum core-course GPA is **2.3**. Waiting until twelfth grade to start science is a 10/7 problem even if two science years eventually appear. That is an athletic calendar, not a teaching claim.

“Lab if offered” is conditional language. It is not “two years of lab.” It is not “lab optional because you homeschool.” Conservative reading for this book: build investigation into at least one of the two science years, title that year without hiding the lab (**Biology with Lab** is the toolkit sample), and keep student work that shows investigations. A standalone “Chemistry Lab” course will not be approved separately from the associated science course.

As of this book’s access date (17 September 2026), a 2026 Division I committee recommended eliminating the lab-if-offered sentence; the live Division I fact sheet still carried lab language. Open the live sheet in the year you file before you claim the rule is gone. Division II saw council action toward elimination; still open that live sheet before you claim status. Point to the current NCAA Home School Toolkit and Core-Course Worksheet — not blogs.

⁴⁸NCAA *Home School Toolkit 2025–26*; Division I public fact sheet pattern: 16 core courses including 2 years science (including one year of lab if offered); 10/7 rule; 2.3 core GPA; proof of graduation. Science is core. Point to the Toolkit, not blogs. NY/HI graduation-proof path per Toolkit: district/state letter or equivalency exam. Confirm current Division I and Division II lab language on ncaa.org at the time of use — 2026 committee and council movement does not replace the live sheet until you open it.

The homeschool packet includes a transcript (ninth-grade start date; administrator signature), an administrator statement that instruction followed *state* law, a Core-Course Worksheet for each core course, and proof of graduation. Evaluation begins after those documents are in **and** an NCAA school has placed the student on an Institutional Request List. CLEP and credit-by-exam do not count as core. There is no preapproved publisher package. Worksheet course name equals transcript title. Hawaii and New York: the Eligibility Center cannot accept proof of graduation from a homeschool-issued diploma — district/state letter or equivalency path per the Toolkit. If athletics are not in view, the same titles still serve colleges and transfers.

Place by skill, not birthday

Can the student name the system boundary and one flow? If not, they are still in systems looking. Can a stranger reconstruct the trial from the notebook? If not, they are still in recording. Can they write a claim with warrant and limit? If not, they are still before denser CER. High-sounding *titles* cannot skip those moves.

A fifteen-year-old may still need a Physical Science year honestly titled. An eighteen-year-old may still need a Biology reading year before claiming Biology with Lab. Lying on the transcript to match a birthday helps no college and hurts NCAA.

What to keep in the file

1. A dated investigation notebook under **Biology, Chemistry, Physics, Earth Science, Environmental Science, or Science**.
2. Transcript lines a stranger can file — title, year, credit, grade and scale, brief description of texts and lab load, who taught, signature and date.
3. Denser CER paragraphs or short lab reports — samples across a term.
4. Optional publisher review and optional AP / CLEP / dual-enrollment artifacts in their own envelopes.
5. State objects that actually apply (Pennsylvania portfolio samples; New York quarterlies; Virginia list; North Carolina battery in its lane).
6. If athletics are in view: Toolkit packet pieces, including a Core-Course Worksheet for each science year.

Life of the habit, as the file you keep, lives here: date the work; name the skill; keep one wrong turn you can reteach. Revisit next Tuesday is a move in Chapters 7 and 8. The notebook is how Tuesday leaves a trace.

A path through high-school science looking is the promise. A diploma is not. A percentile is not. An AP score is not the only path that counts.

For ages 11–14, see *Science for Young Minds*. For grades 1–12 handbook length on records, AP, and NCAA, see *Science for Homeschooling*. For ages 5–10, see *Science for Little Thinkers*. One pointer each; then teach the 15–18 file.

Chapter 10 — Resources



Figure 12: A library card, a museum postcard, a generic book spine with the title unreadable, a lined notebook page and pencil, a RAMP card beside goggles. Still-life. No logos. No portraits.

