

Science 9–10

Chapter 6 — Communicating

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The scientific report: structure, conventions, scientific vocabulary and referencing

Chapter 6 — Communicating (Science, Levels 9 and 10)

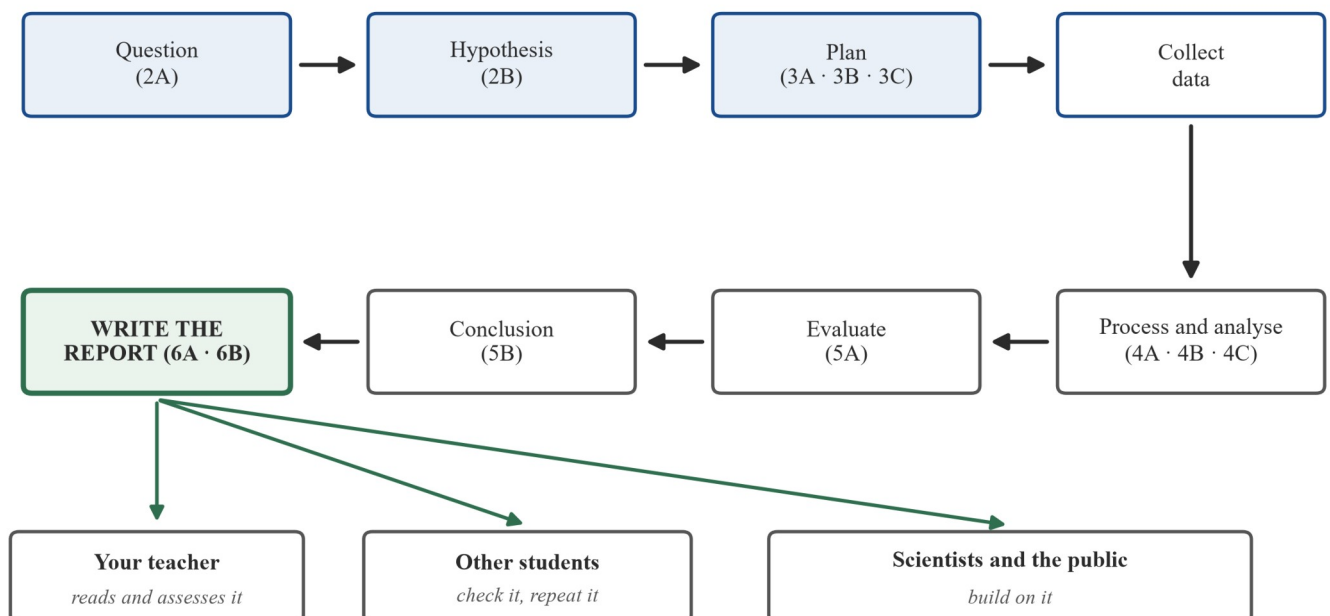
Subtopic 6A · VC2 Science Inquiry Skills — Communicating

CD code: VC2S10I08 † (split delivery — this subtopic is the owner: report structure, conventions, vocabulary and referencing; Subtopic 6B is the partner and delivers format and representation choice for diverse audiences) **Content description (verbatim):** “communicating and justifying scientific ideas, findings and arguments for diverse audiences involves the selection of appropriate presentation formats, content, scientific vocabulary, conventions, models and other representations, and may include the use of digital tools” **Elaboration ids drawn on:** VC2S10I08.E01 · VC2S10I08.E05 **Achievement standard (verbatim):** “They select and use appropriate presentation formats, scientific content, vocabulary, models, conventions, formulas and other representations to achieve their purpose when communicating and justifying their ideas, findings, arguments and proposals to diverse audiences.” **Maths interlocks (D11):** VC2M9M04 — calculate and interpret absolute, relative and percentage errors in measurements (the discussion’s comparison with an accepted value uses exactly that maths).

All datasets in this subtopic are simulated data for practice.

Theory

The report is where the work becomes public. Every investigation in this book follows the same inquiry sequence — a question (2A), a hypothesis (2B), a plan (3A · 3B · 3C), collected data, processing and analysis (4A · 4B · 4C), evaluation (5A) and a conclusion (5B). Everything up to that point is your own work, and it stays your own work until it is written up. The **report** is the step where the work becomes public: a written account that any reader can follow, check, repeat and build on. That is what this subtopic teaches you to write.

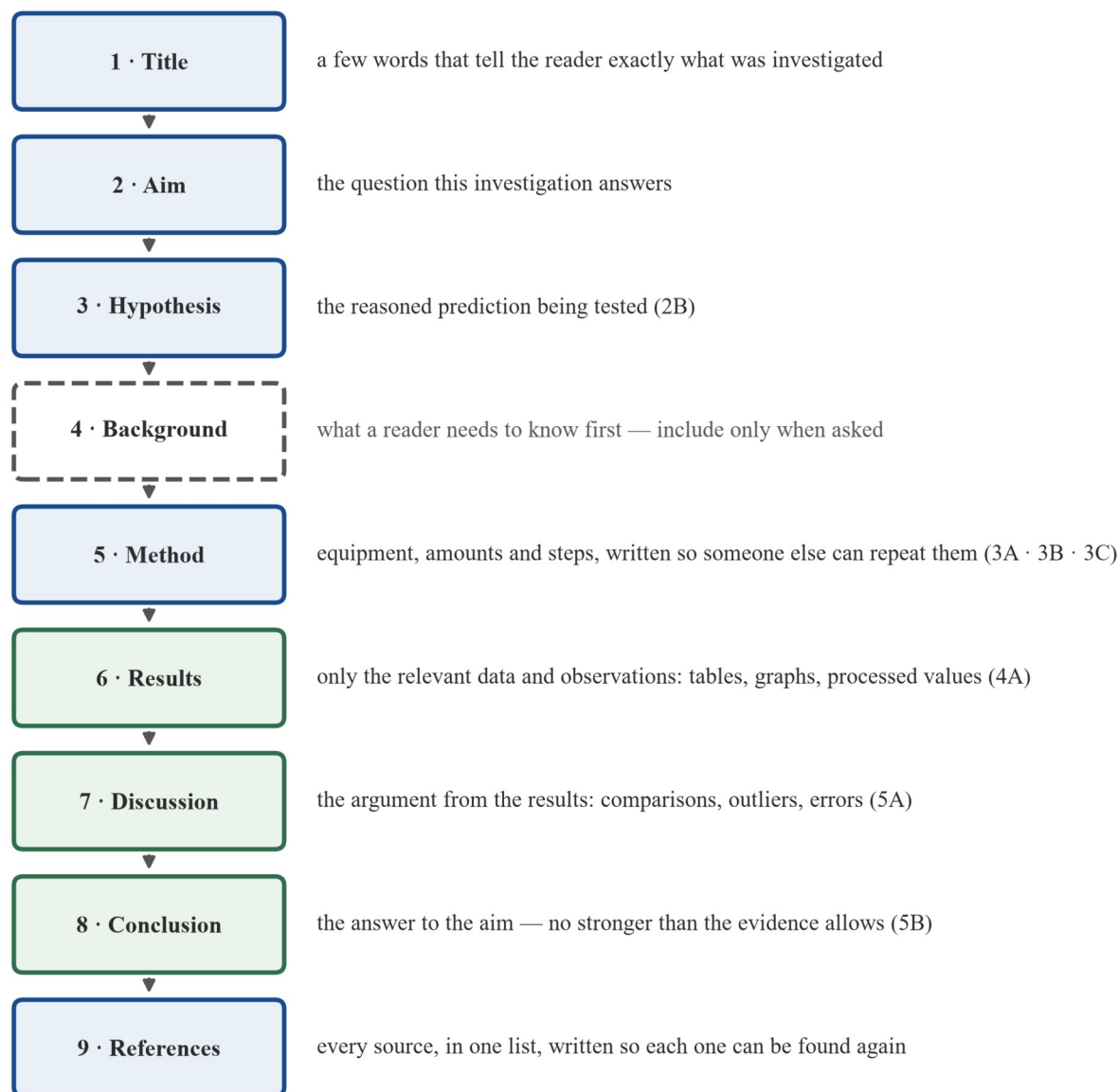


Every earlier step is your own work. The report is where that work becomes public — written so any reader can follow it, check it, repeat it and build on it.

The inquiry sequence as eight linked boxes: Question (2A), Hypothesis (2B), Plan (3A · 3B · 3C) and Collect data across the top, then Process and analyse (4A · 4B · 4C), Evaluate (5A), Conclusion (5B) and a highlighted WRITE THE REPORT (6A · 6B) box along the bottom. Below, three readers of a school report: your teacher, who reads and assesses it; other students, who check it and repeat it; and scientists and the public, who build on it

A school report has at least three readers, and each reads it for a different reason: your teacher reads and assesses it; other students read it to check your work and repeat it; and scientists — and the public — read reports to build on them. All three readers need the same thing from you: a report in a standard shape, with standard conventions, so they can find what they need without guessing. Which *format* suits which audience — report, poster, infographic, presentation — is Subtopic 6B’s job. This subtopic builds the report itself, the format every other format draws on.

The anatomy of a report. A school investigation report has a standard shape. Templates differ between schools, but the job each section does is the same, and the jobs are what matter.



One standard shape for a school investigation report. Templates differ between schools —
the job each section does is the same.

The nine sections of a school investigation report in order, each with its job: 1 Title — a few words that tell the reader exactly what was investigated; 2 Aim — the question this investigation answers; 3 Hypothesis — the reasoned prediction being tested (2B); 4 Background (shown as optional) — what a reader needs to know first, include only when asked; 5 Method — equipment, amounts and steps, written so someone else can repeat them (3A · 3B · 3C); 6 Results — only the relevant data and observations: tables, graphs, processed values (4A); 7 Discussion — the argument from the results: comparisons, outliers, errors (5A); 8 Conclusion — the answer to the aim, no stronger than the evidence allows (5B); 9 References — every source, in one list, written so each one can be found again

Read the anatomy as a division of labour. The **title** names the investigation in a few words; the **aim** states the question; the **hypothesis** states the reasoned prediction being tested (2B); the **method** is written so someone else can

repeat it exactly (3A); the **results** carry only the relevant data and observations; the **discussion** argues from those results; the **conclusion** answers the aim; and the **references** list every source so each one can be found again. A background section appears only when a reader genuinely needs prior knowledge to follow the report — many school reports do not need one. The three sections that carry the argument — results, discussion, conclusion — are the heart of the report, and the rest of this subtopic is about them.

What goes where. The single most common report fault is not bad science but bad sorting: results argued in the discussion, argument leaked into the results, conclusions that never appear in the discussion. Every sentence you write has exactly one home, and sorting your sentences before you write is the fix. Here is the sort, using the running investigation of this subtopic — the bounce height of a tennis ball dropped from four heights on a hard floor.

Method	Results	Discussion	Conclusion
A tennis ball was dropped from heights of 0.50, 1.00, 1.50 and 2.00 m.	Mean bounce height at a 1.00 m drop: 0.72 m.	Bounce height was about 0.7 times the drop height, as predicted.	As drop height increased, bounce height increased.
The ruler was held vertical and read at eye level.	Raw readings at the 1.50 m drop: 1.02, 1.05, 1.08 m.	Parallax when reading the ruler may have made some readings a little high.	The aim was answered: drop height sets bounce height for this ball.

Every sentence has exactly one home. Sorting your sentences before you write keeps results out of the discussion — and argument out of the results.

Eight sentences sorted under four section headings. Method: “A tennis ball was dropped from heights of 0.50, 1.00, 1.50 and 2.00 m” and “The ruler was held vertical and read at eye level.” Results: “Mean bounce height at a 1.00 m drop: 0.72 m” and “Raw readings at the 1.50 m drop: 1.02, 1.05, 1.08 m.” Discussion: “Bounce height was about 0.7 times the drop height, as predicted” and “Parallax when reading the ruler may have made some readings a little high.” Conclusion: “As drop height increased, bounce height increased” and “The aim was answered: drop height sets bounce height for this ball.”

Check the logic of the sort. “The ruler was held vertical and read at eye level” says what was *done* — Method. “Mean bounce height at a 1.00 m drop: 0.72 m” says what was *found* — Results, no argument attached. “Bounce height was about 0.7 times the drop height, as predicted” compares the results with the prediction — that is an argument, so Discussion. “Parallax when reading the ruler may have made some readings a little high” names a possible source of error and its effect — also Discussion (parallax is the shift in a reading when the scale is read from an angle rather than eye level). And “As drop height increased, bounce height increased” answers the aim in one line — Conclusion. The test to apply to every sentence is: *is this what was done, what was found, what it means, or what it answers?*

Results: tables and their conventions (elaboration VC2S10I08.E01). Elaboration VC2S10I08.E01 is about writing a report “ensuring only relevant data and observations are reported in the results”. The results section reports — it never argues, never explains, and never gives an opinion. The table below carries the bounce data, and the flags on it are the conventions every results table in this book follows.

