Science 7–8

Chapter 2 — Questioning and predicting

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Investigable questions: identifying patterns, testing relationships, and telling correlation from causation

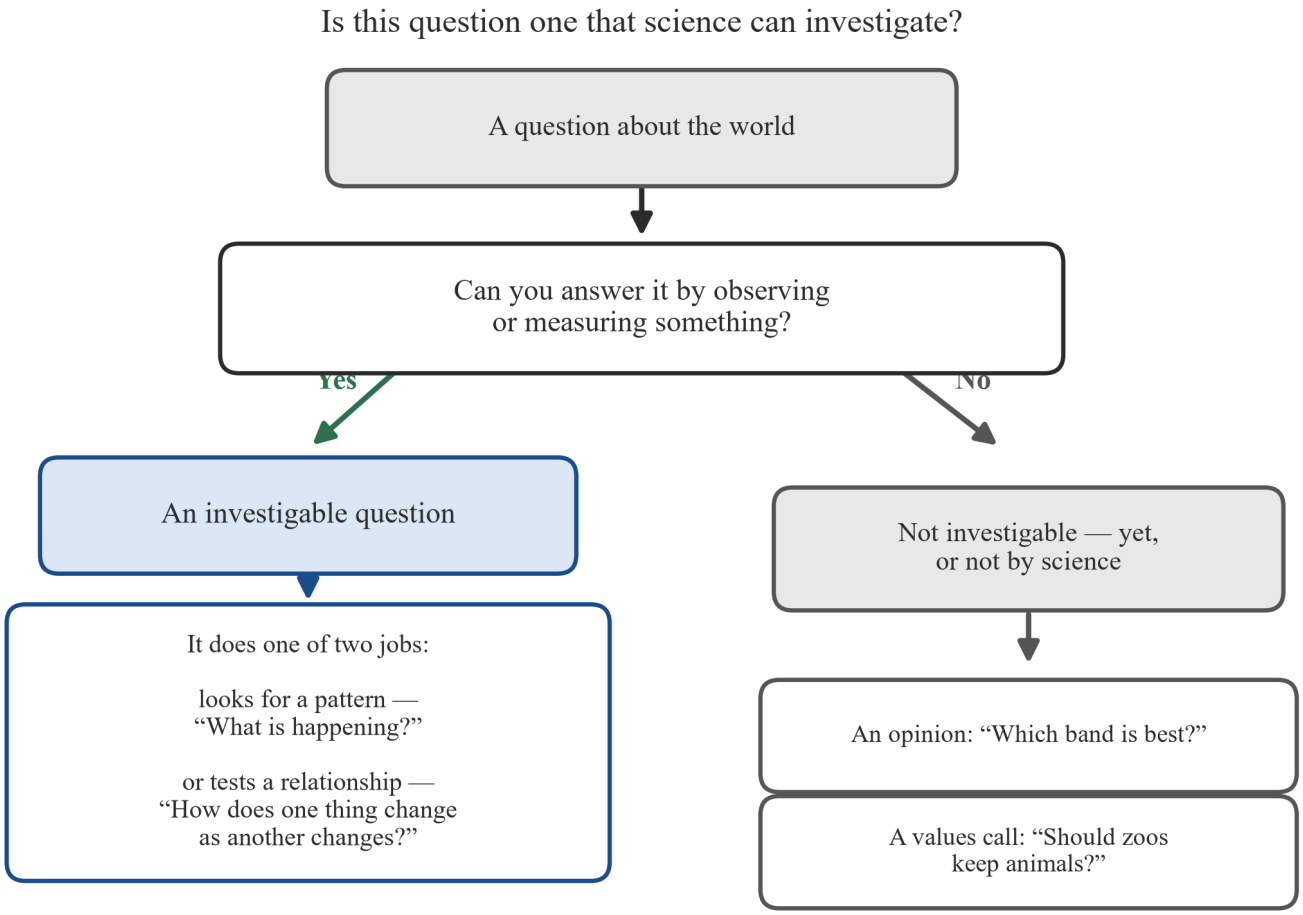
What we teach here — VC2S8I01 (Victorian Curriculum F–10 Version 2.0, Science, Levels 7 and 8): *"investigable questions, reasoned predictions and hypotheses can be developed in guiding investigations to identify patterns, test relationships and analyse and evaluate scientific models"* **This subtopic owns the questions clause only**: developing investigable questions that identify patterns and test relationships, and — with its first elaboration — telling a causal relationship from a correlation. The rest of the CD — reasoned predictions and hypotheses, and analysing and evaluating scientific models — belongs to the partner subtopic **2B** († split delivery, D6). **In our words:** a good science question is one you can answer by observing or measuring, and every investigable question does one of two jobs: it looks for a pattern (*what is happening?*) or it tests a relationship (*how does one thing change as another changes?*). And when two things change together, that togetherness is a clue, not a conclusion — *because* is a much bigger claim than *together*, and this subtopic is where you learn the difference. **Achievement-standard extract served here (D13):** *"Students develop hypotheses and make reasoned predictions to identify patterns, test relationships and analyse and evaluate scientific models when investigating phenomena at various scales."* 2A is the owner of VC2S8I01, so the extract appears here in full; the partner subtopic 2B cites it by reference to this header. **Elaborations drawn on:** VC2S8I01.E01 (discussing what is meant by a causal relationship and examining how causation is different from correlation) and VC2S8I01.E02 (developing investigable questions to test relationships, such as the balloon-and-temperature and tide-and-lunar-cycle questions used here). Elaborations VC2S8I01.E03 and .E04 belong to 2B. **Scope notes:** the elaborations-are-context rule (D12) is not a trap here — E01 and E02 point exactly at this subtopic's content. The scope ceiling is held: hypotheses and reasoned predictions are 2B's, the *why* of the heated balloon (particles) is Ch10's, the Moon–tide explanation is 14B's, and the formal naming of variables and fair-test planning is 3A's. Here we stay with the question itself.

Word watch — *correlation*, *causation*, *variable*. The curriculum's elaboration E01 uses the words *correlation* and *causation* without defining them, so this subtopic states the working meanings it uses. A **causal relationship** is one where a change in one thing *brings about* the change in the other — do this, and that happens. A **correlation** is a *togetherness*: two things that change together, rising and falling in step, without any claim about which (if either) is doing the causing. Correlation is counted and seen; causes have to be argued for and tested. And *variable*: in everyday talk it means "changeable", as in variable weather. In this subtopic, a **variable** is anything in an investigation that can take different values — temperature, height, tide level, the number of swoops. The formal names for the three variables of a fair test arrive in 3A; here we describe them in plain words.

Theory

The test every question must pass

Science starts with noticing — the puddle gone by afternoon, the tide further up the beach than yesterday, the balloon that sulked in the cold. Noticing becomes science when it becomes a question. But not every question is one that science can answer. Before anything else, a question has to pass one test: *can it be answered by observing or measuring something?*



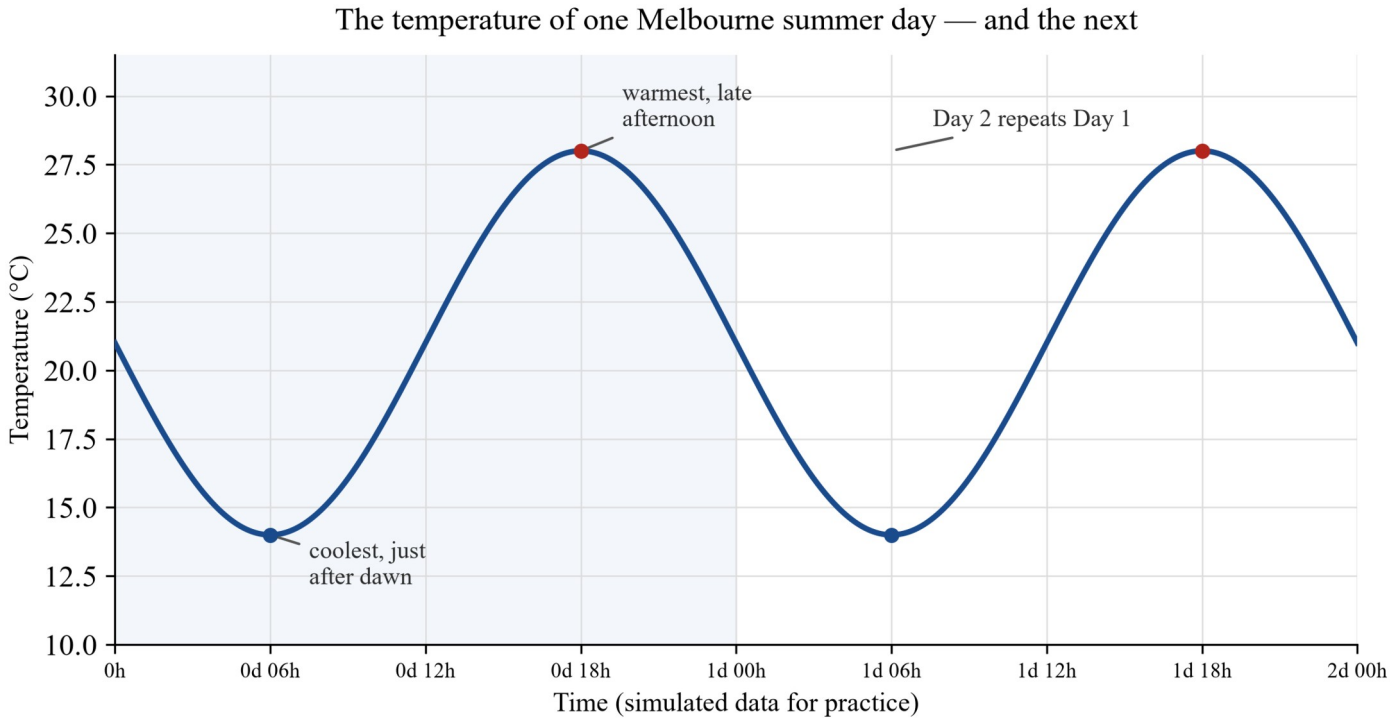
Decision flow chart titled "Is this question one that science can investigate?" A question about the world meets the test "Can you answer it by observing or measuring something?"; the yes branch leads to "An investigable question", which either looks for a pattern ("What is happening?") or tests a relationship ("How does one thing change as another changes?"), while the no branch leads to questions that are not investigable — an opinion such as "Which band is best?" or a values call such as "Should zoos keep animals?"

If the answer is *yes*, the question is **investigable**. If the answer is *no*, the question is not nonsense — it is just not science's question. *Which band is best?* is a question about preference; you could count votes, but votes measure popularity, not bestness. *Should zoos keep animals?* is a values question; people can reason about it carefully, but no measurement settles it. And some questions are simply out of reach for now: nothing we can observe or measure will answer them yet. The habit this subtopic builds is sorting questions *before* you spend time on them — science is disciplined about what it asks.

Two jobs: looking for patterns, testing relationships

Every investigable question does one of two jobs.

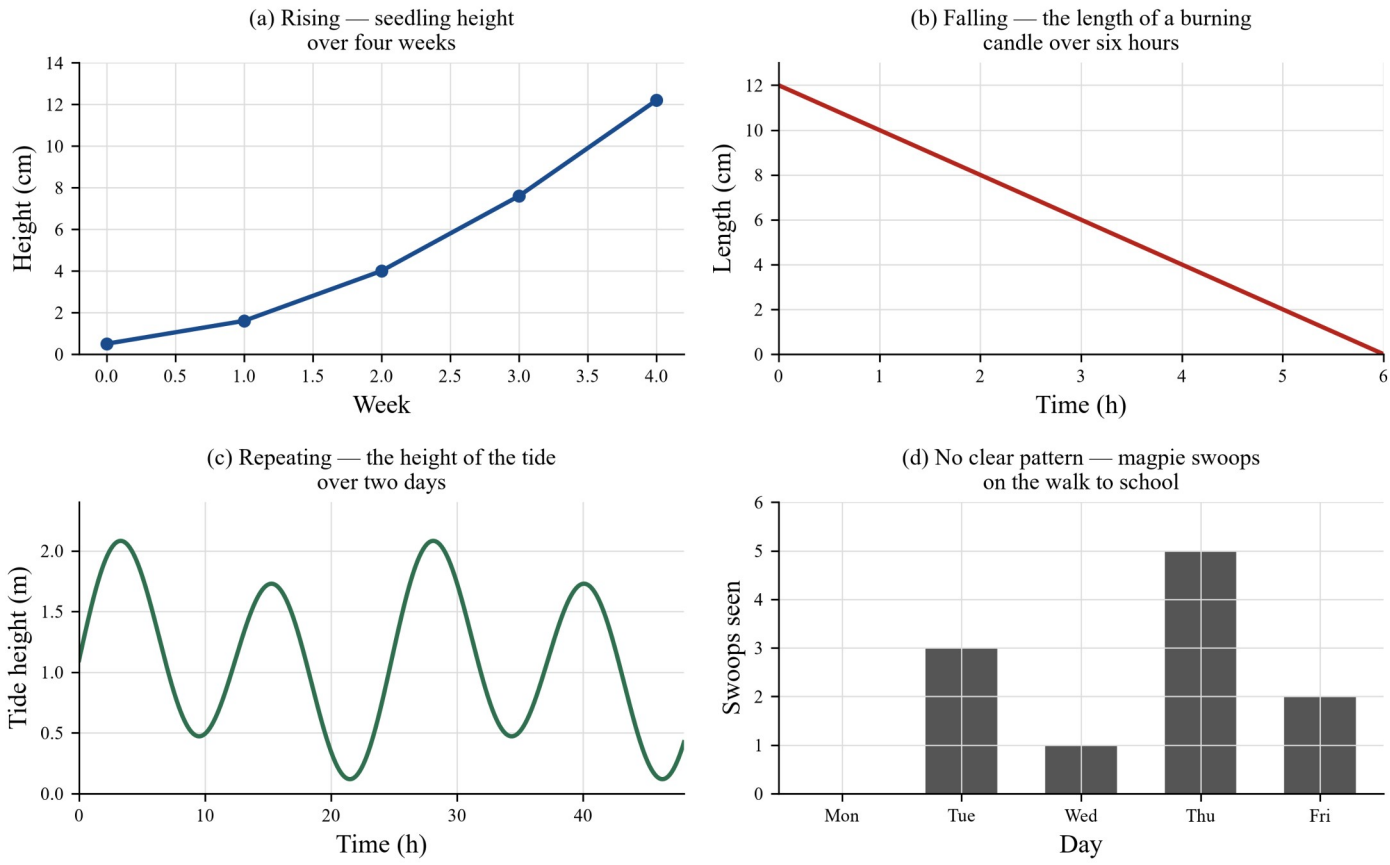
A question can **look for a pattern**. A pattern is a change or repetition you could, in principle, predict — something that happens the same way often enough that you could say what comes next. Watch the air temperature through one Melbourne summer day and into the next, and a pattern shows up: cool just after dawn, warming through the morning, warmest late in the afternoon, cooling into the night — and then the whole shape repeats.



Line graph of simulated temperature over two consecutive days, falling to about 14 °C just after dawn each day, peaking at about 28 °C late in the afternoon, and repeating the same shape on day 2, labelled "simulated data for practice"

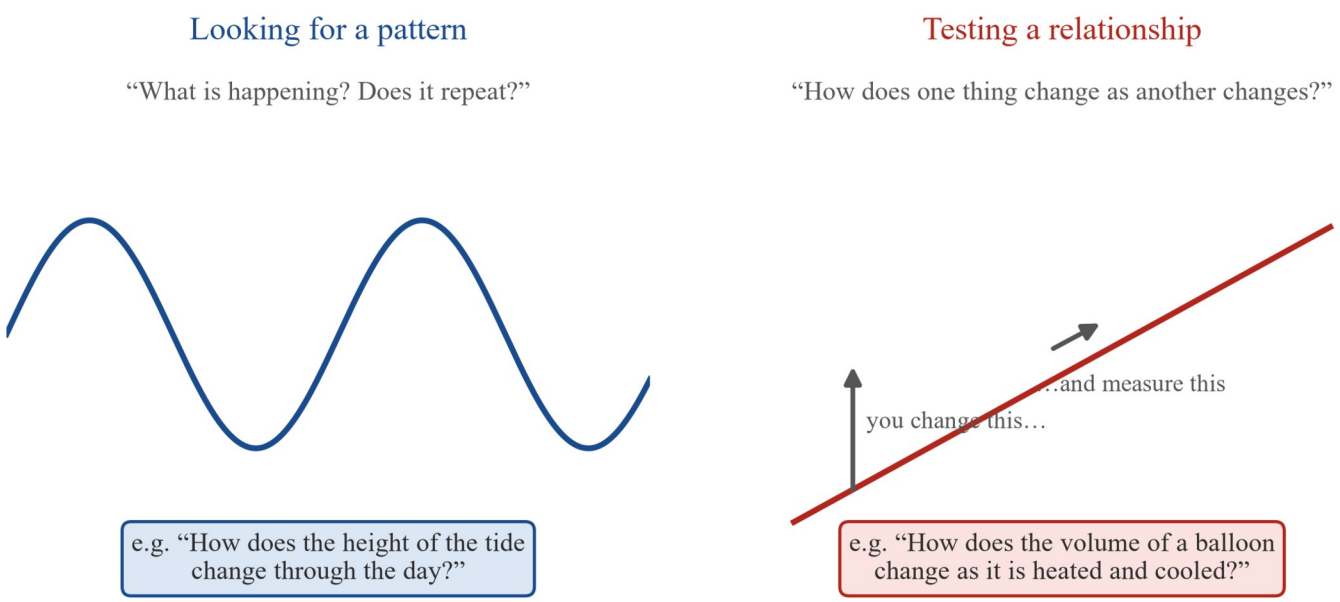
Patterns come in several shapes. Some rise, some fall, some repeat, and some data — thankfully, magpies allow — shows no clear pattern at all, which is also a finding.

Four shapes a pattern can take (simulated data for practice)



Four small graphs showing the shapes a pattern can take: a rising curve of seedling height over four weeks, a falling straight line of a burning candle's length over six hours, a repeating curve of tide height over two days, and an irregular bar chart of magpie swoops per day with no clear pattern, all labelled "simulated data for practice"

A question can instead **test a relationship** — ask how one thing changes as another changes. The curriculum's own examples (`VC2S8I01.E02`) are exactly this shape: *"How does the volume of a balloon change as it is heated and cooled?"* and *"What happens to the height of the tide at different points of the lunar cycle?"* Both questions point one quantity at another — temperature at balloon size, the lunar cycle at tide height — and ask what the second does as the first changes.



Two panels contrasting the two jobs of an investigable question: on the left, "Looking for a pattern — What is happening? Does it repeat?" over a repeating wave and the tide question; on the right, "Testing a relationship — How does one thing change as another changes?" over a rising line with arrows marking the thing changed and the thing measured, and the heated-balloon question

Notice what both shapes have in common: they are answerable with observations and measurements, and they name the things being watched. That is the skeleton of every good question in this book.