This chapter names programs families actually meet at ages 15–18. It does not rank them. It does not sell them. It is a fit list so you can match an object to the table you already have: how much of the teaching you will carry, whether the spine is a conversational student text, a school-shaped textbook, free digital chapters, or college OER, whether the house wants a religious frame or a secular one, and whether the publisher describes a high-school Biology / Chemistry / Physics credit shape.

A “grade 11 Biology workbook” is a publisher’s scope, not a legal grade. Placement is by skill. The record, as Chapter 9 said, still says **Biology, Chemistry, Physics, Earth Science, Environmental Science**, or **Science**. Combining two honest objects does not mint a new title. Never Emerging Adults Science I.

This week you can name *why* tonight’s object fits this student — usually a library shelf and a museum postcard before a catalog cart. Today the student tries that page. They are not on a shopping task.

How to read a program

Five questions do the work.

Parent load. Are you sitting nearby while an independent high-schooler works a chapter? Hosting a talk box after a try? Building lessons around a dense textbook? Booking a co-op lab or community-college section?

Spine. Conversational text written to the student? School-shaped basal with optional video? Classical doing / reading / writing? Free digital FlexBook? College-density OER? Kit box with materials included?

Religious or secular. Some programs say so on the first page. Some do not market a worldview. Fit is a house decision, not a ranking.

High-school credit shape. Does the publisher describe a year of Biology, Chemistry, or Physics a stranger could file? A publisher’s “credit” sentence is a scope. The registrar still wants a mappable title and a description of the work — including whether “with Lab” is honest.

Cost shape. Nothing tonight with a library card. A free PDF. A print set whose dollars change. Fees this book did not lock for 2026. Confirm a current price on the page before you buy. This chapter omits list prices that were not locked.

Reach numbers on an organization's page are that organization's copy, not a home-school census. Homeschooling was about 3.4 percent of U.S. school-age children in 2022–23 (~1.765 million); the 9th–12th cell was 3.1 percent.⁴⁹ That is the pond. It is not a finding that most high-school homeschoolers use any one spine.

Library, museum, and nature — \$0 first

A public-library card. A high-school or adult nonfiction science shelf. Research help. A museum, historical site, nature center, zoo, or aquarium. A yard or park transect with a notebook. That is tonight.

Fit. Parent load: presence and talk, not a script. Looking: one exhibit, one field question, or two sources on this week's system. Placement: the student's interest and reading stamina, not a grade sticker. Cost shape: **\$0 first** with a card. Fines, holds, museum admission, parking, and zoo free-day calendars are local objects — this book does not invent a national free-museum guarantee.

In 2016, **58 percent** of 9th–12th-equivalent homeschool households used the library as a source of curriculum and books. In 2022–23, **53 percent** of the Homeschool-total row had visited a library in the past month, against 29 percent of all K–12; **43 percent** had visited an art gallery, museum, or historical site, against 23 percent; **28 percent** had visited a zoo or aquarium, against 21 percent.⁵⁰ Those are different questions in different years. Both are a free-or-low-cost hour. At ages 15–18 the free hour is systems looking and denser claim: take out a chapter or two field sources, name the system boundary, write a dated claim from *this* notebook, record the work under Biology or Chemistry or Physics or Earth Science or Environmental Science.

Interlibrary loan, used bookstores, and free digital texts (CK-12; OpenStax PDF) are \$0 or near-\$0 when a title is not on the local shelf. A gallery walk is not a transcript line by itself. It does not replace a chronological spine for a family that wants one. It is the honest starting inventory before a catalog purchase. Library, museum, nature, and lab-path neighbors motivate. They do not replace the

⁴⁹NCES 2024-113: 3.4% homeschooled 2022–23 (~1,765,000); 9th–12th cell **3.1%**. Instruction-at-home is a different bucket. Access date: 17 September 2026.

⁵⁰Cui and Hanson, NCES 2020-001, Table 6 grades 9–12: library as curriculum source **58%**. NCES 2024-113 Table A-5 Homeschool row: library visit past month **53%** (vs 29% all K–12); art gallery / museum / historical site **43%** (vs 23%); zoo or aquarium **28%** (vs 21%). Do not swap 53 for 58.

systems-and-claim looking move.