Table 1. Bounce height of a tennis ball dropped from four heights on a hard floor
(simulated data for practice)

Drop height (m)	Trial 1 (m)	Trial 2 (m)	Trial 3 (m)	Mean bounce height (m)
0.50	0.36	0.38	0.40	0.38
1.00	0.70	0.72	0.74	0.72
1.50	1.02	1.05	1.08	1.05
2.00	1.32	1.36	1.40	1.36

Means worked from the three trials, e.g. first row: $(0.36 + 0.38 + 0.40) \div 3 = 0.38$ m.

number and caption sit
above the table

units in every
column heading

all readings to the same
number of decimal places

processed values (means)
sit beside the raw trials

only data and observations —
no opinions, no explanations

The results section reports. Every opinion and every explanation of these numbers belongs in the discussion.

An annotated results table, “Table 1. Bounce height of a tennis ball dropped from four heights on a hard floor (simulated data for practice)”. Columns: Drop height (m), Trial 1 (m), Trial 2 (m), Trial 3 (m), Mean bounce height (m). Rows: 0.50 m drop with trials 0.36, 0.38, 0.40 and mean 0.38; 1.00 m with 0.70, 0.72, 0.74 and mean 0.72; 1.50 m with 1.02, 1.05, 1.08 and mean 1.05; 2.00 m with 1.32, 1.36, 1.40 and mean 1.36. A working line shows the first mean: $(0.36 + 0.38 + 0.40) \div 3 = 0.38$ m. Five flags: number and caption sit above the table; units in every column heading; all readings to the same number of decimal places; processed values (means) sit beside the raw trials; only data and observations — no opinions, no explanations

Five conventions, each with a reason. The **number and caption sit above the table**, so a reader meets the table already knowing what it is. **Units go in every column heading**, which keeps the body of the table to bare numbers — “0.38”, not “0.38 m”, because the heading already says metres. **All readings run to the same number of decimal places**, because the decimal places record the precision of the instrument (3C), and mixing them would pretend the precision changed mid-experiment. **Processed values sit beside the raw trials** — the mean of each row is worked from the three trials, e.g. $(0.36 + 0.38 + 0.40) \div 3 = 0.38$ m, and a reader can check every one. And the table holds **only data and observations**: no opinions (“which was cool”), no explanations (“parallax may have...”). Those belong to the discussion.

Results: figures and their conventions. The same data, drawn. A figure has its own conventions, and two of them are the mirror image of the table’s.

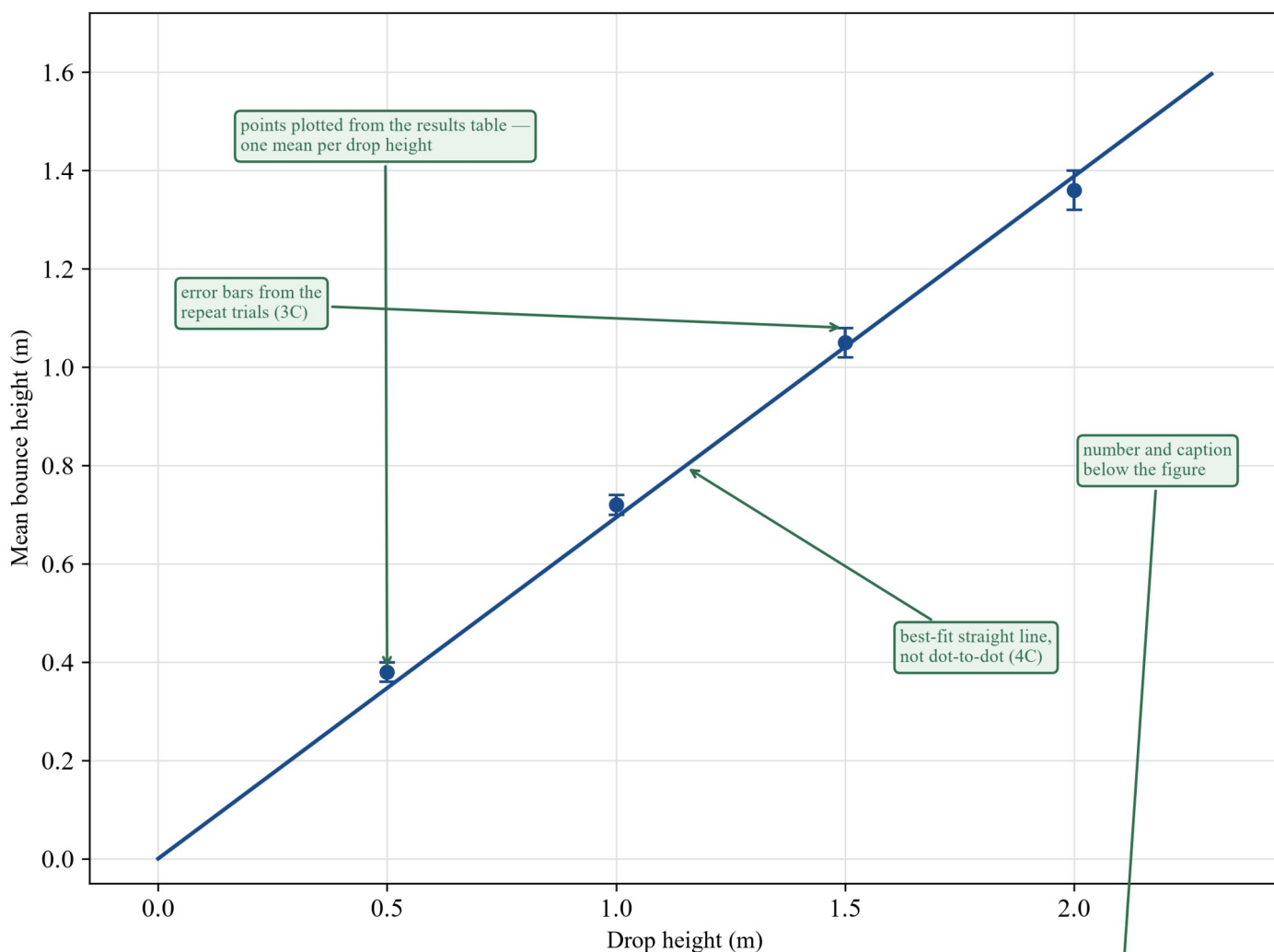


Figure 1. Mean bounce height of a tennis ball against drop height on a hard floor.

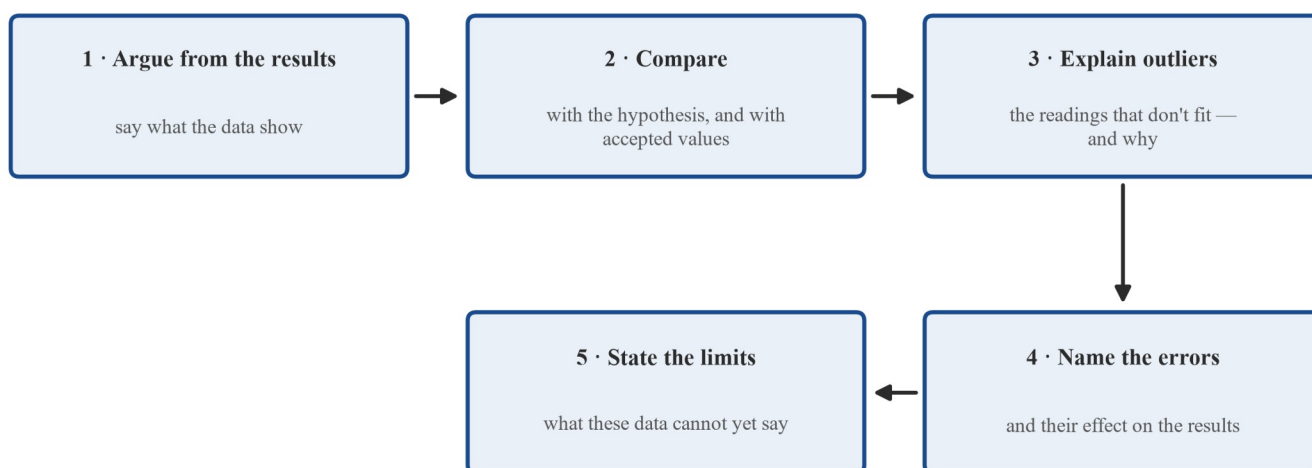
Error bars show half the range of three trials (simulated data for practice).

Every axis carries its quantity and its unit — a reader must never have to guess what is plotted.

An annotated graph of the bounce data: mean bounce height (m) on the vertical axis against drop height (m) on the horizontal axis, four points with error bars at (0.50, 0.38), (1.00, 0.72), (1.50, 1.05) and (2.00, 1.36), and a best-fit straight line through the origin. Flags: points plotted from the results table — one mean per drop height; error bars from the repeat trials (3C); best-fit straight line, not dot-to-dot (4C); and number and caption below the figure. Below the frame: “Figure 1. Mean bounce height of a tennis ball against drop height on a hard floor. Error bars show half the range of three trials (simulated data for practice). Every axis carries its quantity and its unit — a reader must never have to guess what is plotted.”

The **number and caption sit below the figure** — above for tables, below for figures, and never swapped. **Every axis carries its quantity and its unit**, because a reader must never have to guess what is plotted. The **points come straight from the results table** — one mean per drop height — so the figure and the table agree exactly. The **error bars come from the repeat trials**: half the range of the three trials, the $\pm$ uncertainty of Subtopic 3C (± 0.02 , 0.02 , 0.03 and 0.04 m here). And the line is a **best-fit straight line, not dot-to-dot (4C)**: the trend, not a join-the-dots picture of the scatter. Tables and figures are representations chosen to do a job (4A) — the table for exact values, the figure for the pattern — and the conventions are what make either one checkable.

The discussion does the arguing (elaboration VC2S10I08 .E01). If the results report, the discussion argues. Elaboration VC2S10I08 .E01 names what a discussion must contain: an argument based on the results, comparisons related to accepted values, an explanation of outliers, and the effect of possible sources of error. Those become five moves.



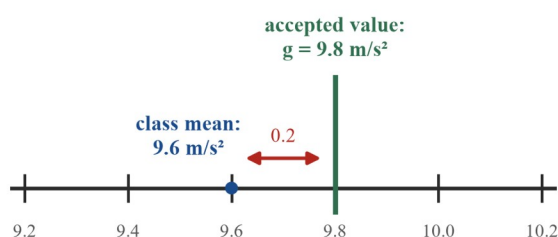
The five moves of a discussion, from VC2S10I08.E01. A discussion is an argument about the results — not a second results section.

The five moves of a discussion as five linked boxes in a loop: 1 Argue from the results — say what the data show; 2 Compare — with the hypothesis, and with accepted values; 3 Explain outliers — the readings that don't fit, and why; 4 Name the errors — and their effect on the results; 5 State the limits — what these data cannot yet say

Move 1 says what the data show, in plain trend language: bounce height rose from 0.38 m to 1.36 m as drop height rose from 0.50 m to 2.00 m — roughly 0.7 times the drop height (the ratios run 0.76, 0.72, 0.70, 0.68). Move 2 compares: with the hypothesis (“as predicted” or “not, and here is where”), and with any accepted value. Move 3 explains **outliers** — readings that sit far outside the pattern of the repeats — instead of quietly deleting them: a reading is only discarded with a stated reason, and an undocumented deletion is a flaw in the report, not a tidy-up. Move 4 names the errors and their likely effect: parallax reading the ruler may have pushed some readings a little high; reaction time in judging the top of the bounce scatters the trials. Move 5 states the limits: one ball, one floor, four heights — what these data cannot yet say. A discussion is an argument *about* the results, not a second results section: if a sentence repeats a number without adding a comparison, an explanation or a limit, it belongs back in the results.

Comparing with an accepted value (VC2M9M04). Move 2's comparison with an accepted value uses the maths of VC2M9M04: absolute error and percentage error. Suppose a class measures the gravitational field strength as $g = 9.6 \text{ m/s}^2$, where the accepted value is 9.8 m/s^2 .

A class result meets the accepted value



The comparison, in two numbers

$$\text{absolute error} = |\text{measured} - \text{accepted}|$$

$$= |9.6 - 9.8| = 0.2 \text{ m/s}^2$$

$$\text{percentage error} = (0.2 \div 9.8) \times 100$$

$$= 2.0\%$$

Close enough to trust, small enough to explain — the discussion must do both.

Comparing with an accepted value, with the VC2M9M04 maths: absolute error and percentage error.