Try it 1 — sort the questions (`VC2S8I01.E02`)

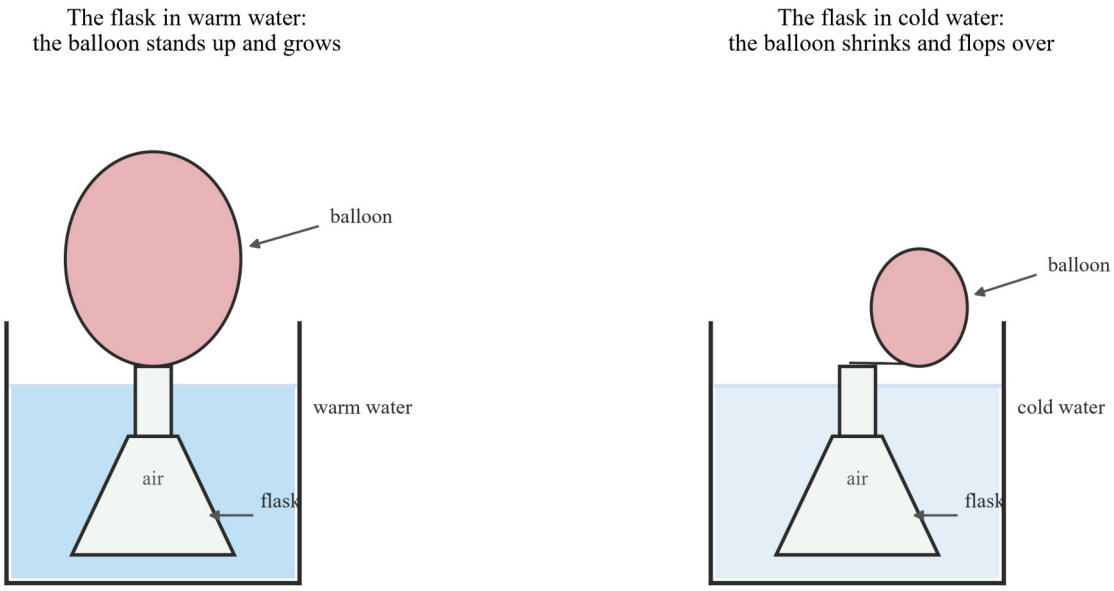
Copy the six questions below into a three-column table: *pattern question*, *relationship question*, *not investigable*. For each one, write a single line of reason.

1. How does the mass of a puddle change across a sunny day?
2. Which ice-cream flavour is the nicest?
3. Does the length of a stick's shadow change across the school day?
4. Should students wear sun hats in term 1?
5. How does the bounce height of a basketball change as the amount of air pumped into it changes?
6. Are cats better pets than dogs?

Check your sorting against two tests. First, did you ask *can it be answered by observing or measuring?* before sorting it. Second, for the investigable ones, did you notice which job each question does — a pattern question watches one thing over time or cases; a relationship question points one thing at another.

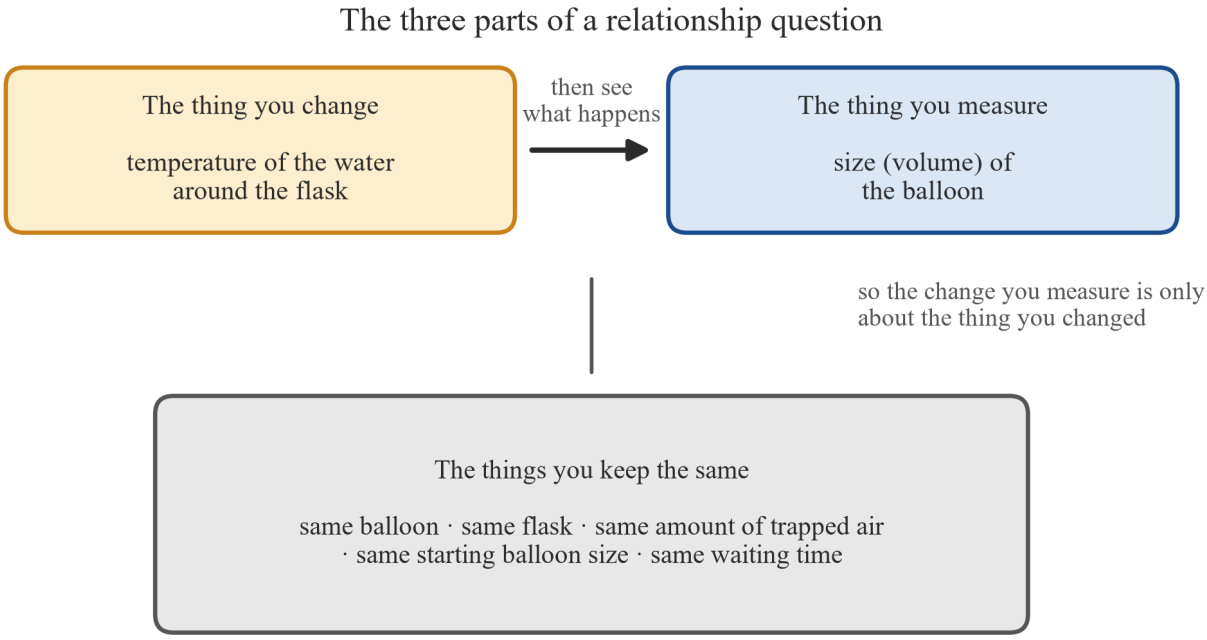
The three parts of a relationship question

A relationship question always has three parts, even when only two are said out loud. Take the balloon question. Sit one sealed flask of air in warm water and one in cold water, a balloon stretched over each neck, and something visible happens: in the warm water the balloon stands up and grows; in the cold one it shrinks and flops. *(Teacher demonstration; warm tap water, not boiling — see the laboratory safety note in 3B for the house risk-assessment habit.)*



Two labelled apparatus sketches: a flask with a balloon on its neck standing in a beaker of warm water with the balloon inflated and upright, and the same apparatus in cold water with the balloon shrunken and flopped over, labelled balloon, flask, trapped air, warm water and cold water

The question *"How does the volume of a balloon change as it is heated and cooled?"* quietly carries all three parts of a relationship question: **the thing you change** (the temperature of the air in the flask), **the thing you measure** (the size of the balloon), and **the things you keep the same** (the same balloon, the same flask, the same trapped air) so that any change you measure is about the one thing you changed.



These three parts get their formal names in subtopic 3A — here, just describe them in plain words.

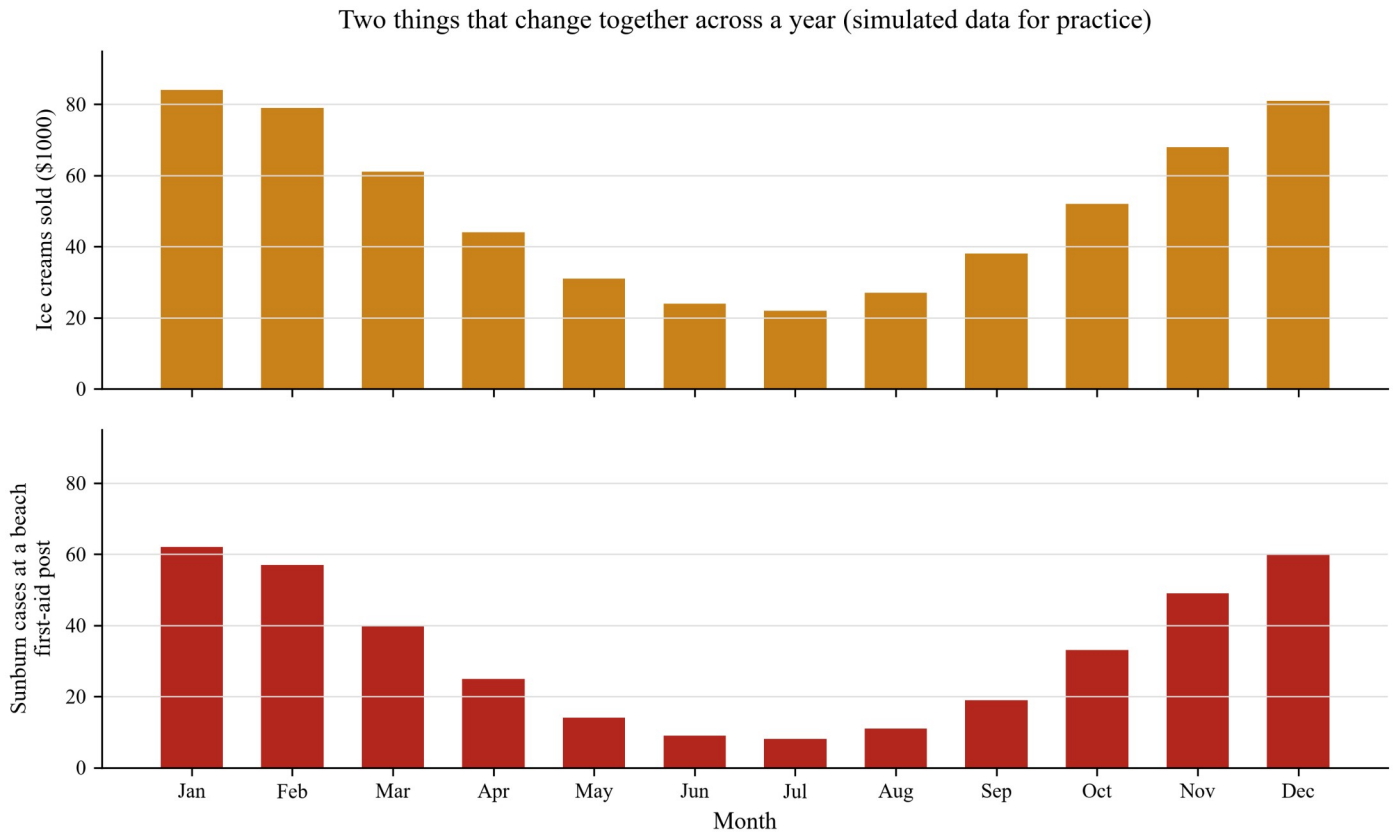
Diagram of the three parts of a relationship question: "The thing you change — temperature of the water around the flask" leads to "The thing you measure — size (volume) of the balloon", above "The things you keep the same — same balloon, same flask, same amount of trapped air, same starting balloon size, same waiting time", with the note that the three parts get their formal names in subtopic 3A

Two honest notes. One: we are not yet asking *why* the balloon grows — the particle story of heated air is Chapter 10's job, and a question does not need its answer before it is a good question. Two: the three parts drawn above get their

formal names in **3A**, where planning a whole investigation is the content. Here, plain words are enough — and plain words, used precisely, are most of the skill.

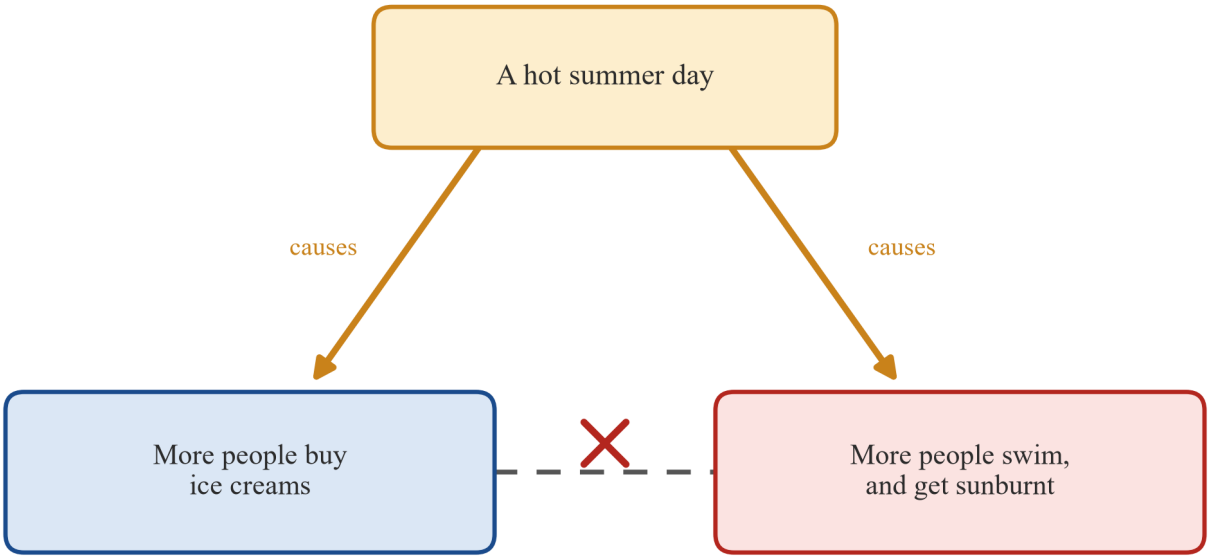
Together is not *because*: correlation and causation (`VC2S8I01.E01`)

Here is a year of simulated numbers from a beach town: ice creams sold, and sunburn cases treated at the beach first-aid post, month by month.



Two stacked bar charts sharing the same months, January to December: ice creams sold in thousands of dollars and sunburn cases at a beach first-aid post, both high in summer, low in winter, and rising and falling together, labelled "simulated data for practice"

The two lines of bars rise together and fall together. That togetherness has a name: a **correlation**. It is real — you can see it in the bars. Now here is the trap: it is tempting to read *together* as *because*, and say that buying ice creams causes sunburn. Nobody who has ever eaten an ice cream believes that. The real story is the one drawn below: a **third factor**, the hot weather, causes *both*. Hot days sell ice creams, and hot days put people in the sun with their sleeves up. Remove the ice creams and the sunburn stays; the correlation was a shadow of a shared cause.



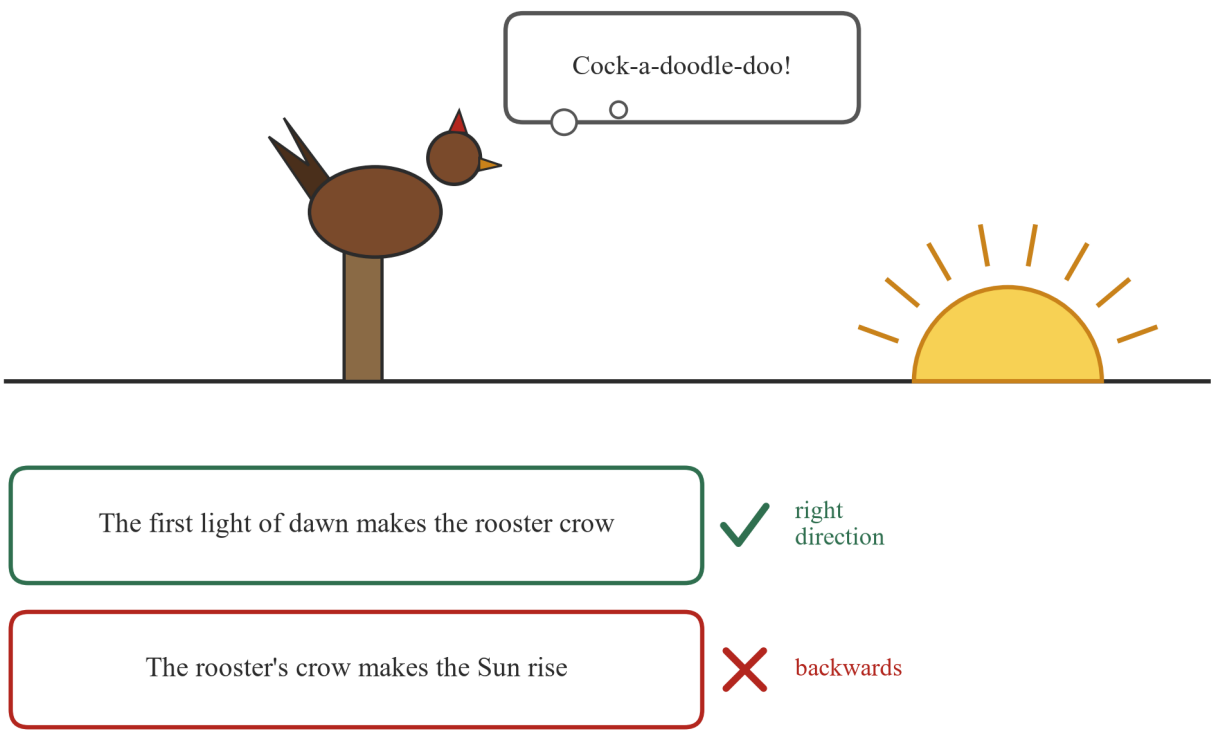
Ice creams do not cause sunburn. A third factor — the hot weather — causes both, so the two rise and fall together.

Causal diagram with "A hot summer day" at the top and two arrows labelled "causes" pointing down to "More people buy ice creams" and "More people swim, and get sunburnt", with a crossed-out dashed line between the two lower boxes and the caption "Ice creams do not cause sunburn. A third factor — the hot weather — causes both, so the two rise and fall together."