Library hour (high-school grain). Find two sources on this week’s system or question. Name them. Run a short try or field look when you can. Write denser CER from the notebook — claim, evidence pointer, warrant, one limitation. At fifteen to eighteen this is a **research and investigation** hour, not storytime as the default.

Museum or historical-site hour. One exhibit. One systems sketch (boundary, inputs, outputs, what the model leaves out). One claim the exhibit supports and one piece of evidence that is missing. Photograph nothing you are not allowed to photograph; draw or note instead.

Nature / zoo / aquarium hour. Outdoor looking with ordinary care — weather, traffic, water edges, plants that must not be tasted, insects that sting. Adult present. Free is not the same as unsupervised. Soft entry on living things: care, return, wash hands.

Nature study and field looking remain a **method**, not a brand. Outdoor looking sits beside many families’ weeks without buying a named program. At this age the notebook wants more than a caption: a systems question and a denser claim with warrant. You can use the method without a franchise.

Kitchen-table science is still science. A conservation weighing try is looking. A plant inputs–outputs picture with a real observation is Biology looking. A change-of-motion card is Physics looking. None of those is automatic Chemistry-with-Lab. All of them can be dated and named if a thicker state later wants a log. Keep the safety spine from the Science Hour: adult present for heat, electricity, outdoor water, chemicals, and glass; household-safer materials when a chemical is needed at all; no unauthorized mixing; RAMP before the try; mold cultivation refused by default; home vertebrate dissection refused as default. Curiosity is not a permit.

Transcript. Not a course by itself. Materials under Biology / Chemistry / Physics / Earth Science / Environmental Science / Science if a credit is claimed: “library texts and field guides, titles listed; dated investigations; museum / park notes; denser CER from the notebook.” Never Emerging Adults Science I. Never “Library Hour 1.”

The teaching chapters of this book are written for this object first. A purchased program is a fit, not a requirement.

Apologia — Exploring Creation Biology / Chemistry / Physics

The publisher describes a Christian conversational curriculum written directly to the student. High-school titles commonly named: Biology, Chemistry, Physics, plus neighboring Marine Biology, Advanced Biology, Advanced Chemistry, Advanced Physics, Astronomy, Forensics, and Health. Hands-on work with household items is encouraged in publisher copy; a vendor FAQ states experiments are encouraged but not mandatory — publisher copy, not a safety plan and not an athletic lab plan. Live classes, self-paced, and co-op options are described. A publisher “recommended course sequence” is one possible option as the publisher labels it — not this book’s required cycle.⁵¹

Fit. A Christian family that wants student-facing narrative science at high-school grain. Not a fit if you need a secular text. Transcript title: **Biology / Chemistry / Physics** (or **Biology with Lab** only when investigations actually happened) — not the product name as the credit line. Middle General Science / Physical Science belong with *Science for Young Minds*.

BJU Press — Biology / Chemistry / Physics

The publisher describes high-school Biology, Chemistry, and Physics with a Christian textbook look and optional video-course paths. Biblical worldview framing, including young-earth framing on opened neighboring pages, is part of the product — label it when worldview is your fit variable. Titles already match stranger-readable nouns.⁵²

Fit. A Christian family that wants a traditional textbook look, optional video, and titles that map cleanly to Biology / Chemistry / Physics. Transcript title: those nouns — never the publisher name as the credit line.

⁵¹Apologia publisher pages for Exploring Creation high-school science (accessed 17 September 2026): conversational Christian curriculum written to the student; Biology / Chemistry / Physics and named neighbors; experiments encouraged but not mandatory per FAQ copy; live / self-paced / co-op options described. Sequence language labelled by the publisher as one possible option.

⁵²BJU Press high-school Biology / Chemistry / Physics product pages (accessed 17 September 2026): Christian textbook / video paths; worldview framing including young-earth language on opened neighboring pages.