A number line from 9.2 to 10.2 with the class mean 9.6 m/s² marked as a point and the accepted value $g = 9.8 \text{ m/s}^2$ as a green line, a red double arrow of 0.2 between them, and a panel working the comparison in two numbers: absolute error = $|\text{measured} - \text{accepted}| = |9.6 - 9.8| = 0.2 \text{ m/s}^2$; percentage error = $(0.2 \div 9.8) \times 100 = 2.0\%$. Caption: close enough to trust, small enough to explain — the discussion must do both

The absolute error is $|9.6 - 9.8| = 0.2 \text{ m/s}^2$, and the percentage error is $(0.2 \div 9.8) \times 100 = 2.0\%$. Two per cent is a small gap — close enough to trust, and small enough to explain with the ordinary errors of a classroom method (the ruler's precision, judging the top of the bounce). The comparison sentence writes itself: *the class value sits 0.2 m/s² (2.0%) below the accepted value, within what the method's errors can explain*. That is the whole of move 2 for an accepted-value comparison — a number, a percentage, and an honest sentence about whether the gap is bigger than the errors.

The conclusion: match the strength to the evidence. The conclusion answers the aim, and it may be no stronger than the evidence allows. Subtopic 5A fixed the test — compare the difference a claim rests on with the uncertainty of the data — and the same test sets the strength of a conclusion's *words*. Here are three candidate conclusions for the one dataset.

The evidence: one tennis ball, one hard floor, four drop heights. Mean bounce height rose from 0.38 m to 1.36 m as drop height rose from 0.50 m to 2.00 m (three trials each).

“This proves that every ball always bounces to 0.7 times its drop height.”

too strong

One ball, one floor, four heights. Data can support a pattern — they never prove it for every case.

“For this ball on this floor, bounce height increased with drop height — about 0.7 times the drop height over the range tested.”

just right

Says exactly what was tested, and no more.

“The results are not much help for answering the aim.”

too weak

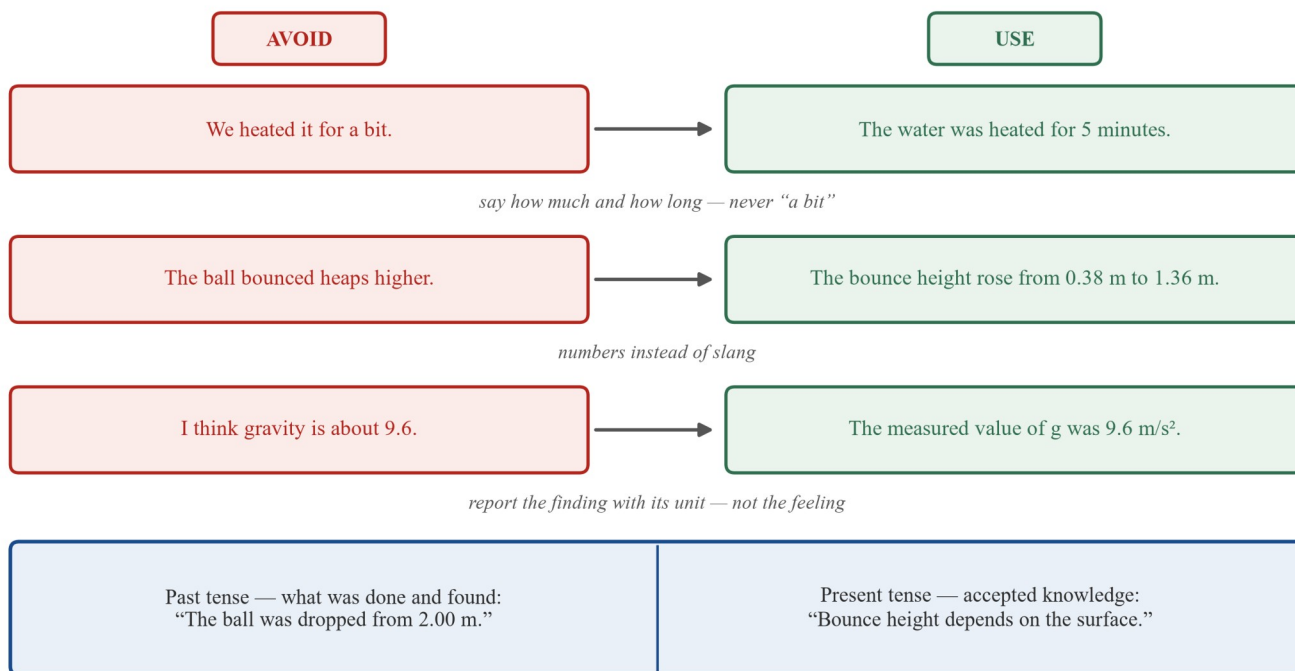
The trend is clear, and far bigger than the spread of the trials.

Match the conclusion to the evidence (5A). Stronger words do not make stronger science.

One evidence strip — one tennis ball, one hard floor, four drop heights, mean bounce height rising from 0.38 m to 1.36 m as drop height rose from 0.50 m to 2.00 m, three trials each — against three candidate conclusions. “This proves that every ball always bounces to 0.7 times its drop height” is judged too strong: one ball, one floor, four heights; data can support a pattern, they never prove it for every case. “For this ball on this floor, bounce height increased with drop height — about 0.7 times the drop height over the range tested” is judged just right: says exactly what was tested, and no more. “The results are not much help for answering the aim” is judged too weak: the trend is clear, and far bigger than the spread of the trials

The first conclusion overclaims: “proves”, “every ball”, “always” — words the single ball and single floor cannot carry. The third underclaims: the trend is clear and far bigger than the spread of the trials, so “not much help” throws away real evidence. The middle one is the model: it says *what* was tested (this ball, this floor), *what* was found (bounce height increased with drop height, about 0.7 times it), and *where it holds* (over the range tested). Stronger words do not make stronger science — the strongest conclusion is the one that matches the evidence exactly (5B).

Register: precise, and keeping the writer out. Scientific writing has a register — a fixed, formal style whose rules are the same in every report. The rules are short: say how much and how long, never “a bit”; numbers instead of slang; report the finding with its unit, not the feeling; and keep the writer out of the sentence, because the reader is interested in the ball, not in you.



Scientific register: precise, impersonal and consistent — the same words mean the same thing everywhere in the report.

Three avoid/use pairs of register. Avoid “We heated it for a bit” — use “The water was heated for 5 minutes” (say how much and how long — never “a bit”). Avoid “The ball bounced heaps higher” — use “The bounce height rose from 0.38 m to 1.36 m” (numbers instead of slang). Avoid “I think gravity is about 9.6” — use “The measured value of g was 9.6 m/s^2 ” (report the finding with its unit — not the feeling). Below, a tense panel: past tense for what was done and found — “The ball was dropped from 2.00 m”; present tense for accepted knowledge — “Bounce height depends on the surface.”

Tense is part of the register. What was done and found is written in the **past tense** — “the ball was dropped from 2.00 m”, “the mean bounce height was 0.72 m” — because it happened, once, in the lab. Accepted knowledge is written in the **present tense** — “bounce height depends on the surface” — because it is taken to hold generally. Mixing the two the wrong way round (“the ball is dropped”, as if it always is) blurs the line between your result and everyone’s knowledge — the same line the results/discussion split draws.

Scientific vocabulary: everyday words, stricter meanings. The CD asks for the selection of appropriate scientific vocabulary, and the first fact of scientific vocabulary is that ordinary words tighten their meaning in science. Four cases:

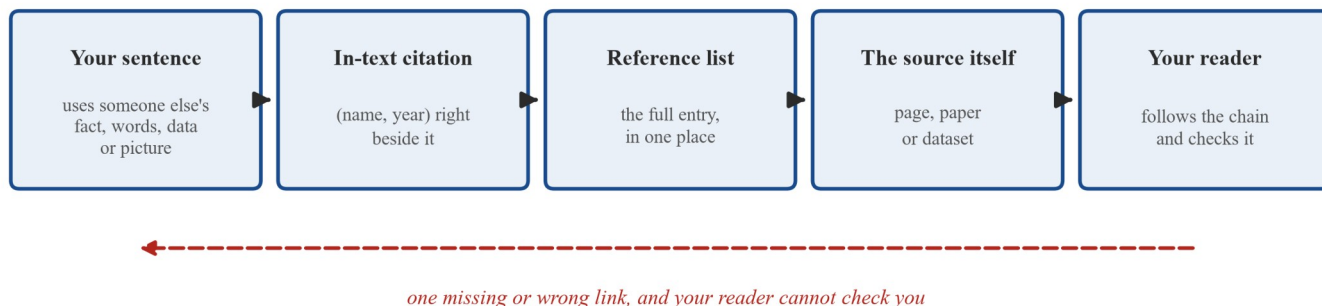
“theory” everyday: a guess — “I have a theory about that” science: a well-tested explanation that ties many findings together (1A)	“error” everyday: a mistake science: the difference between a reading and the true value (3C)
“significant” everyday: big, important science: larger than the uncertainty can explain (5A)	“melted” and “dissolved” everyday: used for both, mixed together science: melting — heat turns a solid to a liquid; dissolving — a solid mixes into a liquid

Everyday words wear stricter meanings in science. In a report the scientific meaning wins — and define any contested term the first time you use it.

Four cards giving everyday and scientific meanings. “theory”: everyday a guess — “I have a theory about that”; science a well-tested explanation that ties many findings together (1A). “error”: everyday a mistake; science the difference between a reading and the true value (3C). “significant”: everyday big, important; science larger than the uncertainty can explain (5A). “melted” and “dissolved”: everyday used for both, mixed together; science melting is heat turning a solid to a liquid, dissolving is a solid mixing into a liquid

In a report the scientific meaning wins, always. A **theory** is not a guess (1A); an **error** is not a mistake but the gap between a reading and the true value (3C); **significant** does not mean “big” but “larger than the uncertainty can explain” (5A) — the 4.0 mL towel difference against ± 2 mL in Subtopic 5A is significant in exactly this sense. And where a term is contested or new to the reader, the report defines it at first use. Precise vocabulary is not decoration: it is the difference between a reader who knows what you mean and a reader who guesses.

Referencing: the chain that makes a report checkable. Every report borrows — a fact, a number, a picture, a turn of phrase — and every borrow carries a debt: the reader must be able to find the source. Referencing is the chain that pays that debt.



Referencing is the chain that makes a report checkable — and honest.

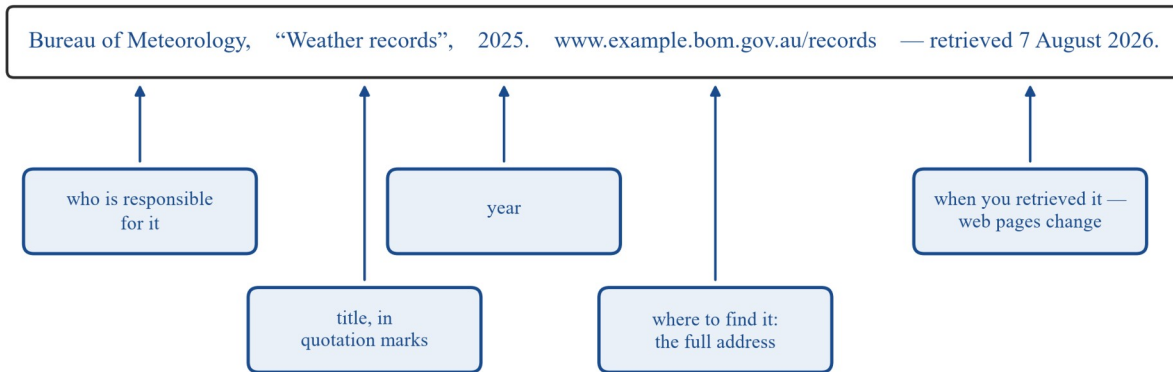
The referencing chain as five linked boxes: Your sentence — uses someone else's fact, words, data or picture; In-text citation — (name, year) right beside it; Reference list — the full entry, in one place; The source itself — page, paper or dataset; Your reader — follows the chain and checks it. A red dashed return arrow reads: one missing or wrong link, and your reader cannot check you

The chain runs from your sentence to the reader. The **in-text citation** — (name, year) — sits right beside the borrow; the **reference list** holds the full entry for every citation, in one place at the end; the entry points to **the source itself**; and the reader follows the chain and checks you. One missing or wrong link — a citation with no entry, an entry with no address, an address that leads nowhere — and the chain breaks, and the reader cannot check you. That is why referencing is not a chore bolted onto the end of a report: it is what makes a report honest *and* checkable. (The ethics of borrowing — including the cultural protocols that attach to some sources — is Subtopic 5B's teaching; this subtopic teaches the mechanics the ethics relies on.)

The parts of a reference-list entry. The entry has five parts, and the in-text citation must match the entry's name and year.

The coldest reading was 2.1 °C (Bureau of Meteorology, 2025).

in-text citation — must match
the entry's name and year



This is the format this book uses. Other styles exist — if your teacher sets a different one, follow theirs.

The parts of a reference-list entry, and the in-text citation that points to it.