A **causal relationship** is the stronger claim: change one thing and you *bring about* the change in the other. When two things are correlated, four stories are possible, and only one of them is causation in the direction you guessed:

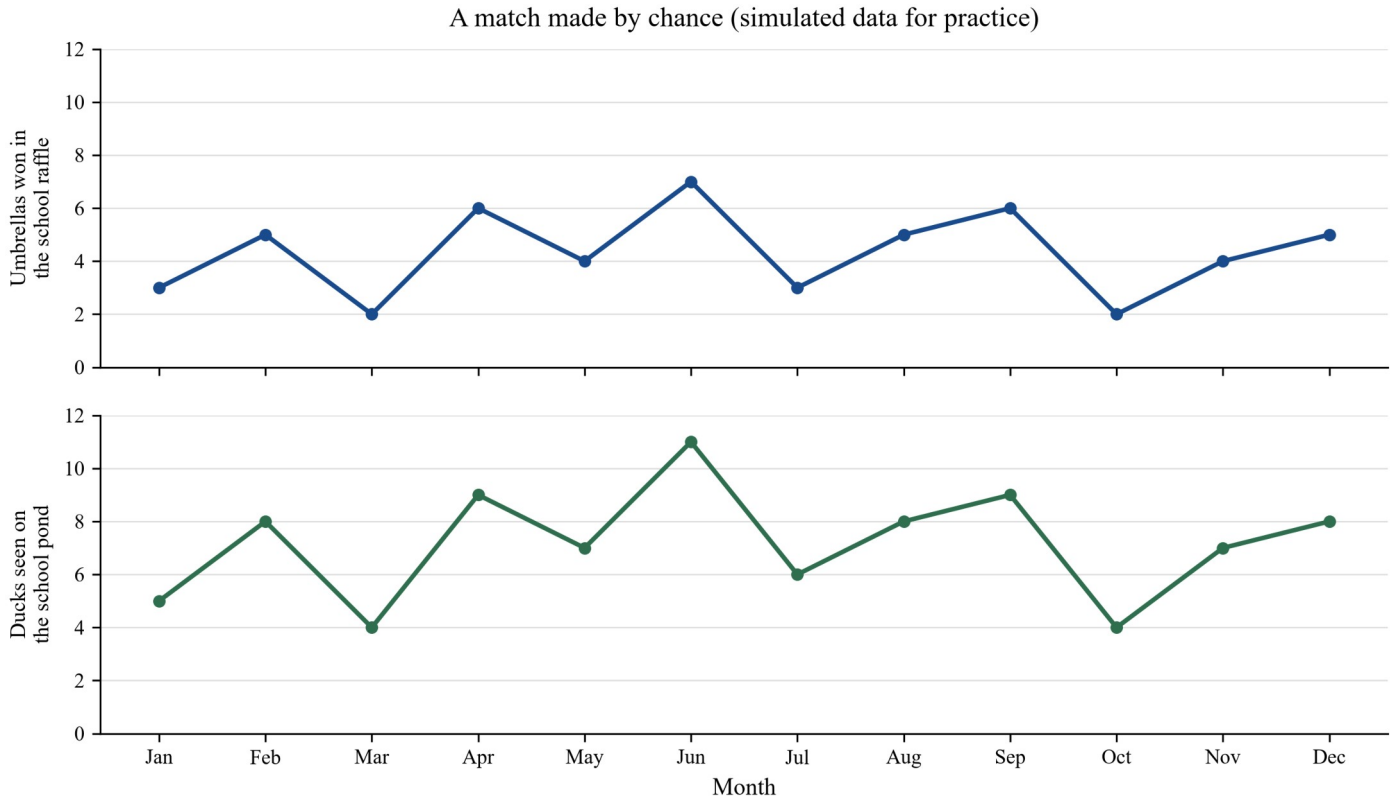
- **X causes Y** — the guess you started with;
- **Y causes X** — the arrow runs the other way;
- **a third factor causes both** — the ice-cream story;
- **chance** — the two drift together by coincidence and nothing connects them at all.

The rooster tells the second story. Every morning, the rooster crows and the Sun rises — a perfect correlation, dawn after dawn. The rooster, if asked, might claim the credit. But the arrow runs the other way: the first light of dawn reaches the rooster's eye and sets off the crow. Crowing at the Sun does nothing to the Sun, which is bad news for the rooster's theory and good news for everyone sleeping near the rooster.



Cartoon of a rooster on a fence post crowing at a half-risen sun on the horizon, above two statements: "The first light of dawn makes the rooster crow" ticked as the right direction, and "The rooster's crow makes the Sun rise" crossed out as backwards

And the fourth story, chance, is the reason scientists never get excited about one matching pair of lines. Here are two simulated series that track each other almost month for month: umbrellas won in a school raffle, and ducks seen on the school pond. Nobody would propose a mechanism — the raffle barrel does not feed the ducks. With enough numbers in the world, some pairs will match by luck; a correlation without a sensible story is a coincidence until proved otherwise.



Two stacked line graphs sharing the same months: umbrellas won in the school raffle and ducks seen on the school pond, two unrelated series that happen to rise and fall together, labelled "simulated data for practice"

So correlation is not causation — but notice what correlation *is*: the place where the hunt for causation begins. Every causal story in science started life as a noticed togetherness. The skill is to treat the togetherness as a lead, not a verdict.

Try it 2 — judge the pair (`VC2S8I01.E01`)

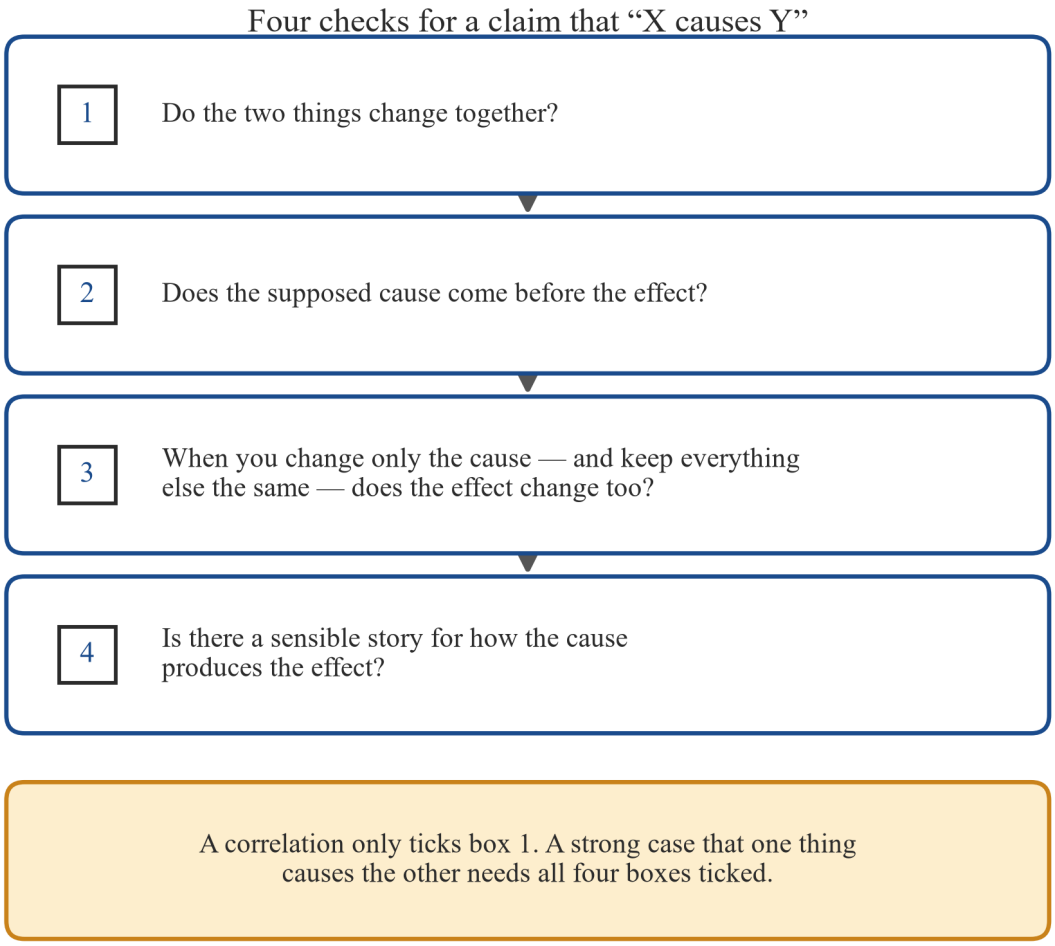
For each pairing below, decide which of the four stories fits best — *X causes Y*, *Y causes X*, *a third factor causes both*, or *chance* — and give your one-line reason.

1. In a primary school, children's shoe size and reading level rise together across the school.
2. The more free throws a basketballer practised each week, the more free throws she made.
3. Across ten years, the number of films released worldwide and the number of bushfires in Victoria rise and fall together.
4. On a cold morning, the sale of hot drinks at the canteen and the number of students wearing gloves rise and fall together across the term.

Compare your reasons with a partner. The point is not speed — it is that two people can look at the same togetherness and tell different stories, and the better story is the one that names *who or what is doing the causing*.

How do you test whether one thing causes another?

If a correlation is only a lead, what turns it into a causal claim? Four checks, in order.



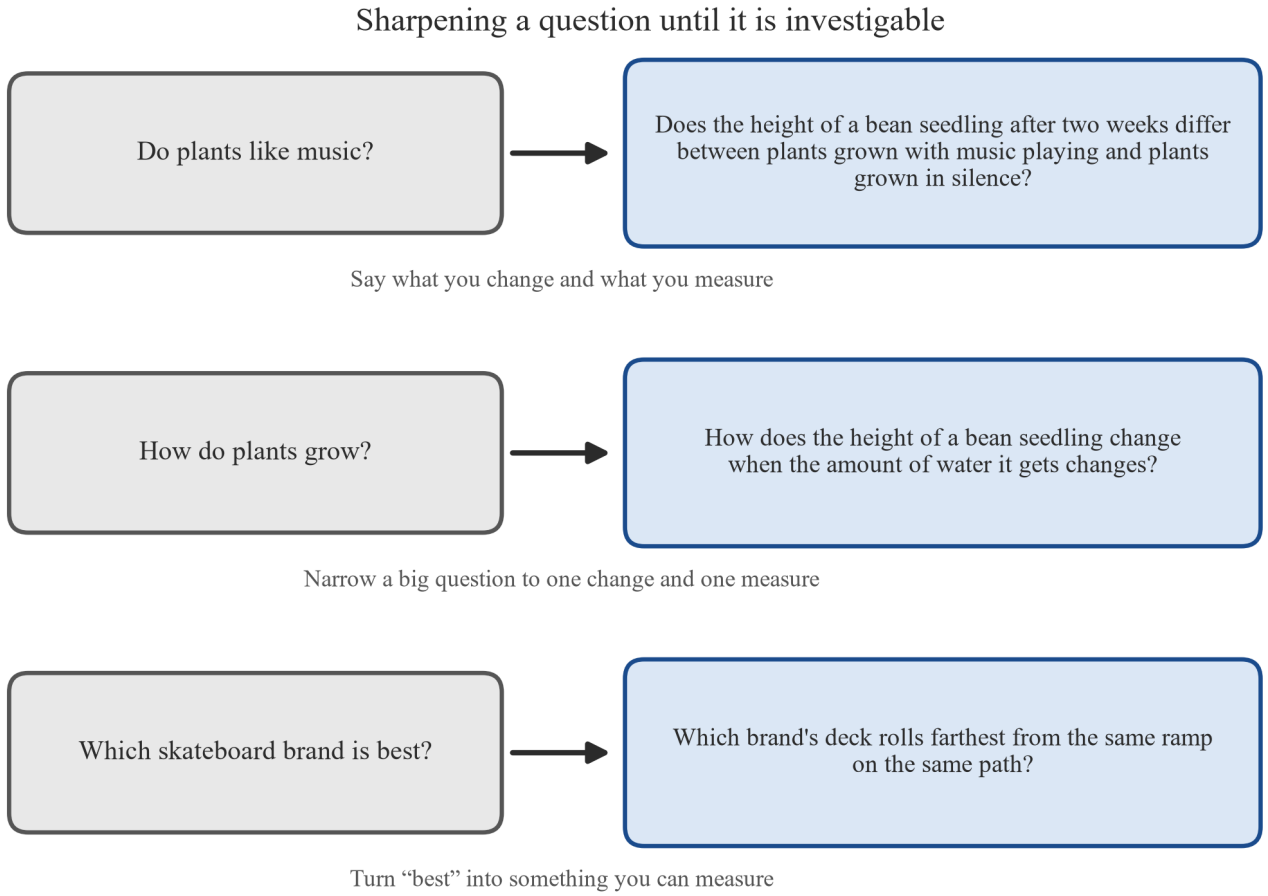
Checklist diagram titled ‘Four checks for a claim that “X causes Y”’: 1, do the two things change together? 2, does the supposed cause come before the effect? 3, when you change only the cause — and keep everything else the same — does the effect change too? 4, is there a sensible story for how the cause produces the effect? With the note that a correlation only ticks box 1, and a strong case that one thing causes the other needs all four boxes ticked

Read the checklist against the ice creams. Box 1 ticks — they change together. Box 2 is where the rooster fell: the Sun’s light arrives *before* the crow, not after, and sunburn follows the sun, not the snack. Box 3 is the big one — change only the cause, keep everything else the same, and see if the effect changes: feed a whole beach ice creams all winter and the sunburn rate will not move, because the thing actually driving sunburn was never touched. (Designing that change-only-the-cause test — a fair test — is exactly what **3A** teaches you to plan.) Box 4 asks for a sensible story of how the cause could produce the effect; heat producing sunburn has one, and ice cream producing sunburn has none.

A correlation alone ticks box 1. That is not a weakness of correlation — it is what correlation means. The four boxes are the ladder from *I noticed* to *I have evidence*, and every investigation in the rest of this book is climbing it.

Try it 3 — sharpen a question (`VC2S8I01.E02`)

The questions on the left are where real curiosity starts; the questions on the right are where investigations start.



Three rows showing vague questions sharpened into investigable ones: “Do plants like music?” becomes “Does the height of a bean seedling after two weeks differ between plants grown with music playing and plants grown in silence?”; “How do plants grow?” becomes “How does the height of a bean seedling change when the amount of water it gets changes?”; “Which skateboard brand is best?” becomes “Which brand’s deck rolls farthest from the same ramp on the same path?”, each with a note on the sharpening move used

Now sharpen two of your own. Take *“Do worms like wet soil?”* and *“Which paper towel is best?”* and rewrite each as an investigable question with a named thing you change and a named thing you measure. Then swap with a partner and check each other’s question against the flow chart from the first section: observing or measuring must be able to answer it.

The whole story in five sentences

An investigable question is one that observing or measuring can answer; opinions, values calls and the unmeasurable wait outside. Every investigable question either looks for a pattern or tests a relationship, and a relationship question always carries a thing you change, a thing you measure, and things you keep the same. When two things change together — a correlation — four stories are possible: cause, reversed cause, third factor, or chance, so *together* is a lead, not a verdict. A causal claim needs the togetherness *and* the cause coming first *and* a change-only-the-cause test *and* a sensible story. Ask well now, and every investigation in this book — and the planning in 3A, the analysis in 4C, the evaluation in 5A — stands on this ground.

Worked examples

Example 1 — scaffolded

Sort each question below, and give the one-line reason.

(a) Which chocolate bar tastes the best?

(b) How does the number of bubbles rising in a glass of soda water change as the time since it was poured changes?

(c) What happens to the height of the tide at different points of the lunar cycle? (`VC2S8I01.E02`)

(d) Should the school build a new skate park?

Working	Comment
(a) Not investigable. "Best taste" is a preference; no observation or measurement of the chocolate settles it.	The test is *can observing or measuring answer it?* — taste votes measure popularity, not bestness.
(b) Relationship question. It points one quantity (time since pouring) at another (bubble count) and asks how the second changes with the first.	"How does Y change as X changes?" is the relationship shape.
(c) Relationship question. It points the lunar cycle at tide height and asks what the tide does as the cycle advances.	A repeating pattern will be what you *find*; the question as asked tests a relationship between two quantities.
(d) Not investigable. It is a values and priorities question; measurements can inform it, but no measurement settles *should*.	Science can measure costs and usage — the *should* still belongs to the community.

Example 2 — scaffolded

Use the ice-cream-and-sunburn chart.

(a) Describe the correlation between ice cream sales and sunburn cases across the year.

(b) Name the third factor that explains it.

(c) Explain, in one or two sentences, why the correlation is not evidence that ice creams cause sunburn.

Working	Comment
(a) Both series are high in December–February, fall through autumn to a June–July low, and climb again into summer — they rise and fall together.	Describing a correlation means describing the togetherness, month by month.
(b) Hot weather: heat drives people to buy ice creams and to be outdoors in the sun with skin exposed.	The third factor must cause *both* series.
(c) If ice creams caused sunburn, removing the hot weather would not remove the link — but on cold, cloudy days ice cream sales are low *and* sunburn is rare, and on hot days both spike even among people who never buy ice creams. The togetherness tracks the weather, not the snack.	A correlation is evidence of togetherness only; the cause here is the shared weather.

Example 3 — unscaffolded

A student asks, *"Do plants like music?"* Rewrite it as an investigable relationship question, name the thing changed and the thing measured, and state one thing that must be kept the same.

Do plants like music? asks about a feeling — *like* — that no observation of a plant can read. Rewritten: *"Does the height of a young bean plant after two weeks differ between plants grown with music playing and plants grown in silence?"* The **thing changed** is whether or not music plays to the plants; the **thing measured** is the height of each plant after two weeks. One **thing kept the same** (any one): the amount of water each plant gets (or the light, the soil, the pot size, the seed type). With a measurable change, a measurable result, and the rest held equal, observing and measuring can now answer the question — which is exactly what *investigable* means.

Example 4 — unscaffolded

A headline reads: *"Children who eat breakfast get better test marks — breakfast causes better marks."* Evaluate the causal claim using the four checks for "X causes Y".

The claim starts from a real correlation — in the study behind the headline, breakfast-eaters did score higher — so box 1 ticks. Box 2 is shaky: the marks come after the breakfasts, but the habit of breakfast was never switched on or off

before the change in marks. Box 3 fails outright: nobody ran the change-only-the-cause test in which otherwise-similar children were randomly given or not given breakfast while sleep, home routine and schooling were held the same — and children who eat breakfast also tend to sleep enough and arrive on time, so a third factor (a settled morning routine) could cause both the breakfast and the marks. Box 4 has a *possible* story (energy and concentration in the morning), but a possible story is not a tested one. ∴ the headline claims more than its evidence shows: the study found a correlation, and the causal claim needs the fair test that was never run.

Practice questions

Scaffolded

Q1. About the test a question must pass. (a) State the one test a question must pass to be investigable. (b) Classify: *Which is better, the beach or the pool?* (c) Classify: *How many magpies are in the school yard at 9 am compared with 3 pm?*

Q2. About patterns. (a) In the two-day temperature graph, roughly when each day is it coolest? (b) What makes the two-day temperature curve a pattern rather than a one-off? (c) Which panel of the four-shapes figure shows data with no clear pattern, and how can you tell?

Q3. About the balloon relationship question. (a) Name the thing you change. (b) Name the thing you measure. (c) Name two of the things you keep the same.

Q4. About correlation and causation. (a) In your own words, what is a correlation? (b) In your own words, what is a causal relationship? (c) Which of the two is the bigger claim, and why?

Q5. About the rooster. (a) Which two things happen together each morning? (b) Which one actually causes the other? (c) Which of the four correlation stories does the rooster's mistake belong to?

Q6. About the four checks. (a) A correlation on its own ticks which box of the checklist? (b) Which box asks about the order of events? (c) Which box is a fair test, in one line?