Abeka — high-school science / health (vendor path)

The publisher describes Christian materials with spiral learning; Science/Health sits as a shop-by-subject category. Parent-led textbooks sit beside Abeka Academy video (with an accredited option on neighboring pages). Exact title-by-grade sequences change — check a current catalog page rather than inventing “Abeka does Biology in tenth.”⁵³

Fit. A Christian family already using Abeka for other subjects, or one that wants video-academy structure. Parent-led Abeka is still a homeschool if the parent instructs and grades. An accredited Academy student may be on a **school** transcript path, not a homeschool NCAA worksheet path — label that difference when athletics are in view. Transcript: **Biology / Chemistry / Physics / Science** by substance, not the brand.

Elemental Science — high-school Biology / Chemistry / Physics

The publisher describes classical Grammar / Logic / Rhetoric stages. High-school Biology, Chemistry, and Physics are the Rhetoric / high-school objects: doing, reading, and writing-it-down with more structure than a picture-book year. Logic Stage and Grammar Stage belong with younger bands.⁵⁴

Fit. A classical homeschool that wants doing / reading / writing at high-school grain. Still a curriculum, not a lab safety plan. Transcript title: **Biology / Chemistry / Physics** — never “Rhetoric Biology” as a fake credit.

Berean Builders — Discovering Design Biology / Chemistry / Physics / Earth Science

The publisher describes Christian science by Dr. Jay Wile, with *Discovering Design* high-school titles in Biology, Chemistry, Physics, and Earth Science. Hands-

⁵³Abeka Science/Health category and Academy neighboring pages (accessed 17 September 2026): Christian spiral materials; parent-led and Academy paths. Exact HS title sequence: confirm on a current catalog page.

⁵⁴Elemental Science high-school Biology / Chemistry / Physics pages (accessed 17 September 2026): classical doing / reading / writing grain at HS.

on work is described as woven in. Exact which title lands at ages fifteen to eighteen for *your* student is **placement by skill**, not a birthday rule. Check a current scope page before you assign a year.⁵⁵

Fit. A Christian family that wants chronological or design-framed high-school science with experiments woven in. Worldview is part of the product. Transcript title: **Biology / Chemistry / Physics / Earth Science** — not the book subtitle as a credit line.

CK-12 FlexBooks — Biology / Chemistry / Physics

FlexBooks are described as free, online, customizable digital textbooks. Science subjects named on opened pages include Earth Science, Life Science, Physical Science, Biology, Chemistry, and Physics. A FlexBook may include interactive simulations. Simulations can illustrate. They do not replace a real investigation when the skill is measuring and claiming from *this* notebook, and they are not athletic lab credit by themselves.⁵⁶

Fit. A secular or mixed-worldview family that wants free adaptable texts whose titles already match the locked list. Not a packaged wet-lab kit. Parent co-holds accounts; COPPA does not bind ages 15–18, but the Science Hour AI box still holds — unaided first on looking and measuring. Transcript title: Biology / Chemistry / Physics / Earth Science / Science by substance — never “CK-12 FlexBook” as the credit line.

OpenStax — Biology / Chemistry / College Physics / Astronomy (college OER)

OpenStax is a **college textbook path**, not a homeschool franchise. Biology 2e is described as a typical two-semester biology for science majors, written with an evolutionary lens; free on the web and as PDF. Chemistry 2e is a college chemistry text. College Physics 2e is algebra/trigonometry-based; the preface describes take-

⁵⁵Berean Builders / Discovering Design Biology / Chemistry / Physics / Earth Science pages (accessed 17 September 2026): Christian HS titles; hands-on work described as woven in.

⁵⁶CK-12 FlexBooks science subjects (accessed 17 September 2026): free digital Biology / Chemistry / Physics / Earth / Life / Physical Science; simulations as features, not athletic lab credit.

home investigations and points students to PhET simulations. Astronomy 2e is an introductory non-majors text.⁵⁷

Fit. A late-high-school student who can read college prose, possibly aiming at AP-adjacent or dual-enrollment rigor without buying a commercial brand. Not a fit for a struggling ninth-grader who still needs Physical Science consolidation. Evolutionary framing in Biology 2e is explicit — relevant to families who chose Apologia or Berean for worldview reasons. Pacing a two-semester majors text as a ninth-grade year is a family decision, not a publisher homeschool cycle. Transcript: **Biology / Chemistry / Physics / Earth Science** — not “OpenStax.”