The anatomy of a reference-list entry, shown as a practice example labelled “not a real publication”. A sentence — “The coldest reading was 2.1 °C (Bureau of Meteorology, 2025).” — carries the in-text citation, flagged as: must match the entry’s name and year. The entry itself is segmented and labelled: “Bureau of Meteorology,” — who is responsible for it; “Weather records”, — title, in quotation marks; 2025. — year; www.example.bom.gov.au/records — where to find it: the full address; — retrieved 7 August 2026. — when you retrieved it, because web pages change. Caption: this is the format this book uses; other styles exist — if your teacher sets a different one, follow theirs

Who is responsible; the title, in quotation marks; the year; where to find it — the full address; and when you retrieved it, because web pages change. The retrieval date is the part students most often drop and referees most often miss: a page read on one date may not exist on another, and the date says exactly which page you stand behind. Other referencing styles exist, and if your teacher sets one, follow theirs — the parts are the same parts in a different order.

Quoting and paraphrasing. There are two honest ways to borrow, and one dishonest one.

Quoting

- the exact words, in quotation marks
- the citation straight after

The handbook says: “Rinse the probe with distilled water between readings.”
(Lab Skills Guide, 2024)

(practice example)

use it for definitions and exact statements — rarely

Paraphrasing

- the idea, in your own words
- still needs a citation

The probe must be rinsed with distilled water between readings
(Lab Skills Guide, 2024).

(practice example)

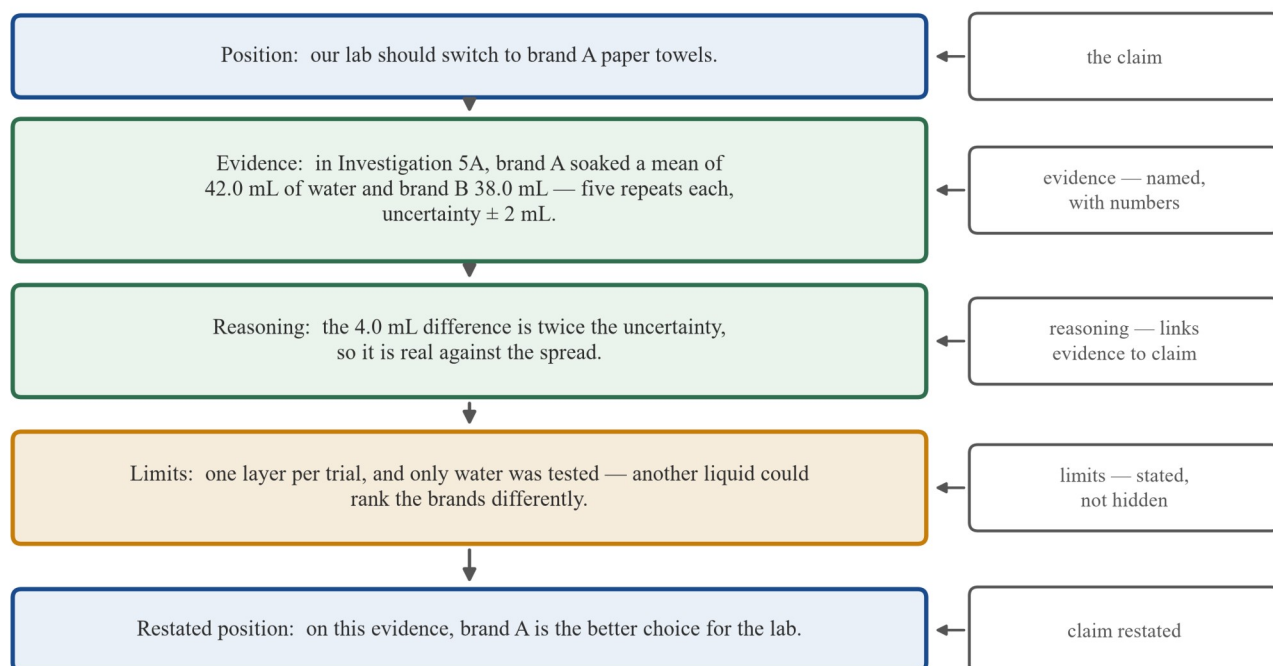
use it for almost every source you borrow from

Quotation marks say: these exact words are theirs. No quotation marks says: the words are mine, the idea is theirs.
Either way, the reader can find the source.

Two panels. Quoting: the exact words, in quotation marks, the citation straight after — example: The handbook says: “Rinse the probe with distilled water between readings.” (Lab Skills Guide, 2024) — use it for definitions and exact statements, rarely. Paraphrasing: the idea, in your own words, still needs a citation — example: The probe must be rinsed with distilled water between readings (Lab Skills Guide, 2024) — use it for almost every source you borrow from. Caption: quotation marks say these exact words are theirs; no quotation marks says the words are mine, the idea is theirs; either way, the reader can find the source

Quoting takes the exact words, in quotation marks, with the citation straight after — kept for definitions and exact statements, and rare in a school report. **Paraphrasing** takes the idea and puts it in your own words — and still needs the citation, because the *idea* is borrowed even when the words are yours. The dishonest third way is **plagiarism** — using someone else’s words or ideas as if they were yours: copied words with no quotation marks, or a borrowed idea with no citation. Paraphrasing without a citation is plagiarism too. Quotation marks say *these exact words are theirs*; no quotation marks says *the words are mine, the idea is theirs*; either way, the reader can find the source.

A justified position (elaboration VC2S10I08 .E05). Communicating is not only reporting; it is also **justifying** — and elaboration VC2S10I08 .E05 justifies a position taken on a selected socio-scientific issue. A justified position is not a louder opinion; it has a structure, and the structure is the same one the discussion uses, stood upright.



A justified position (VC2S10I08.E05): a claim with named evidence, reasoning that links the two, and its limits stated — not a louder opinion.

The structure of a justified position as a five-box stack with side labels. Position: our lab should switch to brand A paper towels (the claim). Evidence: in Investigation 5A, brand A soaked a mean of 42.0 mL of water and brand B 38.0 mL — five repeats each, uncertainty ± 2 mL (evidence — named, with numbers). Reasoning: the 4.0 mL difference is twice the uncertainty, so it is real against the spread (reasoning — links evidence to claim). Limits: one layer per trial, and only water was tested — another liquid could rank the brands differently (limits — stated, not hidden). Restated position: on this evidence, brand A is the better choice for the lab (claim restated)

The stack: the **position** (the claim); the **evidence**, named and carrying its numbers; the **reasoning** that links the evidence to the claim — here the 5A test, the difference against the uncertainty; the **limits**, stated rather than hidden; and the position **restated**, now carrying its evidence. Nothing in the stack is new science — it is the science you already have, arranged so a reader who disagrees knows exactly which link to challenge. The same stack carries the socio-scientific issues of Chapter 16, where the evidence is broader and the audiences wider; the structure does not change.

A report to repair. The student report below breaks nearly every rule in this subtopic. Read it now; Activity 3 and Question 16 return to it.

Bouncing balls — a student's report

Title: the ball experiment

Aim: we wanted to see what happens when you drop balls

Method: dropped the ball from different heights and watched

Results:

drop 0.5 → 0.4, which was cool drop 1.0 → 0.7

drop 1.5 → 0.9, 1.1, 1.1 (we ignored the 0.9)

drop 2.0 → 1.4!!

Discussion:

The results are in the list above. Balls are bouncy.

Conclusion:

PROVEN that the bounce is always double the drop,
for every ball ever.

Also the science website said balls lose energy when
they bounce, which is basically what we saw.

the title never says
what was studied

the aim is not a question

no units — opinions and
slang inside the results

a reading ignored with
no reason given

no argument: nothing compared,
no errors named

far stronger than the evidence —
and the wrong register

a borrowed idea with
no citation

This report needs your help: find each flaw, name the rule or section it breaks, and fix it (Question 16).

A flawed student report, “Bouncing balls — a student’s report”, with seven red flags. Title: “the ball experiment” — the title never says what was studied. Aim: “we wanted to see what happens when you drop balls” — the aim is not a question. Method: “dropped the ball from different heights and watched” — no amounts, no steps. Results: “drop 0.5 → 0.4, which was cool; drop 1.0 → 0.7; drop 1.5 → 0.9, 1.1, 1.1 (we ignored the 0.9); drop 2.0 → 1.4!!” — no units, opinions and slang inside the results, and a reading ignored with no reason given. Discussion: “The results are in the list above. Balls are bouncy.” — no argument: nothing compared, no errors named. Conclusion: “PROVEN that the bounce is always double the drop, for every ball ever.” — far stronger than the evidence, and the wrong register. “Also the science website said balls lose energy when they bounce” — a borrowed idea with no citation

Activities

Activity 1 — Sort the sentences. Work in pairs. Write ten sentences about the Subtopic 5A towel investigation (five about what was done, what was found, what it means, what it answers, and one that cites a source), shuffle them, and take turns placing each sentence in its section — title, aim, method, results, discussion, conclusion, references — saying the reason aloud: “it says what was done, so method” / “it compares with the prediction, so discussion”. Any sentence you disagree on is worth a class discussion: disagreement about sorting is nearly always disagreement about what a section is for.

Activity 2 — Build the table and the figure. Using the raw trials of the results table figure (three trials at each of 0.50, 1.00, 1.50 and 2.00 m), (1) work the four means yourself and check them against the table; (2) rule a blank copy of Table 1 from memory, then check it against the figure’s five flags — caption above, units in the headings, matching decimal places, means beside the raw trials, nothing but data; (3) sketch Figure 1 from your table — axes labelled with quantity and unit, points from the means, error bars of half the range, a best-fit straight line, and the caption *below*. The point of the activity is the check: every difference between your version and the figure is a convention you now know you do not yet own.

Activity 3 — Repair the student report. Using the flawed report figure at the end of the theory (Question 16 returns to it), play the part of the teacher marking it. List every flaw you can find, naming the section or convention each one breaks; then rewrite the report the way you would accept it — a title that says what was studied, an aim as a question, a method someone else could repeat, results in a proper table with the ignored reading either restored or deleted with a stated reason, a discussion that makes the five moves, a conclusion the evidence can carry, and a citation for the borrowed idea.

Worked examples

Datasets in this section are simulated data for practice.

Example 1 — scaffolded

Four fragments from a draft report are each broken in one way. Fix each fragment, naming the convention it breaks.

- (i) “The mean bounce heights were 0.38 m, 0.72 m, 1.05 m and 1.36 m, which were really good results.” (in the results section)
- (ii) A table heading row reading: Drop height | Trial 1 | Trial 2 | Trial 3 | Mean
- (iii) “We dropped the ball from 2 metres and it bounced heaps.”
- (iv) A table whose number and caption sit below it.

Working	Comment
(i) Delete “which were really good results”, leaving “The mean bounce heights were 0.38, 0.72, 1.05 and 1.36 m.”	Results carry only data and observations — the opinion is deleted, not moved; the discussion argues from the numbers instead. Units live in the heading, so the body of the sentence can drop them.
(ii) Add the unit to every heading: Drop height (m) Trial 1 (m) Trial 2 (m) Trial 3 (m) Mean bounce height (m)	Units in every column heading keeps the table body to bare numbers — a heading without a unit makes the reader guess.
(iii) “The ball was dropped from 2.00 m; the bounce height was 1.36 m.”	Register: numbers instead of slang (“heaps”), the same decimal places as the instrument (2.00, not 2), and past tense for what was done and found.
(iv) Move the number and caption above the table.	Tables are captioned above, figures below — never swapped.

Each fix is a convention from the two annotated figures: data only in results, units in headings, register and decimal places, caption above for tables.

Example 2 — scaffolded

A class measures the density of aluminium as 2.9 g/cm³. The accepted value is 2.7 g/cm³.

- (a) Calculate the absolute error.
- (b) Calculate the percentage error to one decimal place.
- (c) Write the one-sentence comparison a discussion would carry, naming one possible source of the error.

Working	Comment
(a) absolute error = $ 2.9 - 2.7 = 0.2 \text{ g/cm}^3$	The VC2M9M04 maths: absolute error = measured – accepted .
(b) percentage error = $(0.2 \div 2.7) \times 100 = 7.4\%$	Percentage error is the absolute error against the accepted value, $\times 100$.
(c) “The class value sits 0.2 g/cm ³ (7.4%) above the accepted value; air bubbles trapped on the aluminium when its volume was measured would make the volume read large and the density high.”	The comparison sentence does both jobs: the number and the percentage, then a named error whose effect points the right way (high, not low).

The discussion sentence is move 2 and move 4 in one breath: the comparison with the accepted value, and a source of error whose effect matches the direction of the gap.

Example 3 — unscaffolded

Return to the Subtopic 5A towel data: Brand A soaks a mean of 42.0 mL, Brand B a mean of 38.0 mL. Write a conclusion the evidence can carry (i) with an uncertainty of ± 2 mL, and (ii) with an uncertainty of ± 6 mL. Each conclusion must state what the data support and where they stop.