Unscaffolded

Q7. Sharpen *"Do fish like warm water?"* into an investigable relationship question. In your answer, name the thing changed and the thing measured. *(2 marks)*

Q8. Classify each question as *pattern*, *relationship* or *not investigable*, with a half-line reason each. (a) How does the height of the tide change across one day? (b) Which season is the most beautiful? (c) How does the bounce height of a tennis ball change as the height it is dropped from changes? *(3 marks)*

Q9. Across a school term, the sale of hot drinks at the canteen and the number of students wearing gloves rise and fall together. Describe the correlation, name the likely third factor, and state what that means for any claim that hot drinks cause glove-wearing. *(2 marks)*

Q10. Across a primary school, shoe size and reading level rise together. Give the third-factor story, and explain in one sentence why *bigger feet cause better reading* fails the "sensible story" check. *(2 marks)*

Q11. Use the four checks to evaluate this claim: *"I watered the plant on the days it faced the window, so window-facing made it grow." (3 marks)*

Q12. A student says the balloon demonstration should really answer *"Why does the balloon grow when heated?"* Explain why that *why* question is not the investigable question at this stage, and what kind of question it is instead. *(2 marks)*

Q13. Write one pattern question and one relationship question about something you could observe in the school yard. Each must name what is watched or measured. *(2 marks)*

Q14. *"I wore my lucky socks and our team won, so the socks caused the win."* Use two of the four checks to show why this causal claim is weak. *(3 marks)*

Answers

Q1. (a) It can be answered by observing or measuring something. (b) Not investigable — an opinion/preference. (c) Investigable — a pattern question (counting at two times). **Q2.** (a) Just after dawn. (b) The same shape repeats on day 2. (c) Panel (d) — the bars jump up and down with no steady rise, fall or repeat. **Q3.** (a) The temperature of the water (and so of the air) around the flask. (b) The size (volume) of the balloon. (c) Any two of: same balloon, same flask, same amount of trapped air, same starting balloon size, same waiting time. **Q4.** (a) Two things that change together, rising and falling in step. (b) A relationship in which a change in one thing brings about the change in the other. (c) Causation — togetherness can happen by third factor, reversed arrow or chance, so cause claims need more. **Q5.** (a) The rooster crows and the Sun rises. (b) The coming of dawn's light causes the crow. (c) *Y causes X* — the arrow runs the other way. **Q6.** (a) Box 1 — do the two things change together? (b) Box 2. (c) Box 3 — change only the cause, keep everything else the same, and see if the effect changes. **Q7.** Example: *How does the time a fish spends near the heater side of the tank change as the water temperature changes?* Changed: water temperature; measured: time the fish spends in the warm side. **Q8.** (a) Pattern (or relationship with time of day — either earns the mark with a reason). (b) Not investigable — beauty is an opinion. (c) Relationship. **Q9.** Correlation: both rise as the term cools and fall as it warms. Third factor: cold weather. So hot drinks do not cause glove-wearing — the togetherness tracks the weather. **Q10.** Third factor: age/growing up — older children have bigger feet and read better. Bigger feet give the brain no help with reading, so there is no sensible story. **Q11.** Box 1 ticks (watering and window-facing went together with growth); box 3 fails — watering changed at the same time, so the change was not only the window-facing; the growth could be the water's doing. No conclusion about the window is possible. **Q12.** *Why* asks for an explanation (a model — the particle story of heated air), not an observation; the investigable question is the *how does it change* one that observing can answer now. **Q13.** Any two correctly-shaped questions, e.g. pattern: *How does the number of students in the yard change across lunchtime?*; relationship: *How does the bounce height of the netball change as the drop height changes?* **Q14.** Box 2 is doubtful and box 3 fails — the socks were never the only change (the team, the opponents, the day all changed too), and no sensible story connects socks to scoring; the togetherness of socks and win is chance.

Fully-worked solutions

Q1. (a) A question is investigable if **observing or measuring can answer it**. (b) *Beach or pool?* is **not investigable** — it is a preference; no measurement reads "better" off the world. (c) Counting magpies at two times is **investigable — a pattern question**; a count is a measurement, and the question watches one quantity across the day.

Q2. (a) Coolest **just after dawn**, near the low point of each day's curve. (b) It is a pattern because **the same shape repeats** on the second day — cool dawn, warm afternoon, cool night, again. (c) Panel **(d)**, the magpie-swoop bars: they jump 0, 3, 1, 5, 2 with **no steady rise, no steady fall and no repeat**, so no pattern is there to predict.

Q3. (a) The thing changed is the **temperature of the water (warm or cold) around the flask**. (b) The thing measured is the **size or volume of the balloon**. (c) Any two of: the same balloon, the same flask, the same amount of trapped air, the same starting balloon size, the same waiting time.

Q4. (a) A correlation is a **togetherness — two things that change together**, rising and falling in step. (b) A causal relationship is one in which **changing one thing brings about the change in the other**. (c) Causation is the bigger claim, because a togetherness can arise **from a reversed arrow, a third factor or plain chance**, so saying *because* needs checks beyond seeing *together*.

Q5. (a) The **rooster's crow and the sunrise** happen together every morning. (b) **Dawn's first light causes the crow** — the light reaches the rooster and sets it off. (c) The rooster's mistake is the ***Y causes X* story** — the arrow of cause runs the opposite way to the one he claims.

Q6. (a) A correlation alone ticks **box 1 — the two things change together**. (b) **Box 2** — does the supposed cause come before the effect? (c) **Box 3** — change only the cause, keep everything else the same, and see whether the effect changes too.

Q7. A correct sharpening names both parts *(1 mark each)*: for example, *"How does the time a fish spends on the warm side of the tank change as the water temperature changes?"* — **changed: water temperature; measured: time spent**

on the warm side. Any question in which observing or measuring can answer, with both parts named, earns both marks.

Q8. (a) **Pattern** — it watches one quantity (tide height) across the day to find its repeat *(1 mark)*. (b) **Not investigable** — "most beautiful" is an opinion; no observation settles it *(1 mark)*. (c) **Relationship** — it points drop height at bounce height and asks how the second changes with the first *(1 mark)*.

Q9. The correlation: as the term cools, hot-drink sales and glove-wearing **rise together**, and they fall together when it warms *(1 mark)*. The likely third factor is **cold weather**, which causes both — so the togetherness is **not evidence that hot drinks cause glove-wearing** *(1 mark)*.

Q10. Third factor: **age** — older children have bigger feet *and* more years of reading, so both rise together through the school *(1 mark)*. *Bigger feet cause better reading* fails the sensible-story check because **feet give the brain no help with reading — there is no way feet could do it** *(1 mark)*.

Q11. Box 1 ticks — growth, watering and window-facing went together *(1 mark)*. But box 3 **fails: the cause that was changed was not only the window-facing — watering changed too**, so the design never separated the two *(1 mark)*. The growth might be the water's doing, and **no conclusion about window-facing is possible** from this arrangement *(1 mark)*.

Q12. *Why does the balloon grow?* asks for an **explanation** — the particle story of heated air, which is a scientific model and this band's Chapter 10 content *(1 mark)*. At this stage the investigable question is the **how/what question** — *how does the balloon's size change as it is heated and cooled?* — because that one **observing and measuring can answer right now** *(1 mark)*.

Q13. One mark per correctly-shaped question. A **pattern question** watches one quantity over time or cases — e.g. *How does the number of students in the yard change across lunchtime? (1 mark)*. A **relationship question** points one measured thing at another — e.g. *How does the bounce height of the netball change as the drop height changes? (1 mark)*.

Q14. Any two checks well used earn the marks. Box 3: **the socks were never the only thing that changed** — the opponents, the team's form and the day all changed too, so the win cannot be pinned on the socks *(1 mark)*. Box 4: **no sensible story connects sock colour to scoring** *(1 mark)*. Box 2 (alternative): the claim never shows the socks coming before any change in how the team played. Conclusion: the socks–win togetherness is **chance, not causation** *(1 mark)*.

Sources

- Victorian Curriculum and Assessment Authority, *Victorian Curriculum F–10 Version 2.0, Science, Levels 7 and 8*, content description `VC2S8I01` and its elaborations, 2026. vcaa.vic.edu.au — retrieved 2026-08-21.

All numerical series in the figures and questions (beach-town ice cream sales and sunburn cases, the raffle umbrellas and pond ducks, the two-day temperature curve, the tide and seedling curves) are **simulated data for practice**, labelled as such in each figure; they are teaching data, not measurements, and carry no source claim. The balloon-in-warm-and-cold-water demonstration is the standard sealed-flask classroom demonstration described from first principles; its quantitative treatment (particle behaviour of heated air) is kept for Chapter 10 (D9).

Elaboration contexts used: `VC2S8I01.E01` (causal relationship versus correlation — the ice-cream/ sunburn third-factor case, the rooster reversed-cause case, and the chance case) and `VC2S8I01.E02` (the heated-balloon and tide-and-lunar-cycle relationship questions). The lunar-cycle question is posed, not answered: the Moon–tide explanation belongs to 14B.

Teacher-facing note (not student text). 2A stops at the question by design. The formal variable names and fair-test planning arrive in 3A, the graphing conventions in 4A/4C, the evaluation of methods and conclusions in 5A, and the explanatory models (particles, tides) in Ch10 and 14B. Forward references in the student text point to those subtopics without teaching them, per D8 and D9. No Aboriginal and Torres Strait Islander content is drawn on here: `VC2S8I01` carries no such elaborations, and D10's sourced treatments sit in the subtopics the TOC names.

Hypotheses and reasoned predictions — including questions that put a scientific model to the test

What we teach here — VC2S8I01 (Victorian Curriculum F–10 Version 2.0, Science, Levels 7 and 8): *"investigable questions, reasoned predictions and hypotheses can be developed in guiding investigations to identify patterns, test relationships and analyse and evaluate scientific models"* **This subtopic owns the second clause only**: reasoned predictions and hypotheses — formulating hypotheses, making predictions backed by reasons, and asking questions that put a scientific model to the test. The rest of the CD — investigable questions that identify patterns and test relationships — belongs to the partner subtopic **2A** († split delivery, D6). **In our words:** a hypothesis is not a fancy guess — it is a proposed explanation that says what *should* be seen if it is right, and that can be shown to be wrong. A reasoned prediction is the next sentence: *so in this test, we expect to observe …* Together they turn a question into a checkable claim — and they are also how scientists put whole models to the test, keeping the ones whose predictions keep coming true and fixing or dropping the ones whose do not. **Achievement-standard extract served here (D13):** cited by reference to the header of the owner subtopic 2A, where the extract appears in full. **Elaborations drawn on:** VC2S8I01.E03 (developing investigable questions to analyse and evaluate scientific models, such as "How does particle theory explain the properties of substances?") and VC2S8I01.E04 (formulating hypotheses such as "An earthquake of greater magnitude will cause more damage" and "The image of a candle formed by a concave mirror gets larger as the candle moves closer to the mirror"). **Authored from the CD text and the elaboration contexts (D12):** the CD's second clause names hypotheses and reasoned predictions without saying how they are built or what makes a good one; E03 and E04 supply the model-testing and hypothesis-forming contexts worked here. Scope notes: 2B does not re-teach 2A's clause (patterns, relationships, correlation against causation), and it does not pre-teach variables and fair tests, which belong to 3A, or the full treatment of models and representations, which belongs to 4B. The plate tectonics case of a theory winning on evidence is 1A's and is referenced here only as an example of a model surviving its tests. The particle model used in the model-testing section is the one students met at Levels 5–6 (VC2S6U03) and will meet again in Chapter 10; it is used here as a familiar model to put to the test, not taught afresh.

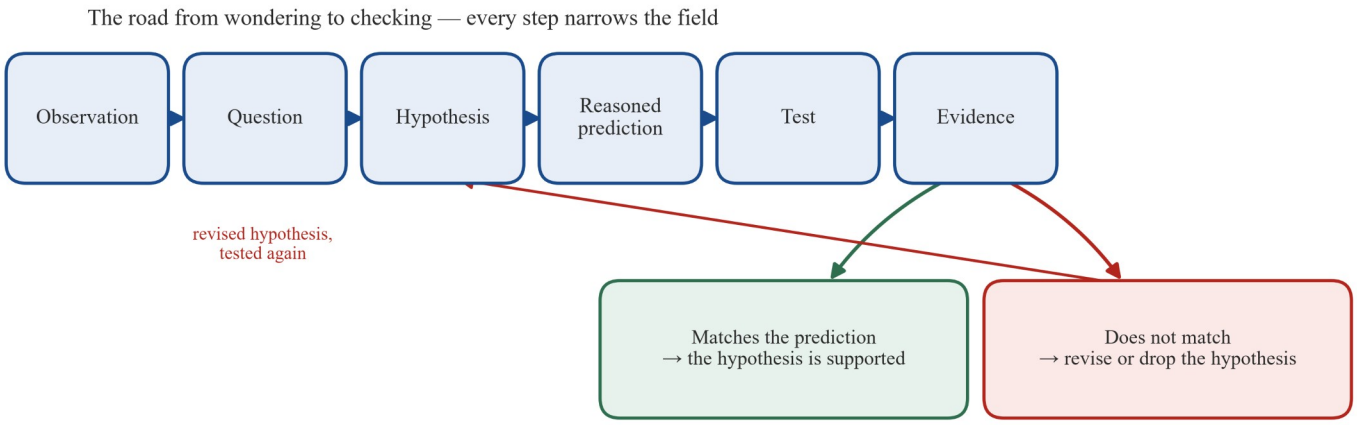
Word watch — *hypothesis* and *prediction*. In everyday talk, people use *hypothesis* and *guess* almost as the same word, and a *prediction* is something a weather app or a horoscope hands you. In this subtopic both words mean something stricter. A **hypothesis** is a *proposed explanation* for something observed — stated so that you can say what would be seen if it were true, and so that some possible observation could show it to be wrong. A **prediction** is a statement of what you expect to observe in one particular test *if* the hypothesis is true — and it is only a *reasoned* prediction when it is backed by knowledge or past observations, not by luck. One more link: a scientific **theory** is not a big hypothesis — it is what a well-tested explanation becomes after many passed tests (subtopic 1A). Keep all three words apart: guess, hypothesis, theory sit at three different places on the road from wondering to knowing.

Theory

The step after the question

Subtopic 2A turned observations into investigable questions — questions that can actually be answered by collecting evidence. A question, though, is only the starting line. The next move is to propose an answer: to say what you think is going on, and — this is the part that makes it science — to say what your answer *commits you to seeing*.

That is what this subtopic builds. The chain runs like this: you observe something and ask a question about it; you propose a testable explanation (the **hypothesis**); you work out what you should observe if the explanation is right (the **reasoned prediction**); you test; you compare the evidence with the prediction; and the result either supports the hypothesis, or sends it back to be revised or dropped. Each step narrows the field: a wild guess becomes a claim with consequences, and a claim with consequences can be checked.



Flow diagram of the steps of a testable investigation, from observation and question, to hypothesis, to reasoned prediction, to test, to evidence, and then branching to supported or not supported

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What a hypothesis is — and what it is not

A **hypothesis** is a proposed explanation for something observed, stated so that:

1. it links things that can be observed or measured;
2. it commits to what *should* be seen if it is true; and
3. some possible observation could show it to be wrong.

The third point is the one students miss most often. A good hypothesis is one you can imagine evidence against. If no observation could ever count against a claim, the claim cannot be tested — and an untestable claim is not a hypothesis, however confident it sounds.

Consider the hypothesis VCAA itself offers as an example (`VC2S8I01.E04`):

> *An earthquake of greater magnitude will cause more damage.*

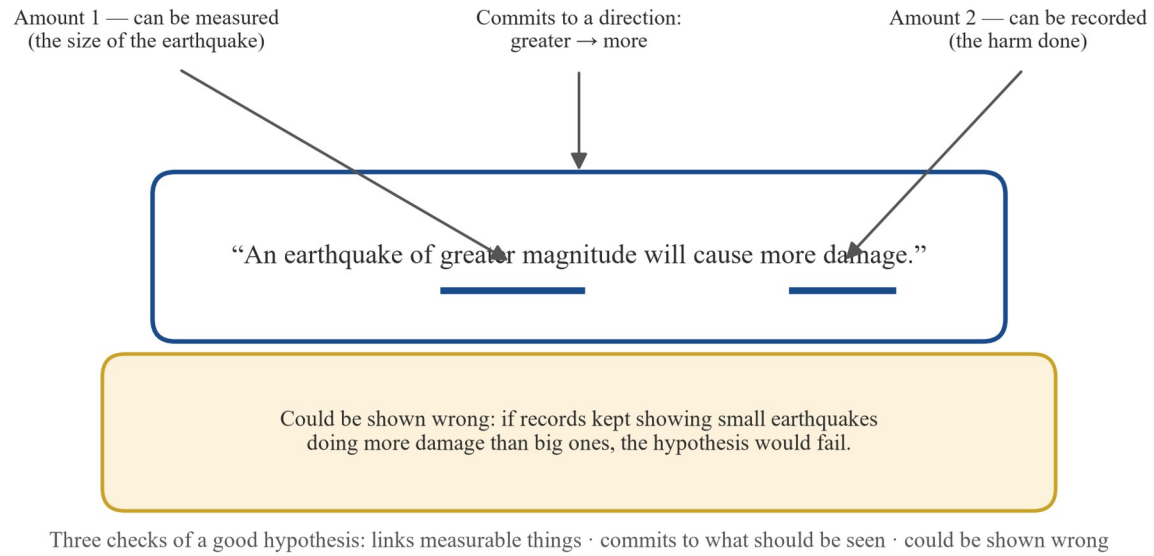
Read it against the three checks:

- it links two things that can be measured or recorded — the **magnitude** of the earthquake and the **amount of damage**;
- it commits to a direction — *greater* magnitude, *more* damage;
- it can fail — if records showed big earthquakes doing less damage than small ones over and over, the hypothesis would not be supported.

The second hypothesis VCAA offers comes from optics: *"The image of a candle formed by a concave mirror gets larger as the candle moves closer to the mirror."* You do not need to know anything about mirrors to see the same shape: one measurable amount (the distance from the candle to the mirror) is claimed to change another measurable amount (the size of the image), and both could be measured in a test.

Now compare two statements that are *not* hypotheses:

- *"Earthquakes are frightening."* This reports a feeling. There is nothing to measure and nothing that could show it wrong — it is an opinion, not a proposed explanation.
- *"Earthquakes happen because the ground is restless."* This sounds like an explanation, but it commits to nothing you could observe or measure. No test could be designed that it might fail — so no test can show it succeeds either. It is words, not a hypothesis.



Labelled box diagram breaking the earthquake hypothesis into its parts, naming the two amounts it links, the direction it commits to, and the observation that could show it wrong

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From hypothesis to reasoned prediction

A hypothesis speaks in general — *earthquakes of greater magnitude cause more damage*. A **prediction** brings it down to one checkable case: it states what you expect to observe in a particular test if the hypothesis is true.

Predictions are often written in an *if … then …* shape, and that shape is useful because it keeps the two halves honest:

> **If** the hypothesis is true, **then** in this test we should observe …

The *if* half names the hypothesis being tested; the *then* half names the observation that would follow. If the *then* half is not something you could actually observe or measure, the prediction is not finished.

A prediction earns the word **reasoned** when it follows from knowledge or from past observations — when you can say *why* you expect what you expect. A guess has no reason behind it; a reasoned prediction can show its working.