Home Science Tools — Science Unlocked Launch + kits-for-use-with

Home Science Tools sells kits and supplies **for use with** Abeka, Apologia, Berean Builders, BJU Press, and neighboring brands, plus its own Science Unlocked sequence. **Launch (8–12)** is the high-school edge; Wonder and Accelerate are younger grain. Chemistry safety equipment and dissection supplies appear in the catalog. This is the **common lab-kit vendor path**. It is not a ranked curriculum.⁵⁸

Fit. A family that wants materials-in-the-box convenience, or supplies matched to a text already in the house. Science Unlocked Launch year-cycles without an opened scope on your desk stay a check-the-page object. Transcript title: **Science / Biology / Chemistry / Physics** by substance — never “Launch Year X” as a credit line. Dissection remains optional, never required, in this book’s Hour.

Nature / field / co-op lab — method neighbors

A supervised co-op lab hour, a museum bench session, a field-station day, or a community-college open lab is a **lab-path neighbor** — labelled as such in this house. Schedule honesty, not guilt. Follow host PPE and procedures. Write denser

⁵⁷OpenStax Biology 2e, Chemistry 2e, College Physics 2e, Astronomy 2e (accessed 17 September 2026): free college OER; Biology 2e evolutionary lens named; College Physics points to PhET. College path, not a homeschool franchise.

⁵⁸Home Science Tools Science Unlocked Launch (8–12) and kits-for-use-with pages (accessed 17 September 2026): vendor kits and supplies; Launch is HS edge; Wonder / Accelerate are younger. Omit unverified 2026 list prices.

CER from *your* measurements afterward. Do not auto-title the week “Chemistry with Lab complete” unless family records policy honestly says the supervised investigations support that claim.

Fit. Parent load shifts toward logistics and talk after the session. Wet-lab ambition without owning a secondary chemical stock. Transcript: materials under Biology / Chemistry / Physics when the year’s work earns that noun; name the site in the description. Co-op brand names stay in the notes column.

Dual-enrollment Biology / Chemistry / Physics — when state gates allow

Community-college or college Biology, Chemistry, or Physics taken for postsecondary credit during high-school ages. Outside teacher of record; official college transcript; NCAA-clean when designated. State gates vary — North Carolina Career and College Promise is one opened pathway with readiness gates; New York home-instructed students generally may not participate in the district instructional program; Virginia accepts a college transcript as one form of evidence of progress.⁵⁹ Eligibility, cost, and age rules are local. This chapter is not a fifty-state dual-enrollment chart.

Fit. A student ready for college pacing and a kitchen that wants an outside teacher of record for a wet-lab year. Edges, not the default spine for every household. Transcript: **Biology / Chemistry / Physics** with dual-enrollment designation — or the college’s own course title clearly marked as college. Never “Emerging Adults DE Science.”

AP and CLEP — edges on the shelf

AP Biology, AP Chemistry, AP Physics 1 / 2 / C, AP Environmental Science, and CLEP Biology / Chemistry are **edges**, not this book’s weekly spine.⁶⁰ Sit them

⁵⁹Dual enrollment is state-variant: NC DNPE Career and College Promise pattern; NYSED home-instruction Q&A (generally no district instructional participation); Virginia evidence-of-progress college-transcript option. NCAA Toolkit: designate college name and send official college transcript. Not a national dual-enrollment right.

⁶⁰College Board AP Biology / Chemistry / Physics 1–2 / Physics C / Environmental Science and CLEP Biology / Chemistry pages (accessed 17 September 2026): edges, not this book’s spine; no

when fit. Safer transcript practice: title **Biology / Chemistry / Physics / Environmental Science**, with the exam score as a separate signal. There is no course titled simply “AP Physics.” CLEP is not NCAA core. Confirm fees and local ordering with a participating AP coordinator or CLEP test center. Full registrar architecture at grades 1–12 handbook length lives in *Science for Homeschooling* — one pointer, then stay here.