- (i) With ± 2 mL the uncertainty bars do not overlap and the 4.0 mL difference is twice the uncertainty, so the conclusion can name the brands: “For the towels and the method used, Brand A soaked up more water than Brand B — a mean of 42.0 mL against 38.0 mL, a difference larger than the uncertainty of the repeats.” (ii) With ± 6 mL the bars overlap and the difference could be spread alone, so the conclusion must weaken to match: “With the repeats this spread gave, the data do not show a clear difference between the brands; more repeats would be needed before the brands can be ranked.” Same means, same difference — the words change because the strength of the evidence changed. A conclusion is only as strong as the data under it (5A), and saying “no clear difference” when the uncertainty swallows the gap is not a weak report: it is an honest one.

Example 4 — unscaffolded

Your lab manager asks whether the lab should switch from Brand B to Brand A paper towels. Using the towel data (42.0 mL against 38.0 mL, five repeats each, uncertainty ± 2 mL) and the justified-position structure of the theory, write the position you would put to the manager.

Position: the lab should switch to Brand A. Evidence: in the class investigation, Brand A soaked a mean of 42.0 mL of water and Brand B 38.0 mL, five repeats each, with an uncertainty of ± 2 mL. Reasoning: the 4.0 mL difference is twice the uncertainty, so it is real against the spread of the repeats — Brand A’s extra soak-up is not chance scatter. Limits: the trials tested one layer of towel and water only; a different liquid, or a soaked-through layer, could rank the brands differently, and cost per towel was not measured. Restated position: on this evidence — and within those limits — Brand A is the better choice for the lab. The manager receives a claim with named evidence, reasoning that links the two, and limits stated in the open: a position that can be checked, and therefore a position that can be justified (E05).

Practice questions

Scaffolded questions

Question 1 Use the report-place figure. (a) Name the step of the inquiry sequence that comes immediately before WRITE THE REPORT. (b) List the three readers the figure names, and the job each does with a report. (c) Explain in one sentence why the report is called “where the work becomes public”.

Question 2 Use the anatomy figure. (a) Which section carries “only the relevant data and observations”? (b) Which section is optional, and when does it appear? (c) Match each job to its section: (i) written so someone else can repeat the investigation; (ii) the answer to the aim, no stronger than the evidence allows; (iii) every source, in one list, so each can be found again.

Question 3 Use the what-goes-where figure. (a) “Parallax when reading the ruler may have made some readings a little high” sits in the Discussion column. State the two reasons it is not a Results sentence and not a Method sentence. (b) “Mean bounce height at a 1.00 m drop: 0.72 m” sits in the Results column. State what would have to be added to it to make it a Discussion sentence. (c) Write one further sentence, of your own, that belongs in the Conclusion of the bounce report.

Question 4 Use the results-table figure. (a) Work the mean of the 1.50 m row from its three trials, and check it against the table. (b) State two conventions the column headings show. (c) A draft of the table adds a last column reading “the 2.00 m drops were the best”. State the convention it breaks and rewrite the column heading the way the convention requires — or delete it, with a reason.

Question 5 Use the figure-conventions graph. (a) State what the error bars on the four points show, and quote the bar size at the 2.00 m drop. (b) State why the line drawn is a best-fit straight line rather than dot-to-dot. (c) State where the caption sits on a figure, and where it sits on a table.

Question 6 Use the register and vocabulary figures. (a) Rewrite “The ball bounced heaps higher” in scientific register. (b) State which tense is used for (i) what was done and found, and (ii) accepted knowledge, with one example of each from the figure. (c) Give the scientific meaning of “significant”, and apply it to the 5A towel difference of 4.0 mL with an uncertainty of ± 2 mL.

Unscaffolded questions

Question 7 The bounce data give ratios of bounce to drop height of 0.76, 0.72, 0.70 and 0.68 across the four drop heights, and a best-fit line of gradient about 0.69 through the origin. (a) Write move 1 of the discussion (say what the data show) for these numbers. (b) Write move 5 (state the limits) for this investigation. (c) A classmate’s discussion repeats the four means in a list and adds “as shown in the results”. State which move this is, and why it is not a discussion.

Question 8 A class measures the boiling point of water as 103 °C; the accepted value is 100 °C. (a) Calculate the absolute error. (b) Calculate the percentage error. (c) Write the discussion comparison sentence, naming one possible source of an error that would push the reading *high*.

Question 9 For each conclusion about the bounce investigation, judge it too strong, just right, or too weak, with the one phrase that decides it. (a) “For this ball on this floor, bounce height increased with drop height over the range tested.” (b) “Drop height determines bounce height for all balls on all surfaces.” (c) “With only one ball tested, the data cannot show anything at all about the relationship.”

Question 10 A student’s reference list holds the single entry: “Bureau of Meteorology, www.example.bom.gov.au/records”. The report’s only in-text citation reads “(BoM, 2024)”. (a) Name the three parts of a full entry that are missing. (b) State the two ways the in-text citation fails to match the entry. (c) Rewrite the entry and the citation so the chain is unbroken (use the practice details of the reference-parts figure).

Question 11 Classify each borrow as quoting, paraphrasing, or plagiarism, and fix any that are broken. (a) The guide states: “Check the zero before every use” (Lab Skills Guide, 2024). (b) The zero of the instrument should be checked before every use (Lab Skills Guide, 2024). (c) The guide says the zero should be checked before every use, so we did. [no citation]

Question 12 A student’s position on the towel question reads: “Brand A is better. Brand A soaked 42.0 mL and Brand B 38.0 mL, and the difference is twice the uncertainty, so it is real.” (a) Name the three parts of the justified-position stack that are present. (b) Name the part that is missing, and write one sentence of it for this case. (c) Explain why stating that part makes the position stronger, not weaker.

Question 13 A draft report reads: “I have a theory about why the bounce was lower on the carpet, and the error was that the ruler slipped.” (a) State the scientific meaning of “theory” and of “error”, and say what each word should mean in this sentence. (b) Rewrite the sentence in register, using the scientific meanings. (c) State the rule for a term that is contested or new to the reader.

Question 14 Sort each sentence into Method, Results, Discussion or Conclusion, with the one-line reason. (a) “The thermometer was checked in melting ice before use.” (b) “With no layers, the water cooled 24.0 °C in 10 minutes.” (c) “The drop shrank as layers were added, as the hypothesis predicted.” (d) “More layers reduced the cooling, over the range tested.”

Question 15 A class measures the speed of sound as 348 m/s; the accepted value is 340 m/s. (a) Calculate the absolute error and the percentage error to one decimal place. (b) Judge the gap: is 348 m/s close enough to the accepted value to trust, in a classroom investigation whose timing errors run to a few metres per second? Justify in one sentence.

Question 16 Use the flawed student report figure (“Bouncing balls”). For each part, name the flaw and fix it. (a) The title and the aim. (b) The method. (c) The results, including the ignored 0.9 reading. (d) The discussion. (e) The conclusion. (f) The borrowed idea about balls losing energy.

Answers

Question 1 (a) Conclusion (5B); (b) your teacher — reads and assesses it; other students — check it and repeat it; scientists and the public — build on it; (c) until the report is written the investigation is private work; the report is the first form in which any reader can follow, check and repeat it. **Question 2** (a) Results; (b) Background — only when a reader genuinely needs prior knowledge to follow the report; (c) (i) Method; (ii) Conclusion; (iii) References.

Question 3 (a) it explains a possible error rather than reporting a reading (so not Results), and it happened as a risk in the measuring, not as a stated step (so not Method); (b) an argument — e.g. a comparison with the hypothesis or with the other means (“in line with the predicted rise”); (c) any conclusion-shaped sentence, e.g. “Within the range tested, the higher the drop, the higher the bounce.” **Question 4** (a) $(1.02 + 1.05 + 1.08) \div 3 = 3.15 \div 3 = 1.05$ m, matching the table; (b) any two — units in every heading; the quantity named; matching decimal places in the body; (c) it breaks “only data and observations — no opinions”; delete it (or, if a processed value were wanted, a heading like “Ratio of bounce to drop height” with numbers, not feelings).

Question 5 (a) half the range of the three trials (the $\pm$ uncertainty, 3C); ± 0.04 m at the 2.00 m drop; (b) the line shows the trend the repeats scatter around; dot-to-dot would draw the scatter instead; (c) below the figure; above the table. **Question 6** (a) e.g. “The bounce height rose from 0.38 m to 1.36 m.”; (b) (i) past tense — “The ball was dropped from 2.00 m”; (ii) present tense — “Bounce height depends on the surface.”; (c) larger than the uncertainty can explain; 4.0 mL is twice ± 2 mL, so the difference is significant.

Question 7 (a) e.g. “Mean bounce height rose from 0.38 m to 1.36 m as drop height rose from 0.50 m to 2.00 m — between 0.68 and 0.76 of the drop height, with a best-fit gradient of about 0.69.”; (b) e.g. “One ball and one floor were tested over four heights, so the result holds for this ball on this floor over this range only.”; (c) it is a repeat of the results (move 1 at best, and not even that — it adds no trend); a discussion must compare, explain or limit, not re-list.

Question 8 (a) $|103 - 100| = 3$ °C; (b) $(3 \div 100) \times 100 = 3.0\%$; (c) e.g. “The class value sits 3 °C (3.0%) above the accepted 100 °C; a thermometer reading high (or heat from the burner warming the thermometer bulb) would push the reading up, as seen.” **Question 9** (a) just right — “over the range tested” matches the claim to the evidence; (b) too strong — “all balls on all surfaces” outruns one ball and one floor; (c) too weak — “cannot show anything” throws away a trend far bigger than the spread of the trials.

Question 10 (a) title, year, retrieval date; (b) the name differs (BoM vs Bureau of Meteorology) and the year differs (2024 vs 2025) — a citation must match the entry’s name and year; (c) entry: Bureau of Meteorology, “Weather records”, 2025, www.example.bom.gov.au/records — retrieved 7 August 2026; citation: (Bureau of Meteorology, 2025). **Question 11** (a) quoting — exact words in quotation marks with the citation; correct as written; (b) paraphrasing — the idea in own words with the citation; correct as written; (c) plagiarism — a borrowed idea with no citation; fix by adding the citation: (Lab Skills Guide, 2024).

Question 12 (a) position, evidence, reasoning; (b) limits — e.g. “Only water was tested, one layer per trial, so another liquid could rank the brands differently.”; (c) stated limits tell the reader exactly where the claim holds, so the claim inside those limits can be trusted — hiding them invites a counter-example to knock the whole position over. **Question 13** (a) theory: a well-tested explanation tying many findings together (not a guess); error: the difference between a reading and the true value (not a mistake); the sentence means a reasoned explanation for the lower bounce, and a named source of error in the measuring; (b) e.g. “One explanation for the lower bounce on carpet is that the surface absorbs energy; the likely source of error was the slipping ruler.”; (c) define it at first use.

Question 14 (a) Method — says what was done to make the data trustworthy; (b) Results — a bare finding, no argument; (c) Discussion — compares the pattern with the hypothesis; (d) Conclusion — answers the aim, bounded by “over the range tested”. **Question 15** (a) absolute error = $|348 - 340| = 8$ m/s; percentage error = $(8 \div 340) \times 100 = 2.4\%$; (b) yes — 2.4% is of the same size as the timing errors themselves, so the class value agrees with the accepted value within the method’s errors.

Question 16 (a) title never says what was studied; aim not a question → “The effect of drop height on the bounce height of a tennis ball”; aim: “How does drop height affect bounce height?”; (b) no amounts, no steps, not repeatable → heights, ball, floor, repeats, how the bounce was judged, all stated; (c) no units, slang and opinion inside results, a reading deleted with no reason → a captioned table with units and matching decimals; the 0.9 kept as an outlier and explained in the discussion, or deleted there with a stated reason; (d) no argument → the five moves: trend, comparison with the hypothesis, the outlier explained, errors named, limits stated; (e) “PROVEN ... for every ball ever” overclaims, and in the wrong register → “For this ball on this floor, bounce height increased with drop height over the range tested.”; (f) borrowed idea, no citation → add an in-text citation and the matching reference-list entry.

Fully-worked solutions

Question 1 (a) The step immediately before WRITE THE REPORT is *Conclusion* (Subtopic 5B). (b) Your teacher reads and assesses the report; other students read it to check it and repeat it; scientists and the public read it to build on

it. (c) Everything before the report is the investigator's private work; the report is the first form in which the work is written so any reader can follow it, check it, repeat it and build on it — public in the sense that matters in science.

Question 2 (a) The Results section: “only the relevant data and observations: tables, graphs, processed values”. (b) The Background section is optional; it appears only when a reader genuinely needs prior knowledge before the report makes sense. (c) (i) Method — written so someone else can repeat the investigation exactly. (ii) Conclusion — the answer to the aim, no stronger than the evidence allows. (iii) References — every source in one list, each written so it can be found again.