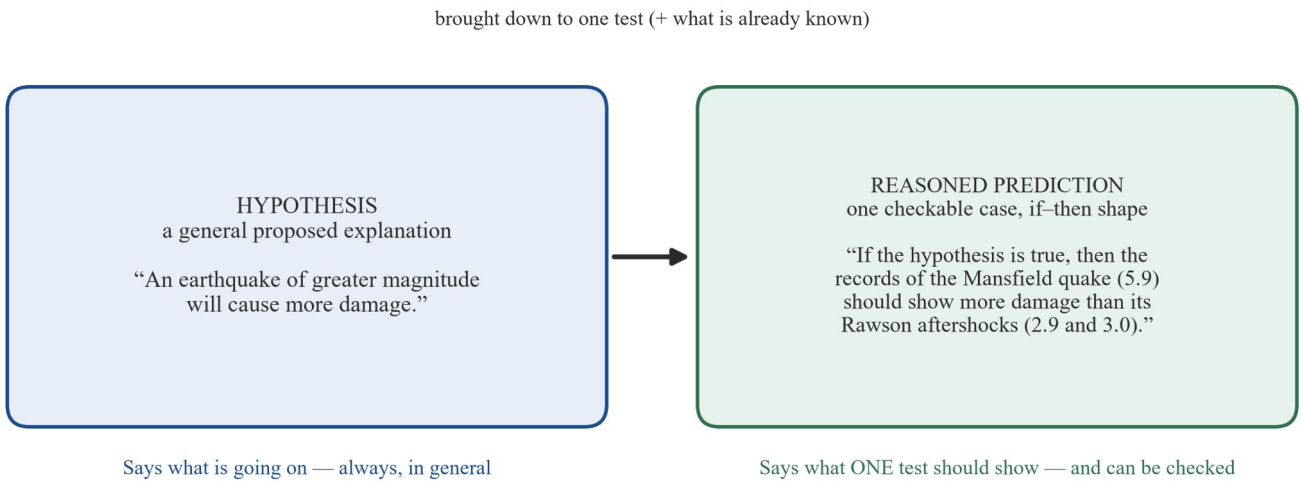
Here is the earthquake hypothesis turned into a reasoned prediction, using a real Victorian event. On 22 September 2021, at about 9:15 am, an earthquake of magnitude 5.9 struck about 53 km south-southeast of Mansfield, near Woods Point, at a depth of about 10 km. It was felt across Victoria — including Melbourne — and even in parts of New South Wales, the ACT, South Australia and Tasmania. It did minor structural damage: chimneys and building fronts were damaged in and around Melbourne. In early October that year, much smaller earthquakes of magnitude 2.9 and 3.0 near Rawson were felt by people close by, with no damage reported.

Source: Wikipedia, “2021 Mansfield earthquake”, 2026 (magnitude and depth as recorded by Geoscience Australia). en.wikipedia.org — retrieved 2026-08-21.

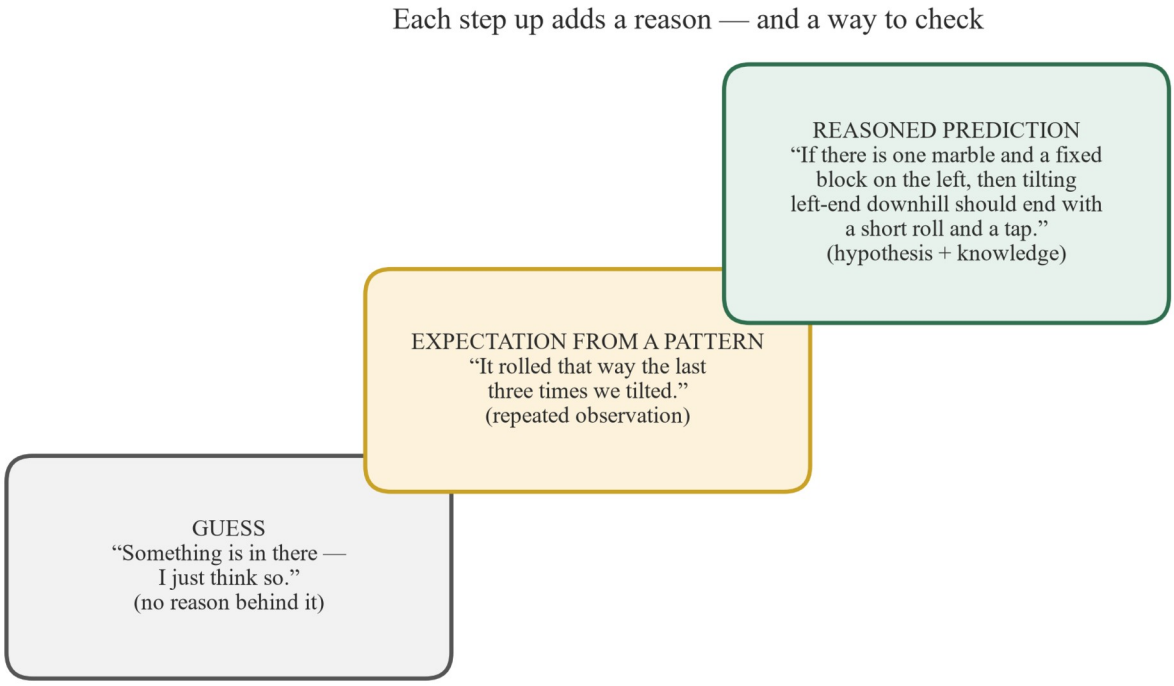
From the hypothesis, a student can make this reasoned prediction:

> **If** earthquakes of greater magnitude cause more damage, **then** the magnitude-5.9 Mansfield earthquake should have caused more damage than its magnitude-2.9 and 3.0 aftershocks near Rawson — and it did.

Notice what happened: the general hypothesis was applied to a known case to say what the records *should* show, and then the records were checked. That is the whole move. One case that agrees does not prove the hypothesis — but a hypothesis that keeps agreeing with the records, case after case, earns trust.

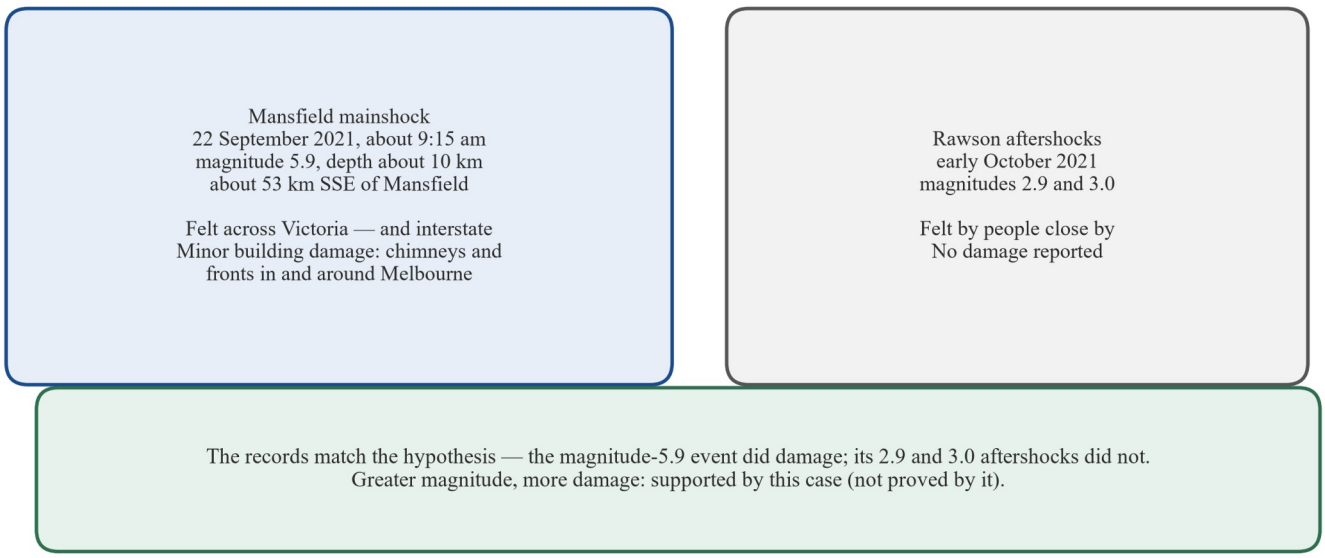


Two-panel diagram contrasting a general hypothesis statement with a specific reasoned prediction derived from it, showing the prediction built from the hypothesis plus what is already known



Three-step ladder diagram contrasting a guess, an expectation from a repeated pattern, and a reasoned prediction backed by a hypothesis or model

One real case, checked against the hypothesis (Wikipedia, “2021 Mansfield earthquake”)



Two-column evidence panel comparing the magnitude 5.9 Mansfield earthquake and its effects with the magnitude 2.9 and 3.0 Rawson aftershocks and their effects, with a verdict line about the hypothesis

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Putting a scientific model to the test (`VC2S8I01.E03`)

A **model** in science is a representation used to explain observations and to make predictions. Models can be physical (a globe), drawn (a particle sketch), or spoken (an idea about how something works). Subtopic 4B looks at models and representations in full; here the question is narrower and more powerful: *how do you put a model to the test?*

The answer is the same move as before, aimed higher. A model does more than describe what is already known — a good model says what should happen in situations *nobody has checked yet*. So you put a model to the test by asking questions it must answer, turning those questions into predictions, and checking the predictions against evidence:

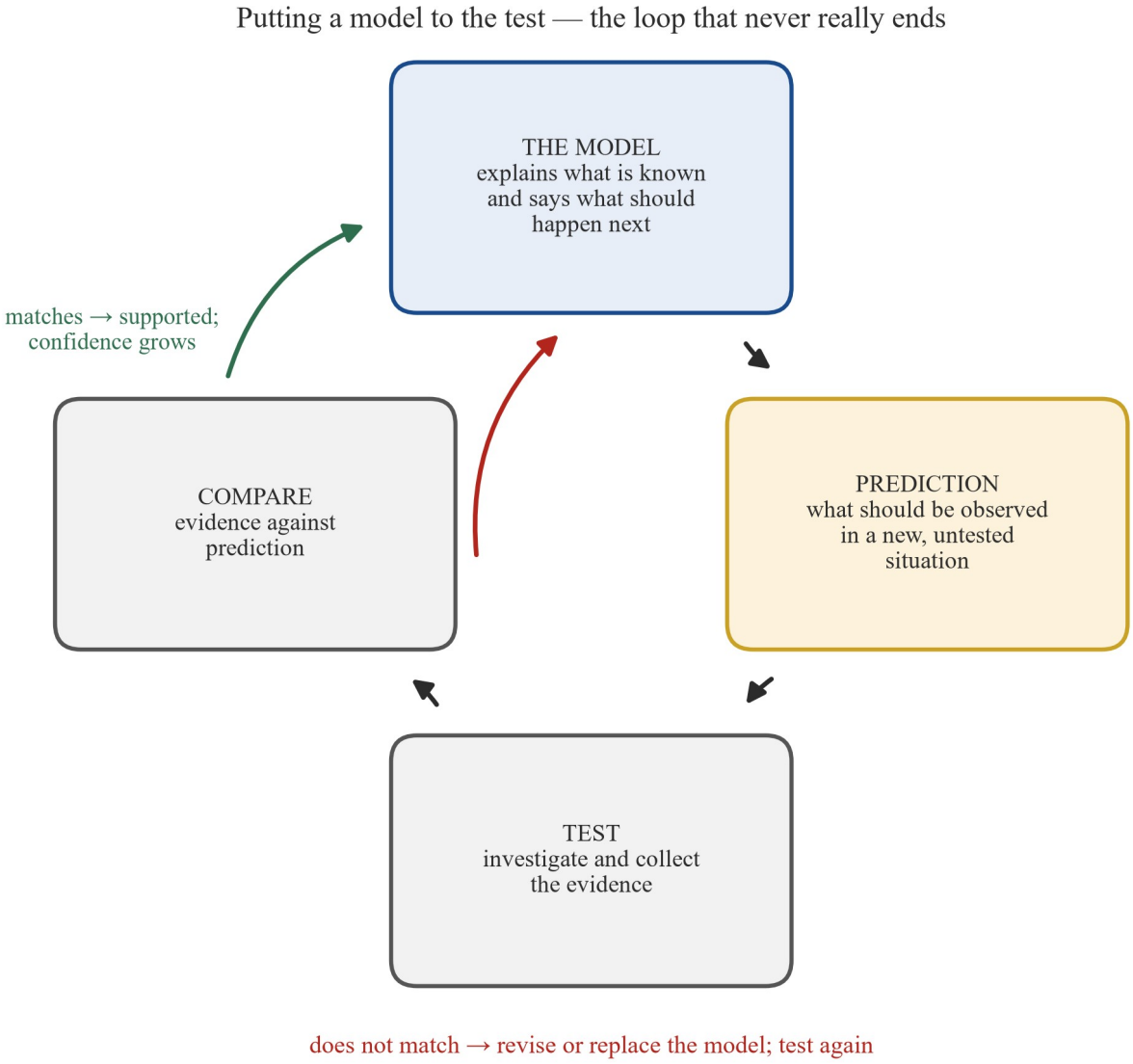
1. **The model explains** what is already known.
2. **The model predicts** what should be observed in a new, untested situation.
3. **You investigate** and collect the evidence.
4. **You compare.** If the evidence matches the prediction, the model is supported. If it does not, the model must be revised or replaced.

VCAA’s example question for this skill is: *“How does particle theory explain the properties of substances?”* (`VC2S8I01.E03`). You have met the particle model of matter in earlier year levels: all substances are made of tiny particles, the particles are arranged and move in different ways in solids, liquids and gases, and the particles of a gas sit far apart while the particles of a solid sit close together in a fixed arrangement. That model is now the thing on trial. Ask it questions it has to answer:

- **Why can a syringe full of air be squashed, but not a syringe full of water?** The model answers: gas particles sit far apart, so there is room to push them closer; liquid particles are already close together. Prediction: the air-filled syringe’s plunger will move in a long way; the water-filled one will move only a little.
- **Why does a solid keep its shape while a gas fills whatever holds it?** The model answers: solid particles are locked in place by their attractions; gas particles move in every direction and spread. Prediction: pour a gas into a larger container and it spreads to fill it; a solid block keeps its shape no matter which container it sits in.
- **Why does the smell of perfume spread across a room?** The model answers: perfume particles move and mix with the air’s particles. Prediction: the smell arrives later at a desk far from the bottle than at one close to it.

Each question is a test the model has volunteered for. The particle model answers all three, and its answers can be checked — which is exactly why it is still used. Chapter 10 puts this same model back on the bench and works it harder, across melting, boiling, density and more.

The loop never really ends. Every passed test is support, not proof — and a failed prediction is not a disaster; it is information. It says the model is incomplete, and shows exactly where the fixing must happen. That is how the story of plate tectonics ran in subtopic 1A: one model explained the evidence better than the one before it, and was accepted — not because it was popular, but because its predictions kept passing.



Cycle diagram of the model-testing loop, from model to prediction to test to evidence, with one branch returning as support and the other returning as revision or replacement

Three-panel diagram of tests that put the particle model to the test, showing a syringe of air being squashed, a syringe of water that will not squash, and perfume particles spreading across a room

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Try it — the mystery box

You will need: a small cardboard box, sealed with tape by your teacher before the lesson; inside it are one or two loose objects and one object fixed in place somewhere (for example, a marble loose and a block of eraser glued to the base). You may lift, tilt, turn and gently shake the box, and listen — but you may not open it, squash it or put anything inside.

The mystery box is a model-testing machine. You cannot see inside, just as scientists cannot see particles, or Earth's deep interior, directly. All you get is what the box does when you ask it a question by tilting or shaking it.

1. Gather evidence. Tilt the box slowly each way. Shake it gently. Hold it still and listen. Note how many loose objects you think are inside, whether anything slides or rolls, and whether anything seems fixed in one spot and where.
2. Write a **hypothesis** about the inside of the box — for example, how many loose objects there are, what kind of motion they make, and where any fixed object sits. State one observation that could show your hypothesis wrong.
3. Write a **reasoned prediction**: *if* your hypothesis is right, *then* when you tilt the box to the left, you should hear and feel …
4. Test the prediction. Did what you expected happen? If not, revise the hypothesis and test again.
5. Design one **new test** — a tilt or turn you have not tried — that would tell apart your hypothesis from a classmate's different one.

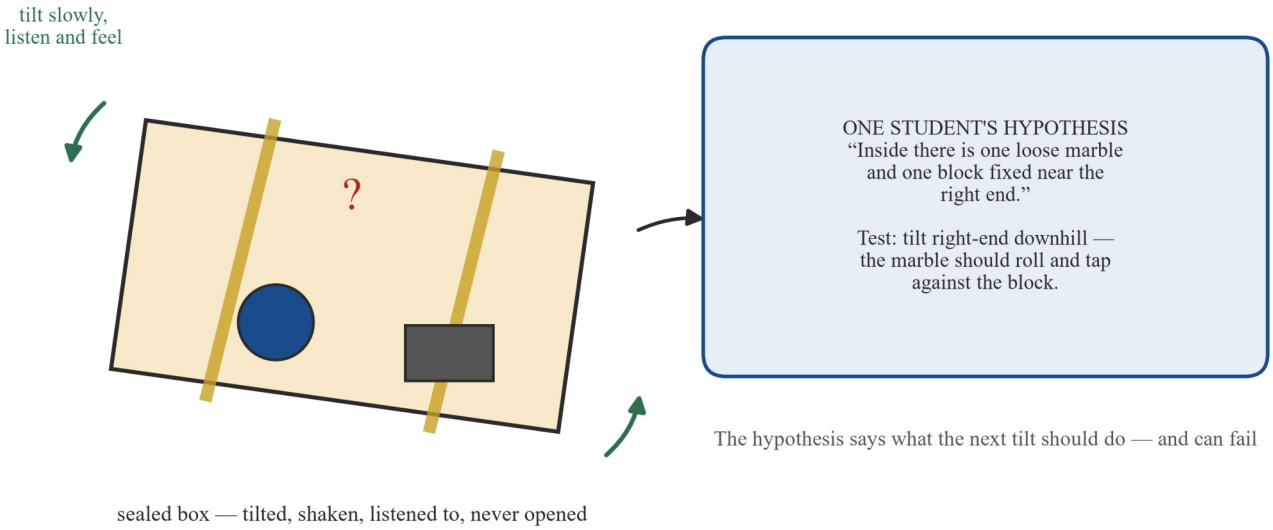

Diagram of the sealed mystery box being tilted and listened to, with callouts for the loose object, the hidden fixed object, and the student's sketch of their hypothesis about the inside

What you did	What it models	What it stands for in science
Tilting and shaking the sealed box	Designing a test and collecting evidence	Experiments on things that cannot be opened — particles, Earth's interior
Writing what you think is inside	Forming a hypothesis or model	Proposing an explanation for what cannot be seen directly
Predicting what the next tilt should do	Making a reasoned prediction	Using a model to say what a new test should show
Revising your idea when a prediction failed	Revising a model in the face of evidence	How scientific models change when they meet new evidence

Ask yourself:

- Your evidence is only sound and feel. Name one thing about the inside of the box that your tests cannot settle — and think of a model of nature where the same limit applies.
- Two students can have different hypotheses that both fit every test done so far. What decides between them?
- The teacher could open the box at the end. In science, nobody can open the box. What does that say about how sure we should ever be?