Combining honestly

Need: \$0 start → library + museum + nature.

Need: Christian conversational student text → Apologia Exploring Creation Biology / Chemistry / Physics.

Need: Christian textbook / video → BJU Press Biology / Chemistry / Physics; Abeka as vendor neighbor.

Need: classical doing / reading / writing → Elemental Science HS Biology / Chemistry / Physics.

Need: Christian chronological / design-framed HS → Berean Discovering Design Biology / Chemistry / Physics / Earth Science.

Need: free digital adaptable → CK-12 Biology / Chemistry / Physics.

Need: free college-density prose → OpenStax Biology / Chemistry / College Physics / Astronomy.

Need: kit / supplies convenience → Home Science Tools Launch or kits-for-use-with.

Need: supervised glassware → co-op / museum / college lab-path neighbor.

Need: outside teacher of record → dual enrollment when gates allow.

Need: external exam signal → AP / CLEP as edges.

Combine without crowning. Put materials in the notes. Keep the credit line ordinary. Multi-age kitchens are common: a younger sibling and a seventeen-year-old can share apparatus with different notebook expectations. The title still follows the work.

Place by skill, not birthday. Vendor age bands are starting guesses. A fifteen-year-old consolidating fair-test notes may need a Physical Science year honestly titled. A seventeen-year-old already writing denser CER with warrant and limitation may be ready for OpenStax or dual enrollment. Moving into review is not a shame label.

course titled simply “AP Physics”; CLEP not NCAA core; confirm fees locally. Fence full 1–12 survey / registrar architecture to *Science for Homeschooling*.

Jumping ahead because a box says “grade eleven” is not required when the student cannot yet name what stayed the same.

Informal learning — kitchen, garden, museum, outdoor looking without a purchased spine — is a named practice in some homes. It is a poor match for a plan that must list syllabi unless you translate lived science into a course title after the fact. The translation is work: name the task, date it, keep the denser CER. The library, museum, and nature hours above stay available to both the formal and the informal.

No opened national survey ranks these programs inside the homeschooled pond. Sales copy is not a census. “Award-winning” is organization or award-committee language — useful as a breadcrumb, not as this book’s ranking.

Digital caution in one breath. Ages 15–18 are off COPPA’s under-thirteen line; parent still hosts and stays in the loop. Ages 15–16: still in the room for Science Hour. Ages 17–18: co-hold plus AP / Common App integrity. A login is not a science year. Tools, if any, stay parent-hosted and point back to the Science Hour AI box — unaided first on looking and measuring; no invent-observation; generated image is not data; no write-my-lab-report.

What this chapter will not do

It will not crown a winner. It will not invent a four-year cycle for any publisher. It will not reprint the grades 1–12 handbook under this cover. It will not treat AP / CLEP / dual enrollment as the required kitchen spine. It will not put a brand — or Emerging Adults Science I — on the transcript. It will not invent 2026 kit list prices. It will not claim PhET is athletic lab credit. It will not confuse a kitchen fizz with Chemistry with Lab.

For ages 11–14 program grain, see *Science for Young Minds*. For grades 1–12 handbook cards, NCAA depth, and secondary safety at length, see *Science for Homeschooling*. For ages 5–10, see *Science for Little Thinkers*. One pointer each. Then choose a fit and put a system on the table.

A Note on Sources

Studies named in the chapters are listed in Notes, in one series at the back. That is where the full citations live, so the teaching pages can stay a teaching voice.

Some items the research behind this book did not open stay out of the teaching voice. I did not invent a coefficient, a statute, or a product feature to fill a hole. If a study is in the chapter, it is in the notes. If we could not open it, it is not used as a finding here.

Program hours, credit claims, and product descriptions in the resources chapter are taken from the companies' own pages. Access date 17 September 2026.