Question 3 (a) It is not Results because it explains rather than reports — no reading is stated in it. It is not Method because reading at eye level was the stated step; parallax is what may have happened *despite* it, a possible source of error and its effect, which is discussion material (move 4). (b) An argument would have to be added — a comparison or explanation, such as “matching the predicted value of 0.70 m” or “in line with the rise at the other heights”. A bare reported value with no comparison or explanation stays in Results. (c) Example: “Within the range tested, bounce height increased with drop height for this ball on this floor.” Any sentence that answers the aim and stays inside the evidence earns the mark.

Question 4 (a) $(1.02 + 1.05 + 1.08) \div 3 = 3.15 \div 3 = 1.05$ m — the table's value checks. (b) The headings carry the quantity *and* the unit in every column (“Drop height (m)”, “Trial 1 (m)” ...), and the body of the table is therefore bare numbers to matching decimal places. (c) “The 2.00 m drops were the best” is an opinion, and the results convention is data and observations only — no opinions, no explanations. The column is deleted; if a processed value were genuinely wanted, it would carry a proper heading and numbers (for example “Ratio of bounce to drop height”: 0.76, 0.72, 0.70, 0.68).

Question 5 (a) The error bars show half the range of the three trials at each drop height — the $\pm$ uncertainty built from the repeats (3C). At the 2.00 m drop the bar is ± 0.04 m (trials 1.32 to 1.40 m). (b) The straight line is the trend the four means scatter about; joining the points dot-to-dot would draw the scatter of the trials rather than the relationship, and the relationship is what a figure is for (4C). (c) A figure's number and caption sit *below* the figure; a table's sit *above* the table.

Question 6 (a) For example: “The bounce height rose from 0.38 m to 1.36 m.” Numbers instead of slang, and the change stated as measured values. (b) (i) Past tense for what was done and found — “The ball was dropped from 2.00 m.” (ii) Present tense for accepted knowledge — “Bounce height depends on the surface.” (c) In science, “significant” means larger than the uncertainty can explain (5A). The towel difference is $42.0 - 38.0 = 4.0$ mL against an uncertainty of ± 2 mL — twice the uncertainty — so the difference is significant: the uncertainty cannot explain it away.

Question 7 (a) Model sentence: “Mean bounce height rose from 0.38 m to 1.36 m as drop height rose from 0.50 m to 2.00 m; the bounce was between 0.68 and 0.76 of the drop height, and the best-fit line through the origin has a gradient of about 0.69.” The move states what the data show, with the numbers that show it. (b) Model sentence: “One ball and one floor were tested, over four drop heights with three trials each, so these results hold for this ball on this floor over this range — not for other balls, other surfaces, or higher drops.” The move states what the data cannot yet say. (c) Re-listing the means is Results work, not Discussion: it repeats numbers without comparing, explaining or limiting. At best it is move 1 without the trend; as written (“as shown in the results”) it adds nothing at all. A discussion sentence must do one of the five moves.

Question 8 (a) Absolute error = $|\text{measured} - \text{accepted}| = |103 - 100| = 3$ °C. (b) Percentage error = $(3 \div 100) \times 100 = 3.0\%$. (c) Model sentence: “The class value of 103 °C sits 3 °C (3.0%) above the accepted 100 °C; a thermometer that reads high, or the burner warming the thermometer bulb as well as the water, would push the reading up in this way.” The sentence pairs the comparison (move 2) with a source of error whose effect points the right way (move 4).

Question 9 (a) Just right. The deciding phrase is “over the range tested”: the claim says what was tested (this ball, this floor) and what was found, and stops exactly where the evidence stops. (b) Too strong. The deciding phrase is “all balls on all surfaces”: one ball and one floor were tested, and data can support a pattern for what was tested — they never prove it for every case. (c) Too weak. The deciding phrase is “cannot show anything at all”: the trend (0.38 m rising to 1.36 m) is clear and far bigger than the spread of the trials, so the data do show a relationship for this ball on this floor; saying they show nothing discards real evidence.

Question 10 (a) The entry is missing the title (in quotation marks), the year, and the retrieval date. As it stands the reader has a name and an address only. (b) The citation's name (BoM) does not match the entry's name (Bureau of Meteorology), and its year (2024) does not match the entry's year once one is added — the in-text citation must match the entry's name and year, or the chain breaks at the first link. (c) Entry: Bureau of Meteorology, "Weather records", 2025, www.example.bom.gov.au/records — retrieved 7 August 2026. Citation beside the borrow: (Bureau of Meteorology, 2025). Name and year now match end to end (and the example remains a practice example, not a real publication).

Question 11 (a) Quoting — the exact words appear in quotation marks with the citation straight after. It is correct as written, and appropriate for an exact instruction. (b) Paraphrasing — the idea is restated in the writer's own words and the citation is still present. It is correct as written; this is the usual way to borrow. (c) Plagiarism — the idea is borrowed ("the guide says...") yet no citation is given, so the reader cannot find the source. Fix: keep the words, add the citation — "The guide says the zero should be checked before every use (Lab Skills Guide, 2024), so we did." Borrowed ideas need a citation even when the words are yours.

Question 12 (a) Present: the position ("Brand A is better"), the evidence (42.0 mL against 38.0 mL), and the reasoning (the 4.0 mL difference is twice the uncertainty, so it is real against the spread). (b) Missing: the limits. One sentence for this case: "Only water was tested, one layer per trial, and cost was not considered — another liquid or a soaked layer could rank the brands differently." (c) Stating the limits marks the boundary inside which the claim holds, so a reader who disagrees knows exactly which link to challenge and cannot knock the position over with a counter-example from outside it. A position with its limits in the open is easier to trust, not harder — which is what justifying means (E05).

Question 13 (a) In science a **theory** is a well-tested explanation that ties many findings together — not a guess; and an **error** is the difference between a reading and the true value — not a mistake. In the sentence, the writer means "a reasoned explanation for the lower bounce" and "the source of the inaccuracy in the readings". (b) Model rewrite: "One explanation for the lower bounce on carpet is that the soft surface absorbs energy; the likely source of error was the ruler slipping during the drops." (c) A term that is contested, or new to the reader, is defined at first use — the reader is never left to guess which meaning of a word the report is carrying.

Question 14 (a) Method. It says what was done (the melting-ice check) to make the data trustworthy — a step, not a finding. (b) Results. A bare reported value — what was found — with no comparison or explanation attached. (c) Discussion. It compares the pattern with the hypothesis ("as the hypothesis predicted") — an argument about the results. (d) Conclusion. It answers the aim in one bounded sentence — "over the range tested" keeps the claim inside the evidence.

Question 15 (a) Absolute error = $|348 - 340| = 8$ m/s. Percentage error = $(8 \div 340) \times 100 = 2.352\ldots\% \approx 2.4\%$. (b) Yes. Timing and distance errors in a classroom measurement of the speed of sound run to a few metres per second, so a gap of 8 m/s (2.4%) is of the same size as the method's own errors: the class value agrees with the accepted value within what the method can explain. The discussion would say exactly that — close enough to trust, small enough to explain.

Question 16 (a) The title ("the ball experiment") never says what was studied, and the aim is a want, not a question. Fix: title "The effect of drop height on the bounce height of a tennis ball on a hard floor"; aim "How does drop height affect the bounce height of a tennis ball?" (b) The method states no heights, no ball, no floor, no repeats and no rule for judging the bounce — nobody else could repeat it. Fix: state the four drop heights, the ball and floor, three trials at each height, the vertical ruler read at eye level, and how the top of the bounce was judged. (c) The results carry no units, hold slang ("cool") and an exclamation, and delete the 0.9 reading with no reason. Fix: a numbered, captioned table with units in every heading and matching decimal places; the 0.9 m reading either kept and then explained in the discussion as an outlier, or deleted *in the discussion* with a stated reason — never quietly dropped in the results. (d) The discussion contains no argument: nothing is compared with the hypothesis or an accepted value, the outlier is unexplained, no error is named, no limit stated. Fix: make the five moves — the trend (bounce height rose with drop height), the comparison with the hypothesis, the outlier explained, the errors named with their effect (judging the top of the bounce by eye), and the limits (one ball, one floor, four heights). (e) The conclusion ("PROVEN ... always double ... for every ball ever") is far stronger than the evidence and abandons the register. Fix: "For this ball on this floor, bounce height increased with drop height over the range tested — roughly 0.7 times the drop height, not double." The conclusion answers the aim and no more. (f) "The science website said balls lose energy when they

bounce” borrows an idea with no citation. Fix: cite it — an in-text citation (name, year) beside the sentence and the matching full entry, with the retrieval date, in the reference list.

Where this leads: Subtopic 6B takes the partner limb of VC2S10I08 — choosing the format and representations that suit each audience, from posters to digital infographics — and the justified-position stack of VC2S10I08 .E05 returns at full scale in the socio-scientific issues of Chapter 16. The report you learn here is also the report you write in SIT-2 (the full investigation report after Chapter 11), the one Topic Test T2 assesses (Chapters 4–6), and the one every VCE science assumes you can already write: structure, conventions, vocabulary and referencing are the implicit prerequisites of every investigation outcome in the senior years.

Communicating and justifying to diverse audiences — format choice, representations and digital tools

Chapter 6 — Communicating (Science, Levels 9 and 10)

Subtopic 6B · VC2 Science Inquiry Skills — Communicating

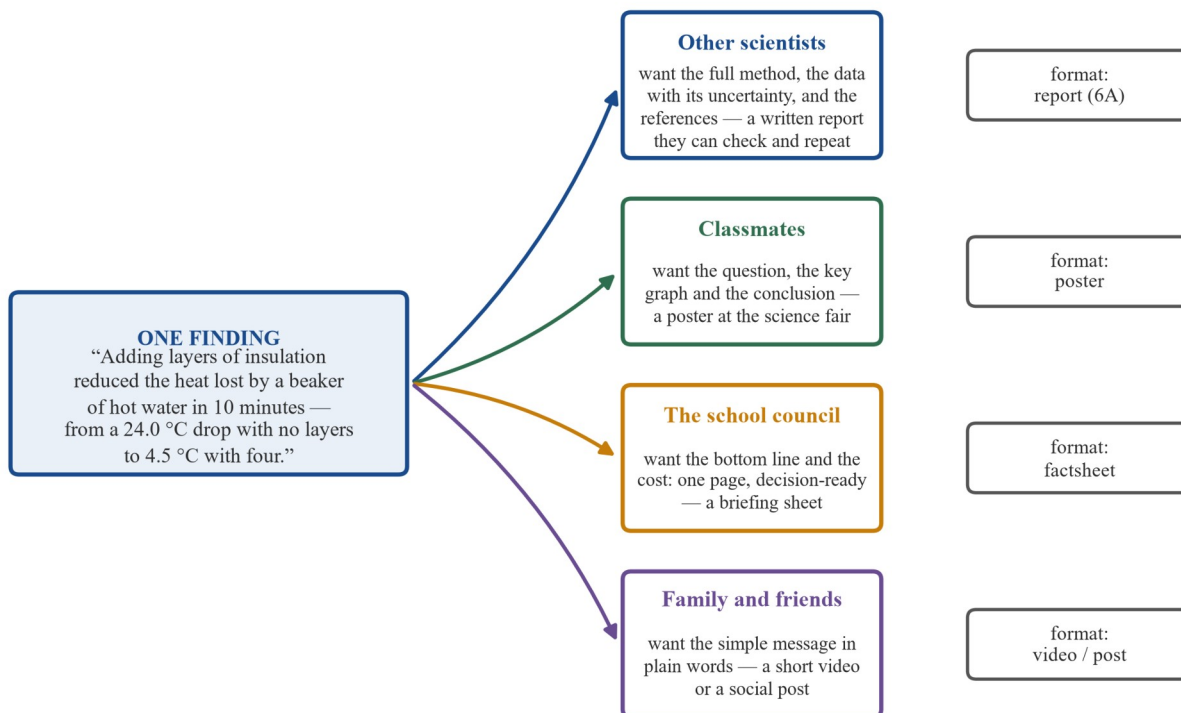
CD code: VC2S10I08 (split delivery †; this subtopic is the partner, not the accountable owner) **Content description (verbatim):** “communicating and justifying scientific ideas, findings and arguments for diverse audiences involves the selection of appropriate presentation formats, content, scientific vocabulary, conventions, models and other representations, and may include the use of digital tools” **This subtopic’s limb (TOC §3 clause split):** format and representation choice for diverse audiences — the selection of presentation formats, models and other representations, and the use of digital tools. The accountable owner 6A delivers the other limb: report structure, conventions, scientific vocabulary and referencing.