Try it — the crater drop

You will need: a tray or shallow box, enough flour to fill it 3–5 cm deep, a marble, a ruler, and a sheet of paper to record results. The marble stands in for a falling object, and the width of the crater it digs stands in for the effect (the "damage") it makes.

1. Level the flour in the tray.
2. Hold the marble 20 cm above the flour's surface (use the ruler to check the height), drop it, and carefully lift it out. Measure the width of the crater it made. Record it.
3. Re-level the flour. Repeat from 40 cm and from 60 cm. Record each width.

Before you drop anything, do the science part:

- Write the **hypothesis** you are testing — for example, about how the drop height and the crater width are linked. Check it against the three tests of a good hypothesis on the previous pages.

- Write a **reasoned prediction** for the 60 cm drop, in the *if … then …* shape. Say what knowledge or observation your prediction rests on.
- After the three drops, compare the evidence with the prediction. Does the evidence support the hypothesis? What would the evidence have had to look like to count against it?

Safety: keep marbles out of walkways — a rolling marble underfoot is a slip hazard — and sweep up spilt flour straight away.

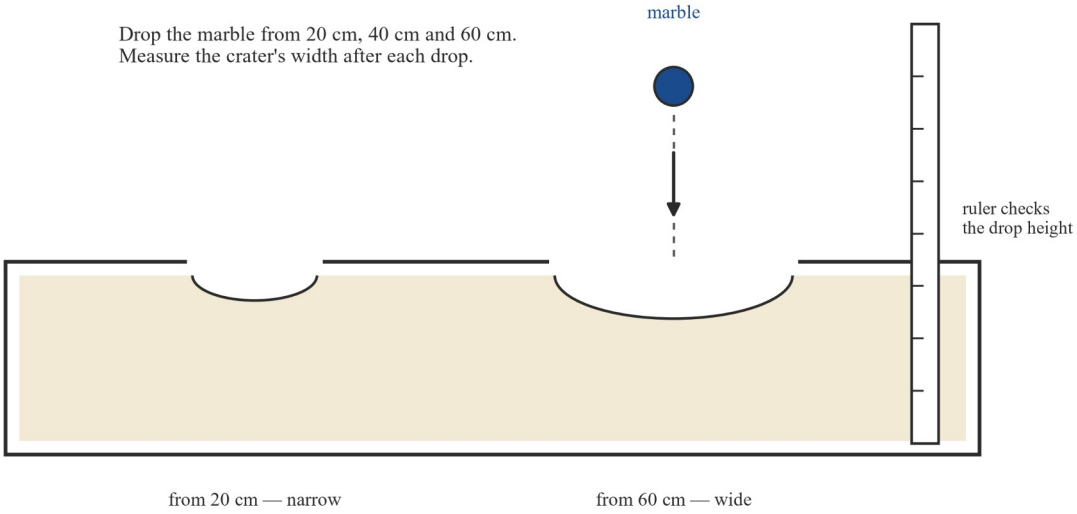

Diagram of the crater-drop activity showing a marble falling from a measured height into a tray of flour, with two craters drawn to show a narrow crater from a low drop and a wide crater from a high drop

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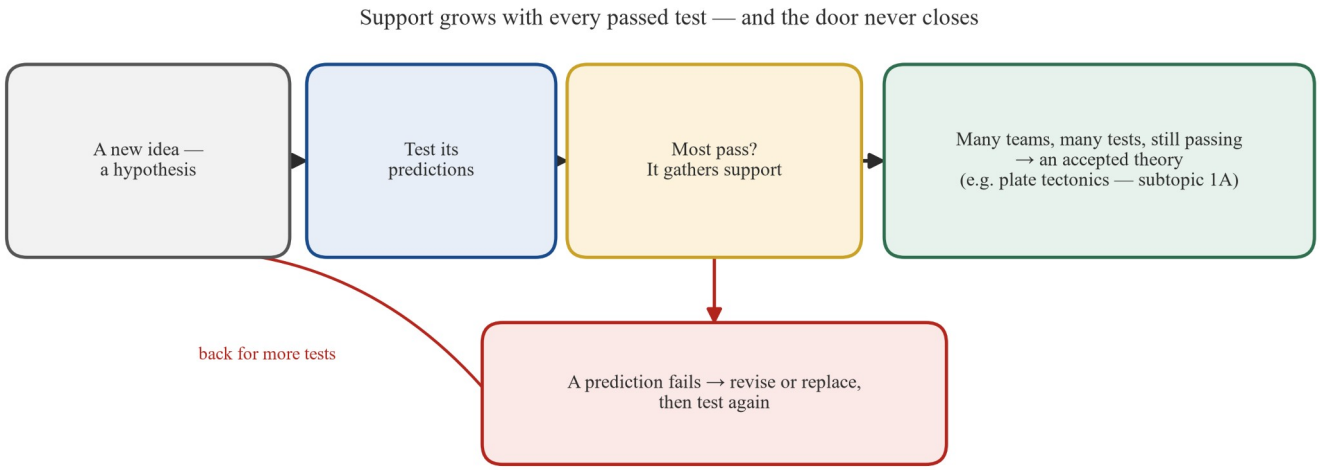
What the evidence does to a hypothesis

There are only two things evidence can do to a hypothesis, and neither of them is *prove*.

- **Evidence supports a hypothesis** when the observations keep matching its predictions. Support grows with every passed test, with every team that repeats the test, and with every new situation the hypothesis gets right. But support is not proof: the next test could still be the one that fails. Science keeps its claims open to that possibility on purpose — it is what keeps them honest.
- **Evidence counts against a hypothesis** when the observations do not match its predictions. This is not a failure — it is progress. A hypothesis that has been shown wrong has cleared the road for a better one. The right response is to revise the hypothesis (maybe the claim needs a limit: *more damage, up to a point …*) or to replace it, and then test again.

The same rule applies to whole models and, at the top of the scale, to theories. A **theory** is what an explanation earns when it has survived many tests by many people and keeps making predictions that come true — plate tectonics in subtopic 1A is the example in this book. The road runs one way, and every step on it is a test: an idea begins as a hypothesis; if its predictions keep passing, it gathers support; if it keeps passing tests that other explanations fail, it can become part of an accepted theory. And even then, the door stays open — a theory changes when the evidence changes, exactly as you saw in Chapter 1.



Path diagram showing an idea beginning as a hypothesis, gaining support as its predictions pass repeated tests, and becoming part of an accepted theory, with a side branch where a failed prediction sends the idea back for revision

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The whole story in four sentences

A hypothesis is a proposed explanation that says what should be seen if it is right and what could show it wrong. A reasoned prediction brings the hypothesis down to one test — *if it is true, then in this test we should observe …* — and the evidence either supports it or sends it back to be revised or replaced. Scientific models are put to the test the same way: ask a model a question it must answer, check its prediction against evidence, and keep the models that survive. That loop — propose, predict, test, compare — is how science moves from wondering to knowing, and it is the engine behind everything else in Chapters 2 to 6.

Worked examples

Example 1 — scaffolded

Consider these four statements about earthquakes.

#	Statement
I	An earthquake of greater magnitude will cause more damage.
II	The magnitude-5.9 Mansfield earthquake of 22 September 2021 caused more damage than its magnitude-2.9 and 3.0 aftershocks near Rawson.
III	Earthquakes are the most frightening of all the natural hazards.
IV	If earthquakes of greater magnitude cause more damage, then the records of the Mansfield earthquake should show damage while the records of its small aftershocks should show none.

(a) Which statement is a hypothesis?

(b) Which statement is a reasoned prediction?

(c) Classify the remaining two statements as either an observation (or record) or an opinion, and say why each one is not a hypothesis.

Working	Comment
(a) Statement I.	It proposes a general explanation linking two measurable amounts — magnitude and damage — and a

Working	Comment
	record of earthquakes could show it wrong.
(b) Statement IV.	It takes the hypothesis and states, in *if … then …* form, what one particular set of records should show if the hypothesis is true.
(c) Statement II is a record of what actually happened — an observation with real events and magnitudes, not a proposed explanation. Statement III is an opinion — "most frightening" reports a feeling, links nothing measurable, and no observation could show it wrong.	A hypothesis proposes; an observation reports; an opinion evaluates. Only the first can be tested.

Example 2 — scaffolded

A group of students wonders whether stirring changes how fast sugar dissolves in water. Their question: *"Does stirring make sugar dissolve faster in water?"*

(a) Write a hypothesis for this question.
(b) Write a reasoned prediction from your hypothesis, in the *if … then …* shape, for a test using two identical beakers of water at the same temperature.
(c) State one thing the students must keep the same in both beakers for the comparison to be fair, and say why.

Working	Comment
(a) *Sugar dissolves faster in water when the water is stirred.*	It links two things that can be observed or timed — stirring, and how long the sugar takes to dissolve — and it could fail: if stirred and unstirred water took the same time, it would not be supported.
(b) *If* stirring makes sugar dissolve faster, *then* the same amount of sugar in the stirred beaker should disappear in less time than in the unstirred beaker.	The *if* half names the hypothesis; the *then* half names the observation — a time you can measure.
(c) Any one of: the amount of water, the temperature of the water, the amount and kind of sugar.	If those differed between the beakers, you could not tell whether the stirring or the difference was responsible for the result. (Variables and fair tests are taught in full in subtopic 3A.)

Example 3 — unscaffolded

A student writes: *"Big earthquakes are worse than small ones."* Explain why this is not yet a testable hypothesis, and rewrite it as one.

The sentence is not testable because its key words commit to nothing measurable. "Big" does not say whether the student means magnitude, depth, or the area shaken, and "worse" does not say whether the claim is about damage, injuries, fear, or cost — and the two halves might not even be measured the same way from one earthquake to the next. Because no observation is named, no test can be designed and nothing could show the claim wrong. A testable rewrite links two measurable amounts and commits to a direction: *An earthquake of greater magnitude will cause more damage to buildings near its centre.* Now "greater magnitude" and "more damage" can both be recorded, and earthquake records could support the claim or count against it.

Example 4 — unscaffolded

A student says: *"The particle model of matter is just a drawing of dots, so it cannot be wrong."* Evaluate this claim. In your answer, explain what a scientific model actually is, and give two questions that put the particle model to the test.

The claim confuses the *representation* with the *model*. The dots on the page are only the drawing; the model is the idea behind it — that substances are made of particles whose arrangement and motion differ between solids, liquids and gases. And the claim gets the testability backwards: the particle model *can* be wrong, exactly because it makes claims about how substances behave. Any model that explains observations also predicts new ones, and every prediction is a test the model has volunteered for. Two questions that put the particle model to the test: (1) *Why can a syringe full of air be squashed but not one full of water?* — the model predicts the air plunger moves far because gas

particles sit far apart, and the test can check it; (2) *Why does the smell of perfume spread across a room?* — the model predicts moving particles mixing with the air, and the timing of the smell at different distances can check it. If such tests kept failing, the model would have to be revised or replaced — as happened to earlier models in the story of plate tectonics (subtopic 1A). A model that cannot be wrong cannot be tested, and a model that cannot be tested is not doing science's work.

Practice questions

Scaffolded

Q1. Answer the following about hypotheses. (a) What is a hypothesis? (b) State the three checks of a good hypothesis used in this subtopic. (c) Explain why *"Earthquakes happen because the ground is restless"* is not a hypothesis.

Q2. Consider the hypothesis *"An earthquake of greater magnitude will cause more damage"* (`VC2S8I01.E04`). (a) Name the two amounts this hypothesis links. (b) Write a reasoned prediction from this hypothesis about the 2021 Mansfield earthquake (magnitude 5.9) and its smaller aftershocks of magnitude 2.9 and 3.0 near Rawson. (c) Describe a result of checking earthquake records that would count against the hypothesis.

Q3. Answer the following about predictions. (a) What is a reasoned prediction? (b) How is a reasoned prediction different from a guess? (c) Complete the sentence: *If the hypothesis is true, then in this test we should …* — and explain why the *then* half must name something observable or measurable.

Q4. Answer the following about scientific models (`VC2S8I01.E03`). (a) What is a scientific model? (b) State two questions that put the particle model of matter to the test. (c) What happens to a model when its predictions keep failing tests?

Q5. In the mystery box Try-it, a group hears one loose object rolling and thinks something is fixed near one end of the box. (a) Write a hypothesis the group could make about the inside of the box. (b) Write a reasoned prediction from that hypothesis for a new test: tilting the box so the fixed end is downhill. (c) Explain why the group cannot be completely sure of their hypothesis, even after many tilts.

Q6. In the crater-drop Try-it, a student predicts that a marble dropped from 60 cm will dig a wider crater than one dropped from 20 cm. (a) Write the hypothesis this prediction comes from. (b) State one observation that would count against the hypothesis. (c) Name one thing the student should keep the same between drops so the comparison is fair.

Unscaffolded

Q7. Rewrite the statement *"Music helps plants grow better"* as a testable hypothesis, and state one prediction that follows from it. *(2 marks)*

Q8. A student says: *"A prediction is the same thing as a hypothesis."* Evaluate this claim. In your answer, explain the job of each one and give one example of each from the earthquake investigation in this subtopic. *(3 marks)*

Q9. *"The evidence supported our hypothesis, so we have proved it is true."* Evaluate this conclusion, explaining what evidence can and cannot do for a hypothesis. *(2 marks)*

Q10. A scientific model makes a prediction, and a careful test shows the prediction was wrong. State two things scientists could do next, and explain why a failed prediction is useful rather than a waste of time. *(2 marks)*

Q11. A student guesses that a sealed box contains three marbles. Another student, after listening to the box being tilted, predicts there is one marble and one fixed object. Explain why the second student's claim is a stronger scientific idea, even if it turns out to be wrong. *(2 marks)*

Q12. The particle model predicts that gas particles sit far apart, while liquid particles sit close together. Explain how the syringe test (air against water) puts that claim to the test, and state what result would count against the model. *(2 marks)*

Q13. In the mystery box Try-it, the box can never be opened. Explain how this is like the way scientists test models of things they cannot see directly, such as particles or Earth's interior, and state one limit this puts on how certain a model can be. *(2 marks)*

Q14. Bread dough rises faster in a warm spot than in a cool spot. Write a testable hypothesis for this observation, then write a reasoned prediction for a test using two identical loaves — one kept warm, one kept cool. State what result would support your hypothesis and what result would count against it. *(3 marks)*

Answers

Q1. (a) A proposed explanation for something observed, stated so it can be tested. (b) It links observable or measurable things; it commits to what should be seen if it is true; some observation could show it wrong. (c) It commits to nothing observable — "restless" cannot be measured, and no test could show the claim wrong. **Q2.** (a) The magnitude of the earthquake and the amount of damage. (b) Example: *If greater magnitude causes more damage, then the magnitude-5.9 Mansfield earthquake should have caused more damage than its 2.9 and 3.0 aftershocks.* (c) Records repeatedly showing small earthquakes causing more damage than big ones. **Q3.** (a) A statement of what you expect to observe in a particular test if the hypothesis is true, backed by knowledge or past observations. (b) A guess has no reason behind it; a reasoned prediction can show its working. (c) Example: *... we should observe the stirred sugar disappearing in less time.* The *then* half must be observable or measurable because the test compares the prediction against evidence — and evidence is what you observe or measure. **Q4.** (a) A representation used to explain observations and make predictions. (b) Any two of: why can air in a syringe be squashed but not water; why does a solid keep its shape while a gas fills its container; why does a smell spread across a room. (c) It must be revised or replaced. **Q5.** (a) Example: *The box contains one loose marble and one object fixed near the left end.* (b) Example: *If the fixed object is at the left end and the box is tilted left-end downhill, then the marble should roll toward the fixed end and stop against it.* (c) Their evidence is only sound and feel; another arrangement of objects could match every test done so far. **Q6.** (a) Example: *The greater the drop height, the wider the crater the marble digs.* (b) The 20 cm drop digging a wider crater than the 60 cm drop, repeatedly. (c) Any one of: the same marble, the same tray and flour depth, the flour re-levelled before each drop. **Q7.** Example hypothesis: *A plant watered the same way grows taller when it is kept in a room with music playing than when it is kept in a quiet room.* Prediction: *If music helps plants grow, then after four weeks the plants in the music room should be taller.* **Q8.** The claim is wrong. A hypothesis proposes a general explanation; a prediction states what one test should show if the hypothesis is true. Earthquake example: hypothesis — greater magnitude causes more damage; prediction — the Mansfield mainshock's records should show more damage than its small aftershocks' records. **Q9.** Support is not proof. The evidence makes the hypothesis more trustworthy, but the next test could still fail; a hypothesis is never proved beyond all doubt. **Q10.** Revise the model so it matches the new evidence, or replace it with a better one. A failed prediction is useful because it shows exactly where the model is incomplete, and rules out at least one explanation. **Q11.** It is a reasoned claim: it rests on evidence (the sounds and feels of the tilt tests) and it commits to what future tilts should do, so it can be tested and shown wrong. The guess has no evidence behind it and no stated consequences. **Q12.** If gas particles sit far apart, there is room to push them closer, so the air plunger should move in far; if liquid particles are close together already, the water plunger should move only a little. If the air-filled syringe could not be squashed at all — or the water one squashed easily — the result would count against the model. **Q13.** Scientists cannot open the box either: particles and Earth's deep interior cannot be seen directly, so models are tested by the predictions they make about what can be observed. Limit: more than one model may fit all the evidence so far, so a model is supported, never proved. **Q14.** Example hypothesis: *Bread dough rises faster in a warm spot than in a cool spot.* Prediction: *If warmth speeds rising, then the identical loaf kept warm should double in height in less time than the loaf kept cool.* Support: the warm loaf rises faster. Against: the cool loaf rises as fast or faster.

Fully-worked solutions

Q1. (a) A hypothesis is a **proposed explanation** for something observed, stated so that it can be tested *(1 mark)*. (b) It **links things that can be observed or measured**; it **commits to what should be seen if it is true**; and **some possible observation could show it wrong** *(1 mark)*. (c) The word "restless" commits to nothing measurable, and no test could be designed that the claim might fail — an untestable claim is not a hypothesis *(1 mark)*.

Q2. (a) The **magnitude of the earthquake** and the **amount of damage** *(1 mark)*. (b) Example: ***If*** **earthquakes of greater magnitude cause more damage, *then* the magnitude-5.9 Mansfield earthquake of 22 September 2021 should have caused more damage than its magnitude-2.9 and 3.0 aftershocks near Rawson** — the *if* half names the hypothesis, the *then* half names a checkable record *(1 mark)*. (c) Records that repeatedly showed **smaller earthquakes causing more damage than bigger ones** — the opposite of what the hypothesis commits to *(1 mark)*.