Elaboration ids drawn on: VC2S10I08.E02 · VC2S10I08.E03 · VC2S10I08.E04 · VC2S10I08.E06 (ids VC2S10I08.E01 and VC2S10I08.E05 are drawn on by Subtopic 6A; VC2S10I08.E07 is reserved under the TOC’s D10 ICIP decision and is not taught here) **Achievement standard (verbatim):** “They select and use appropriate presentation formats, scientific content, vocabulary, models, conventions, formulas and other representations to achieve their purpose when communicating and justifying their ideas, findings, arguments and proposals to diverse audiences.” **Maths interlocks (D11):** VC2M10ST04 — analyse claims, inferences and conclusions of statistical reports in the media and other places, by linking claims to displays, statistics and representative data, including ethical considerations and identification of potential sources of bias (the claim-and-display honesty checks of this subtopic practise that linking); VC2M9M05 — use mathematical modelling to solve practical problems involving direct proportion, rates, ratio and scale (reading “double the acceleration, double the force” off a table, and working with percentage shares of a footprint, are proportional reasoning of that kind).

All datasets in this subtopic are simulated data for practice.

Theory

One finding, many audiences. By the time an investigation reaches this chapter, it has a question (2A), a hypothesis (2B), a valid and reproducible method (3A, 3B, 3C), processed data (4A, 4B, 4C), an evaluation (5A) and a conclusion (5B). One thing is left: telling people. And “people” is not one audience. This subtopic is about **communicating** — putting a finding in front of an audience — and **justifying** — showing the audience why the finding deserves to be believed. The figure below takes one finding from the insulation investigation you evaluated in Subtopic 5A (the mean temperature drop in 10 minutes fell from 24.0 °C with no layers to 4.5 °C with four) and sends it to four different audiences.

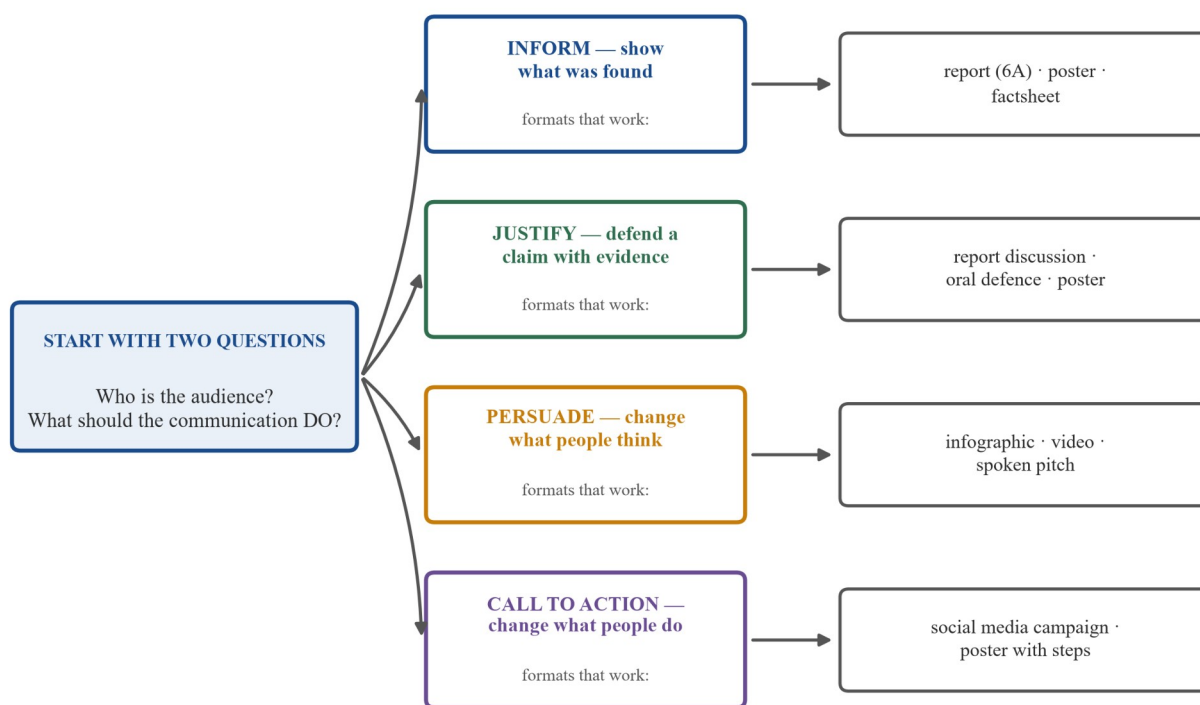


The finding does not change. What changes — with the audience — is the format, the detail kept, and the words used.

A blue box on the left labelled ONE FINDING holds the sentence “Adding layers of insulation reduced the heat lost by a beaker of hot water in 10 minutes — from a 24.0 °C drop with no layers to 4.5 °C with four.” Four coloured arrows lead to four audience boxes, each paired with a format box: Other scientists — want the full method, the data with its uncertainty, and the references, a written report they can check and repeat (format: report, 6A); Classmates — want the question, the key graph and the conclusion, a poster at the science fair (format: poster); The school council — want the bottom line and the cost, one page, decision-ready (format: factsheet); Family and friends — want the simple message in plain words (format: video or post). Caption: the finding does not change; what changes with the audience is the format, the detail kept, and the words used.

The finding is the same in all four boxes. What changes is the **format** (the kind of communication it is), the **detail** that is kept, and the **words** used. An **audience** is simply the group of people the communication is for, and matching the communication to them is the whole skill of this subtopic.

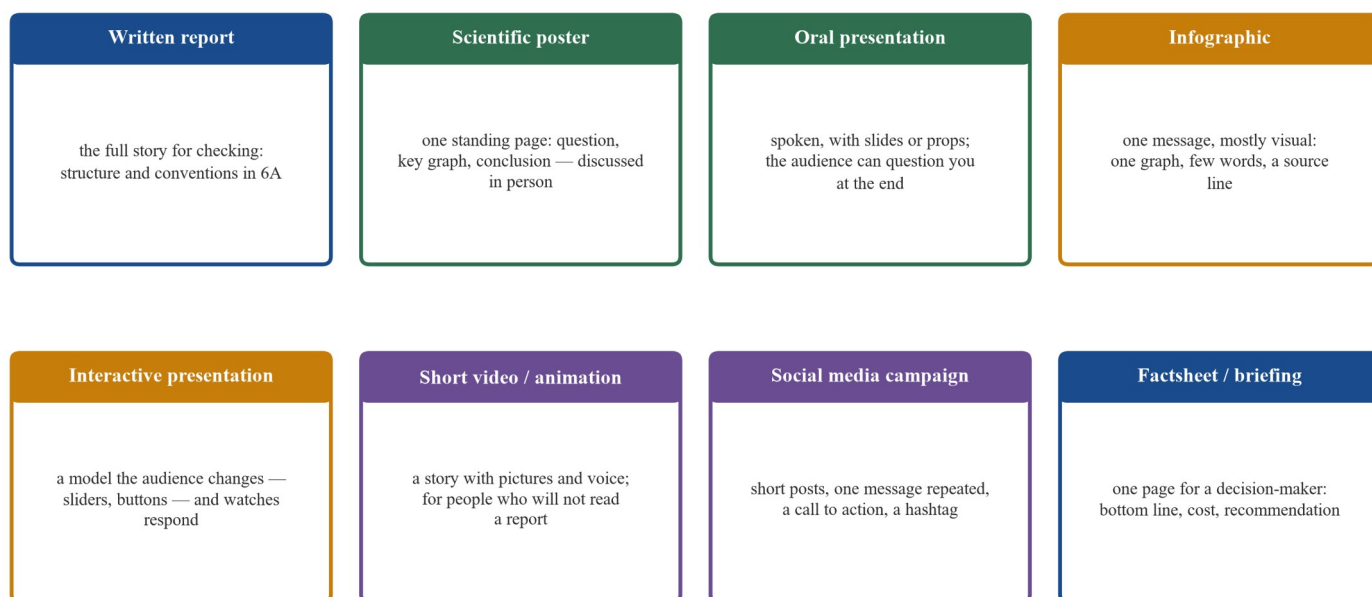
Choosing a format: purpose first, audience second. Before you pick a format, ask two questions: *who is the audience?* and *what should the communication do?* The second question has four common answers, and each answer points to certain formats.



Then let the audience narrow the choice: the same purpose takes a different format for specialists, for younger students, or for the public.

A decision map. A blue start box reads “START WITH TWO QUESTIONS — Who is the audience? What should the communication DO?” Four arrows fan out to four purpose boxes, each with an arrow to a formats box: INFORM — show what was found (report 6A, poster, factsheet); JUSTIFY — defend a claim with evidence (report discussion, oral defence, poster); PERSUADE — change what people think (infographic, video, spoken pitch); CALL TO ACTION — change what people do (social media campaign, poster with steps). Caption: then let the audience narrow the choice — the same purpose takes a different format for specialists, for younger students, or for the public.

The purpose narrows the field; the audience makes the final choice. A poster can inform classmates at a science fair, but the same poster would fail before a group of specialists who need to check every step — they need the written report. The gallery below lists the eight formats this book works with, and what each is best for.

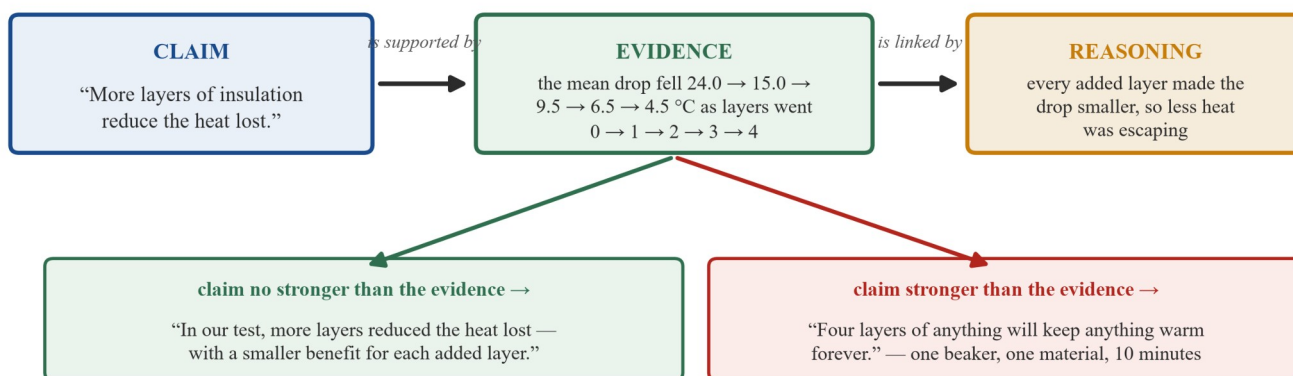


No format is best in itself — each is best FOR something. The choice belongs to the audience and the purpose.

Eight cards in two rows, each with a coloured title band and a short description: Written report — the full story for checking, structure and conventions in 6A; Scientific poster — one standing page: question, key graph, conclusion, discussed in person; Oral presentation — spoken, with slides or props, the audience can question you at the end; Infographic — one message, mostly visual: one graph, few words, a source line; Interactive presentation — a model the audience changes (sliders, buttons) and watches respond; Short video / animation — a story with pictures and voice, for people who will not read a report; Social media campaign — short posts, one message repeated, a call to action, a hashtag; Factsheet / briefing — one page for a decision-maker: bottom line, cost, recommendation. Caption: no format is best in itself — each is best FOR something; the choice belongs to the audience and the purpose.

No format is best in itself. A format is a choice, and the choice is judged by one test only: *does it carry the message to this audience, for this purpose?*

Justifying: claim, evidence, reasoning — all three links. Every audience, sooner or later, asks “why should I believe this?” Answering that question is **justifying**. A justification has three links: a **claim** (what you say is true), the **evidence** (the data that supports it), and the **reasoning** (the sentence that joins the two — why that evidence supports that claim). The figure works the chain on the insulation finding, and shows the two ways a justification fails.