Q3. (a) A reasoned prediction states **what you expect to observe in one particular test if the hypothesis is true**, and it is backed by knowledge or past observations *(1 mark)*. (b) A guess has **no reason behind it**; a reasoned prediction **can show its working** — you can say why you expect what you expect *(1 mark)*. (c) Example: *If the hypothesis is true, then in this test we should observe the marble's crater getting wider as the drop height increases.* The *then* half

must name something observable or measurable because a test compares the prediction against **evidence — and evidence is what is observed or measured**; a *then* half nobody could observe could never be checked *(1 mark)*.

Q4. (a) A scientific model is a **representation used to explain observations and to make predictions** *(1 mark)*. (b) Any two of: ***Why can a syringe full of air be squashed, but not one full of water?***; ***Why does a solid keep its shape while a gas fills its container?***; ***Why does the smell of perfume spread across a room?*** *(1 mark)*. (c) When a model's predictions keep failing, the model must be **revised or replaced** *(1 mark)*.

Q5. (a) Example: *The box holds **one loose marble and one fixed object near the left end** — the rolling sound is the marble, and the fixed object is why the sound stops partway when the box tilts left (1 mark)*. (b) Example: ***If*** **the fixed object sits at the left end, *then* tilting the box left-end downhill should make the marble roll toward that end and stop against the fixed object — a short roll and a quiet tap** *(1 mark)*. (c) The group's only evidence is **sound and feel**, and **a different arrangement of objects could match every test done so far** — more than one hypothesis fits the evidence, so none is certain *(1 mark)*.

Q6. (a) Example: ***The greater the height a marble is dropped from, the wider the crater it digs in the flour*** *(1 mark)*. (b) The **20 cm drop digging a wider crater than the 60 cm drop**, and doing so again when the test is repeated *(1 mark)*. (c) Any one of: **the same marble**; **the same tray with the same depth of flour**; **re-levelling the flour before each drop** — keeping these the same means any change in crater width can be put down to the drop height alone *(1 mark)*.

Q7. The rewrite must link measurable amounts *(1 mark)*; example: *A plant grows taller over four weeks when it is kept in a room with music playing than when it is kept in an otherwise identical quiet room.* The prediction must follow from the hypothesis in checkable form *(1 mark)*; example: *If music helps plants grow, then the plants in the music room should measure taller after four weeks.*

Q8. The claim is wrong: the two do different jobs *(1 mark)*. A **hypothesis** proposes a **general explanation** — *earthquakes of greater magnitude cause more damage* — while a **prediction** states what **one particular test** should show if the hypothesis is true — *the Mansfield mainshock's records should show more damage than the records of its small Rawson aftershocks (1 mark)*. The hypothesis is the idea being tested; the prediction is the idea brought down to a checkable case *(1 mark)*.

Q9. The conclusion goes too far *(1 mark)*: evidence can **support** a hypothesis but can never **prove** it — the next test could be the one that fails, and science keeps its claims open to that possibility *(1 mark)*.

Q10. Two possible responses: **revise the model** so it matches the new evidence (perhaps the claim needs a limit), or **replace it** with a better explanation *(1 mark)*. A failed prediction is useful because it **shows exactly where the model is incomplete** and rules out at least one way things could be — it narrows the field, which is progress *(1 mark)*.

Q11. The second student's claim is **reasoned**: it rests on **evidence gathered from the tilt tests**, and it commits to what future tilts should do, so it can be tested and improved *(1 mark)*. The first student's guess has no evidence behind it and no stated consequences — it cannot guide any test *(1 mark)*. Being testable is what makes an idea scientific, not being right.

Q12. The model says gas particles sit **far apart**, so there is room to push them closer — the prediction is that the **air-filled plunger moves in a long way**; liquid particles are **already close together**, so the **water-filled plunger should move only a little** *(1 mark)*. A result against the model: the air-filled syringe not squashing at all, or the water-filled one squashing easily *(1 mark)*.

Q13. Particles and Earth's deep interior, like the inside of the sealed box, **cannot be seen directly** — their models are tested through **predictions about what can be observed** *(1 mark)*. Limit: **more than one model can fit all the evidence so far**, so a model earns support, never proof — the door stays open for a better model *(1 mark)*.

Q14. Hypothesis *(1 mark)*: example — *Bread dough rises faster at a warmer temperature.* Prediction *(1 mark)*: example — *If warmth speeds rising, then two identical loaves started together should show the warm one doubling in height in less time than the cool one.* Support and against *(1 mark)*: the warm loaf rising faster supports the hypothesis; the cool loaf rising as fast or faster counts against it.

Sources

Web sources below were retrieved 2026-08-21.

- Wikipedia, “2021 Mansfield earthquake”, 2026 (event details as recorded by Geoscience Australia: moment magnitude 5.9, depth about 10 km, 22 September 2021, about 53 km south-southeast of Mansfield near Woods Point; minor structural damage in and around Melbourne; felt across Victoria and in parts of New South Wales, the ACT, South Australia and Tasmania; aftershocks including magnitude 2.9 and 3.0 events near Rawson in early October 2021). en.wikipedia.org
- Victorian Curriculum and Assessment Authority, *Victorian Curriculum F–10 Version 2.0, Science, Levels 7 and 8*, content description VC2S8I01 and its elaborations, 2026. vcaa.vic.edu.au

All worked examples, activity instructions and question scenarios in this subtopic are original compositions for this book. The earthquake facts (magnitude, depth, date, location and damage of the 2021 Mansfield earthquake and its Rawson aftershocks) are real and are carried by the source line above; every other scenario — the mystery box, the crater drop, the sugar-dissolving and bread-dough items — is an everyday classroom situation invented for practice, and no invented measurements are presented as real data.

The particle model of matter used in the model-testing section is prior learning from Levels 5–6 (VC2S6U03, *Victorian Curriculum F–10 Version 2.0, Science, Levels 5 and 6*: “the observable properties of matter (solids, liquids and gases) can be explained by modelling the motion and arrangement of their particles”); it is recalled here as a familiar model to put to the test, not taught afresh, and is developed again in Chapter 10 (VC2S8U05).

Elaboration contexts used: VC2S8I01.E03 (developing investigable questions to analyse and evaluate scientific models, such as “How does particle theory explain the properties of substances?”) and VC2S8I01.E04 (formulating hypotheses such as “An earthquake of greater magnitude will cause more damage” and “The image of a candle formed by a concave mirror gets larger as the candle moves closer to the mirror”). E04’s earthquake hypothesis is the running example of this subtopic and is checked against the real records of the 2021 Mansfield earthquake; its concave-mirror example is quoted once, for its form as a hypothesis, without teaching any optics. E03’s particle-theory question drives the model-testing section.

Test A

Topic test 1 — How science works, and asking a good question

Science as a human endeavour and science inquiry · Chapters 1–2 · Subtopics 1A, 1B, 2A and 2B · Codes VC2S8H01, VC2S8H02 and VC2S8I01

> **Total: 30 marks** · Section A (multiple choice): 8 marks · Section B (short/structured response): 22 marks
>
> **17 of the 30 marks are science inquiry marks** (code `VC2S8I01`).
>
> **Planned for about 35 minutes. This paper is untimed — there is no time to beat.**
>
> This is a school-designed paper. It is not a VCAA instrument. Achievement at Levels 7 and 8 is reported against the Victorian Curriculum achievement standard on teacher judgement; the marks here are one source of evidence towards that judgement.

Conditions

- Completion is **untimed**. The 35 minutes is planning guidance only; take as long as you need.
- **Reading support** is permitted. Your teacher may read any question out to you if you need it. Reading is not what is being looked at, and your teacher will not help with the answer.
- **No calculator is required.** Nothing on this paper needs one. No formula sheet. No reading time.
- Answer every question. For multiple-choice questions, circle the letter of the best answer. There is only one best answer for each question.

In this test you will:

- explain how new evidence can change scientific knowledge (Q1–Q3, Q9, Q10)
- discuss how different skills, perspectives and worldviews shape science (Q4, Q5, Q11)
- tell correlation from causation, and use the four checks for "X causes Y" (Q6, Q12, Q15)
- pick out and sharpen investigable questions (Q7, Q8, Q13)
- tell a hypothesis from a reasoned prediction, and judge a claim of proof (Q14)

Section A — Multiple choice (8 marks)

Each question is worth 1 mark. Circle the letter of the best answer.

Q1 *(1 mark · VC2S8H01)* You discover a fossil that has both feathers and a dinosaur-like tail. How can this new evidence help scientists?

A. It proves that the fossil belongs to a modern bird species. B. It helps scientists compare traits when reviewing links between early birds and dinosaurs. C. It shows that every dinosaur had feathers. D. It proves that all animals with feathers are close relatives.

Q2 *(1 mark · VC2S8H01)* You learn that a feature used to identify birds also appears in older reptile fossils. What is the best way to refine a classification that used this feature alone?

A. Keep using the feature as final proof that an organism is a bird. B. Classify all reptiles as birds. C. Ignore the fossils because extinct organisms cannot help classification. D. Treat the feature as one clue and compare it with other evidence.

Q3 *(1 mark · VC2S8H01)* You first group a whale shark with whales because of its name and large size. You then learn that it has gills and a skeleton made of cartilage, like other sharks. Which grouping is best supported?

A. Sharks, because its gills and skeleton match sharks. B. Whales, because its name includes the word whale. C. All ocean animals together, regardless of their body features. D. Mammals, because it swims near whales.

Q4 *(1 mark · VC2S8H02)* You are helping a wildlife scientist who puts animal comfort first. Which research question best matches that value?

A. How can collars send location signals farther? B. Which collar stores location records for the longest time? C. How do quieter tracking collars affect the resting time of koalas? D. Which collar colour is easiest for researchers to spot?

Q5 *(1 mark · VC2S8H02)* You hear one resident support a wasp that controls crop pests because it may reduce chemical spraying. Another resident worries that it could harm native insects. Why is it important to record both views?

A. Benefits and possible harms can matter to different people B. Both views must have exactly the same weight, even if the evidence is different C. Only concerns that are already proven should be written down D. The first person to comment should guide the decision

Q6 *(1 mark · VC2S8I01)* You collect data on sunny days and find that more ice creams are sold on days when more people get sunburn. Which conclusion best shows that two things happening together does not prove causation?

A. Buying an ice cream causes sunburn because both happen more often on the same days. B. Getting sunburn causes people to buy ice creams. C. When two things happen together, each one must cause the other. D. The data show that ice cream sales and sunburn happen together, but they do not prove that buying ice cream causes sunburn. Spending more time in the sun could affect both.

Q7 *(1 mark · VC2S8I01)* You will release the same toy car from ramps that are 6, 16, and 26 centimetres high. You will measure how far the car travels after leaving the ramp. Which question matches this plan?

A. Why do cars move farther from steep ramps? B. How does ramp height of 6, 16, or 26 centimetres affect the distance the toy car travels after leaving the ramp? C. How do ramp height and ramp surface together affect the toy car's travel distance? D. Which ramp gives the most exciting ride?

Q8 *(1 mark · VC2S8I01)* You want to test whether the mass placed on the end of a plastic ruler changes how much it bends. Which wording makes 'bends a lot' measurable?

A. Why does a ruler bend under a load? B. Which ruler is strongest? C. How does a load of 50, 100, or 150 grams at the end of the same ruler affect its downward bend in millimetres? D. How do load mass and ruler length together affect bending?

Section B — Short/structured response (22 marks)

Q9 *(3 marks · VC2S8H01)* In 1912, Alfred Wegener proposed that the continents had once been joined together and had drifted apart. Most geologists did not accept the idea at the time, and decades passed before plate tectonics became the accepted theory.

(a) State two lines of evidence that Wegener used to support his idea. *(2 marks)*
(b) State the main thing that the theory of plate tectonics has that continental drift lacked. *(1 mark)*

Q10 *(2 marks · VC2S8H01)* In his 1869 periodic table, Mendeleev left gaps where no known element fitted the pattern.

(a) State what a gap in Mendeleev's table stood for. *(1 mark)*
(b) In 1875 the element gallium was found, with just the properties Mendeleev had predicted for one of the gaps. Explain why this discovery made chemists trust the table more. *(1 mark)*

Q11 *(3 marks · VC2S8H02)* In 1978, a team in Melbourne gave the world its first working multi-channel bionic ear — an implant that let a person who had lost their hearing hear speech again.

(a) Name two roles in the team, and state what each role contributed. *(2 marks)*
(b) Explain why no single person could have built the bionic ear alone. *(1 mark)*

SCENARIO — invented for skills practice.

Q12 *(4 marks · VC2S8I01)* In one town, umbrella sales and the number of people catching colds both rise in the same months of the year. A shopkeeper says: "Umbrellas cause colds."

(a) What is the word for the situation where two things rise and fall together? *(1 mark)*

(b) Of the four checks for "X causes Y", there is one check that the shopkeeper's claim passes. Identify it and state why it passes. *(1 mark)*

(c) Of the four checks, there is one check that the claim clearly fails. Identify it and state why it fails. *(1 mark)*

(d) Give one third factor that could cause both the umbrella sales and the colds, and explain how. *(1 mark)*

Q13 *(3 marks · VC2S8I01)* A student asks: "Do plants like music?"

(a) Rewrite this as an investigable question about a relationship. Your question must say what will be changed and what will be measured. *(2 marks)*

(b) State whether the question you wrote is a pattern question or a relationship question. *(1 mark)*

Q14 *(4 marks · VC2S8I01)*

(a) State one difference between a hypothesis and a prediction. *(1 mark)*

(b) Hypothesis: stirring makes sugar dissolve faster in water. Write a reasoned prediction from this hypothesis, in the form "If … then in this test we should observe …". *(2 marks)*

(c) A student writes: "Our result matched our prediction, so we have proved that the hypothesis is true." Evaluate this claim. *(1 mark)*

Q15 *(3 marks · VC2S8I01)* Every school day, the school bell rings and a few seconds later the students come out into the yard. A new teacher says: "Students coming out makes the bell ring."

(a) Describe the correlation the new teacher has noticed. *(1 mark)*

(b) State which way the causal arrow actually runs. *(1 mark)*

(c) Use one of the four checks for "X causes Y" to show why the new teacher's claim fails. *(1 mark)*

Test B

Topic test 1 — How science works, and asking a good question

Science as a human endeavour and science inquiry · Chapters 1–2 · Subtopics 1A, 1B, 2A and 2B · Codes VC2S8H01, VC2S8H02 and VC2S8I01

> **Total: 30 marks** · Section A (multiple choice): 8 marks · Section B (short/structured response): 22 marks
>
> **17 of the 30 marks are science inquiry marks** (code `VC2S8I01`).
>
> **Planned for about 35 minutes. This paper is untimed — there is no time to beat.**
>
> This is a school-designed paper. It is not a VCAA instrument. Achievement at Levels 7 and 8 is reported against the Victorian Curriculum achievement standard on teacher judgement; the marks here are one source of evidence towards that judgement.

Conditions

- Completion is **untimed**. The 35 minutes is planning guidance only; take as long as you need.
- **Reading support** is permitted. Your teacher may read any question out to you if you need it. Reading is not what is being looked at, and your teacher will not help with the answer.
- **No calculator is required.** Nothing on this paper needs one. No formula sheet. No reading time.
- Answer every question. For multiple-choice questions, circle the letter of the best answer. There is only one best answer for each question.

In this test you will:

- explain how new evidence can change scientific knowledge (Q1–Q3, Q9, Q10)
- discuss how different skills, perspectives and worldviews shape science (Q4, Q5, Q11)
- tell correlation from causation, and use the four checks for "X causes Y" (Q6, Q15)
- pose pattern questions and relationship questions (Q7, Q8, Q13)
- use a hypothesis and a reasoned prediction with a real earthquake record, and test a model's predictions (Q12, Q14)

Section A — Multiple choice (8 marks)

Each question is worth 1 mark. Circle the letter of the best answer.

Q1 *(1 mark · VC2S8H01)* You first group a tiny animal with spiders because you cannot see its legs clearly. A new scan shows that it has six legs, like insects. What should you do?

A. Keep it with spiders because the older grouping came first. B. Move it closer to insects based on the new body evidence. C. Sort it only by how small it is. D. Create a new group based only on its size.

Q2 *(1 mark · VC2S8H01)* You learn that a juvenile sea animal and an adult sea animal were given separate species names because their bodies look different. New observations show that the juvenile grows into the adult. How should the classification be refined?

A. Retain both species names because the life stages look different. B. Classify the animals mainly by water depth. C. Call the adult a new group because it is larger. D. Treat them as life stages of one species and review the two names.

Q3 *(1 mark · VC2S8H01)* You have two plant specimens that were classified together because their leaves look alike. A closer study shows that one produces cones and the other produces flowers. What does this new evidence suggest?

A. They must be closely related because their leaves look alike. B. Their original grouping can never change. C. Their relationship should be re-examined using reproductive features. D. They should be classified only by leaf size.

Q4 *(1 mark · VC2S8H02)* You care especially about native frogs living near a new road. Which research question matches that concern?

A. How do different roadside lights affect frog movement at night? B. Which road paint dries fastest? C. How do drivers choose a parking place? D. Which road surface is easiest to sweep?

Q5 *(1 mark · VC2S8H02)* You read an overseas study saying that a leaf beetle eats only a target weed. Local land managers say that closely related native plants grow near the release area. What is the most sensible next step?

A. Assume that overseas results will always be identical in the local area B. Ignore the native plants because the target weed is invasive C. Test whether the beetle feeds on the local native plants before release D. Release the beetle first and identify native plants later

Q6 *(1 mark · VC2S8I01)* You notice that classmates carrying umbrellas often also wear raincoats. Which conclusion is safest?

A. Carrying an umbrella causes people to wear raincoats. B. Rainy weather may lead people to use both umbrellas and raincoats. C. People who use umbrellas dislike sunny weather. D. Wearing a raincoat causes people to carry umbrellas.

Q7 *(1 mark · VC2S8I01)* You want to change the question ‘Does jogging make your heart work harder?’ into one you can test by measuring your pulse. Which version is best?

A. Does jogging make people healthier? B. Why does a pulse change after exercise? C. How do running speed and running time affect a pulse? D. How does jogging for 0, 2, or 4 minutes affect the number of pulse beats you count in 30 seconds immediately afterward?

Q8 *(1 mark · VC2S8I01)* You have identical cups, each starting with 300 millilitres of water at 68 degrees Celsius. You will wrap the cups in foam sleeves of different thicknesses. Which question makes the cooling outcome specific?

A. How does foam thickness of 3, 7, or 11 millimetres affect the fall in water temperature in degrees Celsius after 15 minutes? B. Which sleeve keeps water warmest? C. How does cup colour affect how warm the water feels? D. How do foam thickness and cup material together affect cooling?

Section B — Short/structured response (22 marks)

Q9 *(3 marks · VC2S8H01)* An organism was first classified as a plant. New evidence shows that it cannot make its own food from sunlight, and that its outer wall is made of a different material from a plant’s cell wall.

(a) State what scientists should now do with the organism’s classification. *(1 mark)*
(b) Explain why. *(1 mark)*
(c) State what this case shows about scientific knowledge in general. *(1 mark)*

Q10 *(2 marks · VC2S8H01)* Geoscience Australia measures the motion of Australia’s landmass using satellites and GPS. It reports that Australia’s landmass moves north-east about 7 cm per year.

Source: Geoscience Australia, “Earthquake”, 2025, ga.gov.au — retrieved 2026-08-21 (Australia’s landmass moves north-east about 7 cm per year).

(a) Name the theory that this measurement tests. *(1 mark)*
(b) Explain what a measurement like this adds to the theory today. *(1 mark)*

Q11 *(3 marks · VC2S8H02)* In Manizales, Colombia, from the 1840s, settlers built two-storey houses in a style later named *estilo temblorero* — “earthquake-shaking style”. The lower floor was rigid, made of packed earth; the upper floor was *bahareque*, a light frame of bamboo packed with earth and plastered.

(a) State two features of an *estilo temblorero* house that help it survive an earthquake. *(2 marks)*
(b) Explain what this case shows about whose knowledge can contribute to science and engineering. *(1 mark)*

The record below is real.

Q12 *(4 marks · VC2S8I01)* On 22 September 2021, at about 9:15 am, an earthquake of magnitude 5.9 struck about 53 km south-southeast of Mansfield, near Woods Point. It did minor structural damage: chimneys and building fronts

were damaged in and around Melbourne. In early October 2021, much smaller earthquakes of magnitude 2.9 and 3.0 near Rawson were felt by people close by, with no damage reported.

Source: Wikipedia, "2021 Mansfield earthquake", 2026 (magnitude and depth as recorded by Geoscience Australia), en.wikipedia.org — retrieved 2026-08-21.

Consider the hypothesis: *earthquakes of greater magnitude cause more damage.*

(a) Name the two variables in this hypothesis. *(1 mark)*
(b) Write a reasoned prediction from this hypothesis about the Mansfield record, in the form "If … then …". *(2 marks)*
(c) Do the Mansfield records support the hypothesis? State how. *(1 mark)*

SCENARIO — invented for skills practice.

Q13 *(3 marks · VC2S8I01)* A class sets up a rain gauge and a thermometer in the school yard and records the rainfall and the air temperature each day for one term.

(a) Write one pattern question the class could ask about its record. *(1 mark)*
(b) Write one relationship question the class could ask. Your question must say what is changed or watched and what is measured. *(2 marks)*

Q14 *(4 marks · VC2S8I01)* A sealed syringe holds a sample of air. An identical sealed syringe holds a sample of water. The particle model of matter says that gas particles are far apart and liquid particles are close together.

(a) Use the model to predict what happens when each plunger is pushed. *(2 marks)*
(b) A careful test gives a result that disagrees with the model. State what should happen to the model. *(1 mark)*
(c) Particles are far too small to see directly. Explain how scientists can still test a model of something they cannot see. *(1 mark)*

Q15 *(3 marks · VC2S8I01)* A gardener plays music to her tomato plants every day for one month. At the end of the month, the plants are taller than the plants she grew last year without music. She says: "Music made my tomatoes grow taller." Use the four checks for "X causes Y".

(a) State one check her claim fails, and explain why. *(1 mark)*
(b) State a second check her claim fails, and explain why. *(1 mark)*
(c) Describe one change to her method that would make the claim testable. *(1 mark)*

Marking guide

This guide is written for a teacher marker — no specialist science background beyond Chapters 1 and 2 of this book is needed. Award a mark when the student's answer matches an acceptable response below or says the same idea in other words. Do not award half marks. The marks are a record that evidence was seen; they are not used to rank students.

Test A — Section A — Multiple choice

Q	Answer	Code	Source
Q1	**B**	VC2S8H01	bank item VC2S8H01.E01.S01.D1.V04
Q2	**D**	VC2S8H01	bank item VC2S8H01.E01.S01.D2.V03
Q3	**A**	VC2S8H01	bank item VC2S8H01.E01.S01.D1.V05
Q4	**C**	VC2S8H02	bank item VC2S8H02.E01.S01.D1.V02
Q5	**A**	VC2S8H02	bank item VC2S8H02.E02.S01.D1.V06
Q6	**D**	VC2S8I01	bank item VC2S8I01.E01.S01.D1.V01
Q7	**B**	VC2S8I01	bank item VC2S8I01.E02.S01.D1.V03
Q8	**C**	VC2S8I01	bank item VC2S8I01.E02.S01.D2.V11

All eight items are drawn from the MCQ bank under the codes assessed on this paper; none is drawn from a neighbouring code. Items mix easy (D1) and medium (D2) bank difficulties. Items are printed with their stem and options word for word; only the positions of the options have changed for this paper (the bank stores correct answers weighted toward position A, and a printed paper needs the answers spread out).

Why each answer is correct, in brief:

- **Q1 B** — one fossil is evidence to compare traits with and review the links between groups; “every” and “proves” claim more than one fossil can show.
- **Q2 D** — refining a classification means treating a single feature as one clue among several, not as final proof.
- **Q3 A** — classification follows body evidence (gills, a cartilage skeleton), not a name or a size.
- **Q4 C** — a scientist who puts animal comfort first asks about an effect on the animal itself: quieter collars and koala resting time.
- **Q5 A** — both views are recorded because benefits and possible harms can matter to different people; the views are not weighed equally regardless of evidence, and first-to-comment does not decide.
- **Q6 D** — the togetherness is a correlation; the sensible reading is a third factor (more time in the sun) affecting both, not one causing the other.
- **Q7 B** — the question names what is changed (ramp height: 6, 16 or 26 cm) and what is measured (distance travelled), matching the plan exactly.
- **Q8 C** — “bends a lot” becomes measurable once it has named values (50, 100 or 150 g) and a unit (millimetres of downward bend).

Test A — Section B — Short/structured response

Q9 *(3 marks · VC2S8H01)* (a) any two of: the jigsaw fit of the South American and African coastlines; matching *Glossopteris* fossils on southern lands now separated by oceans; traces of old climates on lands now in warm latitudes. *2 marks* (1 mark each). (b) a working mechanism — sea-floor spreading showed *how* the continents could move; Wegener could not say how. *1 mark* Accept "a mechanism" or "an explanation of how the moving happens".

Q10 *(2 marks · VC2S8H01)* (a) a predicted element — one that had not yet been discovered but that the table said should sit in that place. *1 mark* (b) gallium turned up exactly where the table predicted, with the predicted properties — a prediction that came true is evidence that the table reflects something real, and that it can point to things not yet found. *1 mark* Accept any response that says the prediction matched what was found and that this is why trust grew. Do not require the numbers (relative atomic mass about 68 predicted, 69.723 found) — they are welcome but not needed.

Q11 *(3 marks · VC2S8H02)* (a) any two of: Professor Graeme Clark, surgeon-scientist, led the whole project; Dr Brian Pyman, ear surgeon, brought knowledge of the inner ear; Yit Chow Tong, researcher, worked out how pulses of electricity could carry pitch and loudness to the brain; the audiologist, a health professional who measures hearing, tested what the patient actually heard; Rod Saunders, who had lost his hearing, was the first person to receive the implant and gave the team the feedback that made it better. *2 marks* (1 mark each: the role and what it contributed must both be there). (b) the device needed several different kinds of knowledge — surgery, anatomy, engineering, measurement and lived experience — and no one person holds all of them. *1 mark* Accept any response that says the needed skills sit in more than one person.

Q12 *(4 marks · VC2S8I01)* (a) correlation. *1 mark* (b) check 1 — the two things do change together: both rise in the same months. *1 mark* The mark is for naming check 1 (or saying "they change together") as the check that passes. (c) any one named check with its matching reason, for example: check 3 — nobody has run the test in which only umbrella use is changed while everything else is kept the same; check 4 — there is no sensible story for how a piece of cloth in the rain could cause a cold; check 2 — the claim never shows the umbrellas came before the colds. *1 mark* Do not accept a check with the wrong reason attached. (d) cold, rainy weather: people buy umbrellas because it is raining, and in cold months people crowd indoors where cold germs pass from person to person. *1 mark* Accept any third factor that plausibly causes both, with the how. Marker note: the claim starts from a real correlation, so box 1 ticks and the claim must fail on a later box — this mirrors the four-checks work in subtopic 2A.

Q13 *(3 marks · VC2S8I01)* (a) for example: "How does the time of music played each day (0, 1 or 2 hours) affect the height the plant grows in two weeks?" *2 marks* — 1 mark for naming what will be changed (music played or not, or how much), 1 mark for naming what will be measured (growth: height, number of leaves, mass). The question must be one a test could answer; do not award the marks if the student keeps "like" or another unmeasurable idea. (b) a relationship question. *1 mark*

Q14 *(4 marks · VC2S8I01)* (a) a hypothesis is a proposed explanation, stated generally; a prediction states what you expect to observe in one particular test if the hypothesis is true. *1 mark* Accept any one correct distinction (general vs one test; explanation vs expected observation). (b) for example: "If stirring makes sugar dissolve faster, then in this test we should observe the sugar disappear sooner in the beaker that is stirred than in the beaker that is not stirred." *2 marks* — 1 mark for the if–then shape tied to the hypothesis, 1 mark for saying what would actually be observed. (c) the claim is too strong: a result that matches the prediction *supports* the hypothesis, but it does not prove it — a later test could still find otherwise. *1 mark* Accept "supported, not proved" in any wording.

Q15 *(3 marks · VC2S8I01)* (a) the bell ringing and the students coming out happen together every day, one just after the other. *1 mark* (b) the bell causes the students to come out — not the other way around. *1 mark* (c) any one named check with its matching reason, for example: check 2 — the bell rings *first*, seconds before the students come out, so the supposed cause comes after the supposed effect; check 3 — on a school holiday no students come out at all and the bell still rings, so changing only the "students" shows they are not needed; check 4 — there is no sensible story for how students walking into the yard could ring a bell in the building. *1 mark* Do not accept check 1 — the two things do change together, so check 1 passes.

Test B — Section A — Multiple choice

Q	Answer	Code	Source
Q1	**B**	VC2S8H01	bank item VC2S8H01.E01.S01.D1.V12
Q2	**D**	VC2S8H01	bank item VC2S8H01.E01.S01.D2.V15
Q3	**C**	VC2S8H01	bank item VC2S8H01.E01.S01.D1.V06
Q4	**A**	VC2S8H02	bank item VC2S8H02.E01.S01.D1.V12
Q5	**C**	VC2S8H02	bank item VC2S8H02.E02.S01.D2.V07
Q6	**B**	VC2S8I01	bank item VC2S8I01.E01.S01.D1.V02
Q7	**D**	VC2S8I01	bank item VC2S8I01.E02.S01.D1.V04
Q8	**A**	VC2S8I01	bank item VC2S8I01.E02.S01.D2.V02

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Why each answer is correct, in brief:

- **Q1 B** — new body evidence (six legs) moves the grouping; the first grouping is not kept just because it came first, and size is not the evidence at issue.
- **Q2 D** — when observations show that two named forms are life stages of one animal, the refinement is to treat them as one species and review the two names.
- **Q3 C** — reproductive features (cones or flowers) are stronger evidence of relationship than leaves that look alike; the new evidence means the grouping must be re-examined, not frozen.
- **Q4 A** — a concern for native frogs points to the question about frog movement; the other questions serve road workers, not frogs.
- **Q5 C** — an overseas result does not guarantee local safety, so the beetle is tested on the local native plants *before* release.
- **Q6 B** — the safest conclusion is a third factor (rainy weather) that may cause both; neither direction of causation is shown.
- **Q7 D** — the question names what is changed (jogging for 0, 2 or 4 minutes) and what is measured (pulse beats counted in 30 seconds), which makes it testable.
- **Q8 A** — the question names what is changed (foam thickness: 3, 7 or 11 mm) and the specific measured outcome (the fall in temperature, in degrees Celsius, after 15 minutes).

Test B — Section B — Short/structured response

Q9 *(3 marks · VC2S8H01)* (a) review it — move the organism out of the plants (reclassify it). *1 mark* (b) because the new evidence (it cannot make its own food from sunlight; its wall is not made of plant material) does not fit the plant grouping, and classification follows the best evidence available. *1 mark* (c) scientific knowledge changes when new evidence arrives — groupings are the best answer *at the time*, not fixed forever. *1 mark* Marker note: this is the fungi case from subtopic 1A in fresh clothing.

Q10 *(2 marks · VC2S8H01)* (a) plate tectonics. *1 mark* Accept "the theory that the plates move". (b) it is fresh, direct evidence that the plates are still moving — each new measurement checks the theory's prediction that the continents move, so the theory is still being tested today. *1 mark* Accept any response that says the measurement keeps testing or confirming the moving.

Q11 *(3 marks · VC2S8H02)* (a) any two of: the rigid packed-earth lower floor that took the shock; the flexible bamboo (*bahareque*) upper floor that bent and soaked up the shaking; the whole house swayed instead of snapping. *2 marks* (1 mark each). (b) knowledge from builders in other places and times — local, everyday knowing, not only laboratory science — can solve problems, and that local knowledge is now part of the world's engineering knowledge for building in earthquake country. *1 mark* Accept any response that says useful knowledge can come from people outside professional science.

Q12 *(4 marks · VC2S8I01)* (a) the magnitude of the earthquake, and the amount of damage it does. *1 mark* (b) for example: "If earthquakes of greater magnitude cause more damage, then the magnitude-5.9 Mansfield earthquake should have caused more damage than its magnitude-2.9 and 3.0 aftershocks near Rawson." *2 marks* — 1 mark for the if–then shape tied to the hypothesis, 1 mark for using the actual magnitudes from the record. (c) yes — the magnitude-5.9 earthquake did minor structural damage, while the 2.9 and 3.0 aftershocks did none, so the greater magnitude came with the greater damage. *1 mark*

Q13 *(3 marks · VC2S8I01)* (a) for example: "Which week of the term had the most rain?" or "Is there a pattern in the daily temperature across the term?" *1 mark* The question must ask *what is happening* — when, how often, or what shape — without testing one variable against another. (b) for example: "How does the air temperature (watched each day) relate to the rainfall measured that same day?" *2 marks* — 1 mark for naming the variable that is changed or watched, 1 mark for naming the variable that is measured. Marker note: the class cannot change the weather, so the "changed" variable here is a watched variable — subtopic 2A accepts pattern questions and relationship questions alike, and the relationship question only has to name its two variables.

Q14 *(4 marks · VC2S8I01)* (a) the air syringe: the plunger moves in — the air is squeezed into less space, because gas particles are far apart and can be pushed closer together. *1 mark* The water syringe: the plunger barely moves, because liquid particles are already close together. *1 mark* (b) the model is revised or replaced — when a result disagrees with a model, the model changes, not the result. *1 mark* (c) by testing what the model says should happen in a real experiment — if the predictions keep coming true, the model stands; a model of things we cannot see is tested through what it predicts we *can* see. *1 mark*

Q15 *(3 marks · VC2S8I01)* (a) and (b) any two named checks with their matching reasons, for example: check 3 — she did not change only the music: this year's and last year's plants also differ in weather, sunlight, soil and watering, so everything else was *not* kept the same; check 4 — there is no sensible story for how music could feed a plant or make it grow; check 1 — this year with music against last year without it is not enough record to show the two things changing together. *1 mark each* Do not accept check 2 — the music did come before the growth, so check 2 passes. (c) grow two similar groups of plants at the same time, one with music and one without, keeping light, water, soil and pots the same, and compare their growth. *1 mark* Accept any change that turns the claim into a fair test in which only the music differs.

Tracing the items to the achievement standard

Every item traces to the achievement-standard extract of the subtopic that owns its code (§4.1 of the plan of record). The extracts are quoted as the authority file gives them. `VC2S8I01` is split-delivered: 2A owns the questions clause and 2B the predictions clause; both cite the same extract.

Code	Subtopic	Achievement-standard extract	Test A items	Test B items
VC2S8H01	1A	"students explain how new evidence can lead to changes in scientific knowledge."	Q1, Q2, Q3, Q9, Q10	Q1, Q2, Q3, Q9, Q10
VC2S8H02	1B	"They discuss how people with different understandings, skills, perspectives and worldviews have worked in multidisciplinary teams to develop scientific knowledge."	Q4, Q5, Q11	Q4, Q5, Q11
VC2S8I01	2A and 2B	"Students develop hypotheses and make reasoned predictions to identify patterns, test relationships and analyse and evaluate scientific models when investigating phenomena at various scales."	Q6, Q7, Q8, Q12, Q13, Q14, Q15	Q6, Q7, Q8, Q12, Q13, Q14, Q15

Inquiry weighting: 17 of the 30 marks on each paper sit on VC2S8I01 (Section A Q6–Q8 and Section B Q12–Q15) — above the required minimum of 5 inquiry-strand marks per topic test (D7).

Mark record — Test A

Question	Code	Worth	Given
Q1 — new evidence and classification	VC2S8H01	1	
Q2 — refining a classification	VC2S8H01	1	
Q3 — grouping by body evidence	VC2S8H01	1	
Q4 — values shape the question asked	VC2S8H02	1	
Q5 — recording both views	VC2S8H02	1	
Q6 — correlation is not causation	VC2S8I01	1	
Q7 — question matches the plan	VC2S8I01	1	
Q8 — making an outcome measurable	VC2S8I01	1	
Q9 — drift to plate tectonics	VC2S8H01	3	
Q10 — Mendeleev’s gaps and gallium	VC2S8H01	2	
Q11 — the bionic ear team	VC2S8H02	3	
Q12 — four checks on a causal claim	VC2S8I01	4	
Q13 — sharpening a question	VC2S8I01	3	
Q14 — hypothesis, prediction, proof	VC2S8I01	4	
Q15 — which way the causal arrow runs	VC2S8I01	3	
Total		**30**	

Mark record — Test B

Question	Code	Worth	Given
Q1 — new evidence moves a grouping	VC2S8H01	1	
Q2 — life stages and species names	VC2S8H01	1	
Q3 — reproductive features	VC2S8H01	1	
Q4 — concern shapes the question asked	VC2S8H02	1	
Q5 — testing before release	VC2S8H02	1	
Q6 — safest conclusion from a correlation	VC2S8I01	1	
Q7 — sharpening a question	VC2S8I01	1	
Q8 — making the outcome specific	VC2S8I01	1	
Q9 — reclassifying an organism	VC2S8H01	3	
Q10 — measuring plate motion (real record)	VC2S8H01	2	
Q11 — bamboo houses and earthquakes	VC2S8H02	3	
Q12 — the Mansfield earthquake (real record)	VC2S8I01	4	
Q13 — pattern and relationship questions	VC2S8I01	3	
Q14 — putting a model to the test	VC2S8I01	4	
Q15 — four checks on a gardener’s claim	VC2S8I01	3	
Total		**30**	