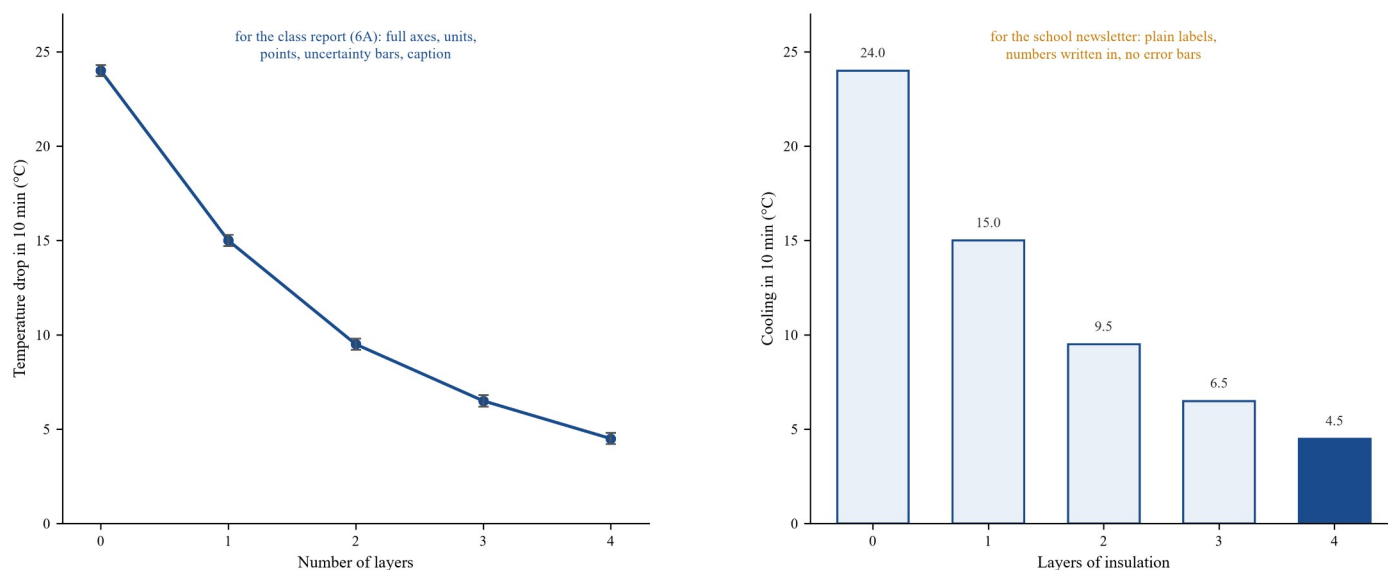
A justification names all three links. If any link is missing, the audience has a claim, not an argument — and the claim may outrun the data (Subtopic 5A).

Audiences check different links: scientists check the evidence and the method; a general audience usually checks whether the reasoning makes sense to them.

Top row: a blue CLAIM box (“More layers of insulation reduce the heat lost”) joined by an arrow labelled “is supported by” to a green EVIDENCE box (the mean drop fell 24.0 → 15.0 → 9.5 → 6.5 → 4.5 °C as layers went 0 → 1 → 2 → 3 → 4), joined by an arrow labelled “is linked by” to an amber REASONING box (every added layer made the drop smaller, so less heat was escaping). Two arrows lead down to two outcome boxes: green — “claim no stronger than the evidence” with the honest claim “In our test, more layers reduced the heat lost — with a smaller benefit for each added layer”; red — “claim stronger than the evidence” with the overclaim “Four layers of anything will keep anything warm forever”, from one beaker, one material, 10 minutes. Captions: a justification names all three links — if any link is missing, the audience has a claim, not an argument, and the claim may outrun the data (Subtopic 5A); audiences check different links — scientists check the evidence and the method, a general audience usually checks whether the reasoning makes sense to them.

The red box is the warning that follows you through every format in this subtopic: the claim must never be stronger than the evidence under it. Subtopic 5A taught you to spot a claim that outruns its data; this subtopic makes it a rule of communication. Different audiences check different links — scientists look hard at the evidence and the method, while a general audience mostly tests whether the reasoning makes sense — so a justification has to hold all three links up for whoever is reading.

The same data, represented for two audiences. A representation is any way of showing data or an idea — a table, a graph, a diagram, a model. Like the format, the representation is a choice about how much detail to keep. The figure shows one dataset (the insulation drops of 24.0, 15.0, 9.5, 6.5 and 4.5 °C for 0 to 4 layers, carried from Subtopic 5A) drawn twice.



Simulated data for practice — the insulation investigation of Subtopic 5A.

Two panels of the same five numbers. Left, “for the class report (6A)”: a line-and-point graph with full axes — x-axis “Number of layers” 0 to 4, y-axis “Temperature drop in 10 min (°C)” 0 to 27 — points at 24.0, 15.0, 9.5, 6.5 and 4.5 with small grey uncertainty bars, and a caption. Right, “for the school newsletter”: a plain bar chart, x-axis “Layers of insulation”, y-axis “Cooling in 10 min (°C)”, bars labelled with the numbers 24.0, 15.0, 9.5, 6.5, 4.5, the four-layer bar shaded dark, no uncertainty bars. Title: one dataset, two representations — same numbers, different detail. Footnote: simulated data for practice — the insulation investigation of Subtopic 5A.

The left panel keeps everything a checking audience needs: every point, the uncertainty bars built in Subtopics 3C and 5A, full axis labels with units. The right panel keeps what a newsletter reader needs: the pattern, and the numbers written in. Dropping the uncertainty bars for that audience is a fair choice — the newsletter is not where the data gets checked. But two things may never be dropped for any audience: honest scales (no axis trick that makes a small difference look big — Subtopic 4C) and the units. A bar chart with no units is not a simpler representation; it is a broken one.

Conventions: what each format’s reader expects. Every format carries **conventions** — the things the reader of that format expects to find. A reader who has to hunt for what your format normally shows spends their attention on the hunt instead of on your science. The written report’s conventions (numbered figures, captions, a reference list, the scientific vocabulary and past tense) are delivered in Subtopic 6A; the figure adds the conventions of the other formats.

Written report (6A)	numbered figures with captions · units on every axis · past tense · reference list
Poster	title readable from 2 m away · one key graph · authors and school named · references shortened
Infographic	the source of every number shown · units on the graph · no decorative numbers that mean nothing
Oral presentation	say what each graph shows as it appears · define a term before using it · invite questions
Social media post	claim in the first line · link or screenshot of the evidence · no exaggeration the data cannot carry

Conventions are what the reader of that format expects. Meeting them is part of communicating clearly; breaking them costs the audience's trust.

Five rows, each a format name in a coloured box beside a white box of its conventions: Written report (6A) — numbered figures with captions, units on every axis, past tense, reference list; Poster — title readable from 2 m away, one key graph, authors and school named, references shortened; Infographic — the source of every number shown, units on the graph, no decorative numbers that mean nothing; Oral presentation — say what each graph shows as it appears, define a term before using it, invite questions; Social media post — claim in the first line, link or screenshot of the evidence, no exaggeration the data cannot carry. Caption: conventions are what the reader of that format expects — meeting them is part of communicating clearly; breaking them costs the audience's trust.

Digital tools — the tool never chooses for you. The CD says communicating “may include the use of digital tools”, and in practice it usually does. The figure matches the common tools to the jobs they are good at.

Spreadsheet process the data, calculate means, draw and redraw graphs quickly	Datalogger software record readings straight into a table or graph while the experiment runs	Presentation software build slides, posters and simple animations for an oral talk
Infographic / design tool lay out one message with icons, numbers and a single graph	Simulation / interactive tool let the audience change a value and watch the model respond	Video / audio editor cut a short story for people who will not read a report
the tool never chooses for you default charts keep their default axes, colours and types — the audience, purpose, representation and honesty checks of this subtopic are still yours to make		

Six tool cards in two rows: Spreadsheet — process the data, calculate means, draw and redraw graphs quickly; Datalogger software — record readings straight into a table or graph while the experiment runs; Presentation

software — build slides, posters and simple animations for an oral talk; Infographic / design tool — lay out one message with icons, numbers and a single graph; Simulation / interactive tool — let the audience change a value and watch the model respond; Video / audio editor — cut a short story for people who will not read a report. Below, a red strip: “the tool never chooses for you — default charts keep their default axes, colours and types; the audience, purpose, representation and honesty checks of this subtopic are still yours to make.”

The red strip is the point. A spreadsheet will happily draw the wrong graph type with a truncated axis and no units; the tool does not know your audience or your purpose. Every choice this subtopic teaches — format, representation, conventions, honesty of the claim — is made *by you, using the tool*, never *by the tool instead of you*.

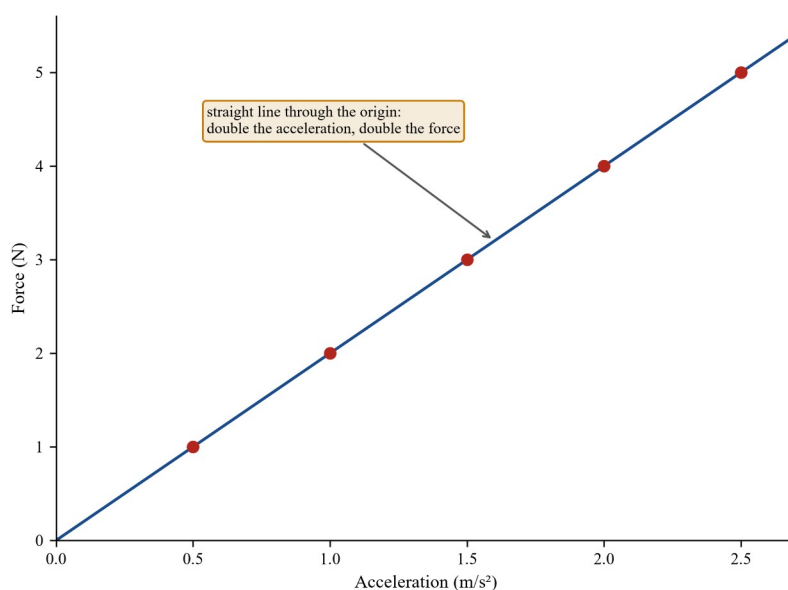
Elaboration E02 — an infographic on force, mass and acceleration (content supplied). The next four paragraphs work the four elaborations this subtopic draws on. In each one the *science content is supplied* as stimulus — the relationship, the body systems, the climate evidence and the footprint numbers are taught later in the book (15B, 8B, 12C and 12D) — and the task is always the communication choice. Elaboration VC2S10I08.E02 asks for an infographic that illustrates the relationship between mass, acceleration and force. The supplied content is a 2.0 kg trolley pulled along a smooth bench: at accelerations of 0.5, 1.0, 1.5, 2.0 and 2.5 m/s² the force needed is 1.0, 2.0, 3.0, 4.0 and 5.0 N.

Content supplied for the communication task

Trolley mass: 2.0 kg, pulled along a smooth bench

Acceleration (m/s ²)	Force needed (N)
0.5	1.0
1.0	2.0
1.5	3.0
2.0	4.0
2.5	5.0

force = mass × acceleration — the relationship itself is taught in Subtopic 15B

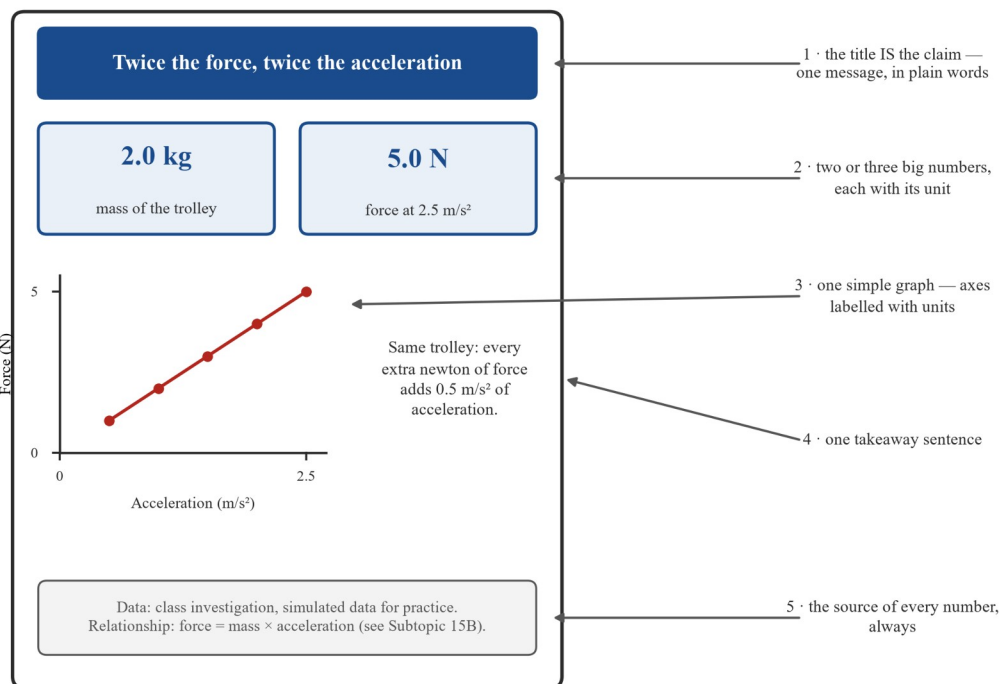


Left: a table titled “Content supplied for the communication task” — trolley mass 2.0 kg, pulled along a smooth bench — with columns “Acceleration (m/s²)” and “Force needed (N)” and rows 0.5/1.0, 1.0/2.0, 1.5/3.0, 2.0/4.0, 2.5/5.0, and a note “force = mass × acceleration — the relationship itself is taught in Subtopic 15B”. Right: a graph of Force (N) against Acceleration (m/s²), axes 0 to 2.7 and 0 to 5.6, five red points lying exactly on a blue straight line through the origin, with a note box and arrow: “straight line through the origin: double the acceleration, double the force.”

An **infographic** is one message on one screen or page, mostly visual, for an audience that gives it seconds. The anatomy figure shows the five parts a force infographic needs, built from exactly the supplied data.

An infographic (elaboration VC2S10I08.E02)

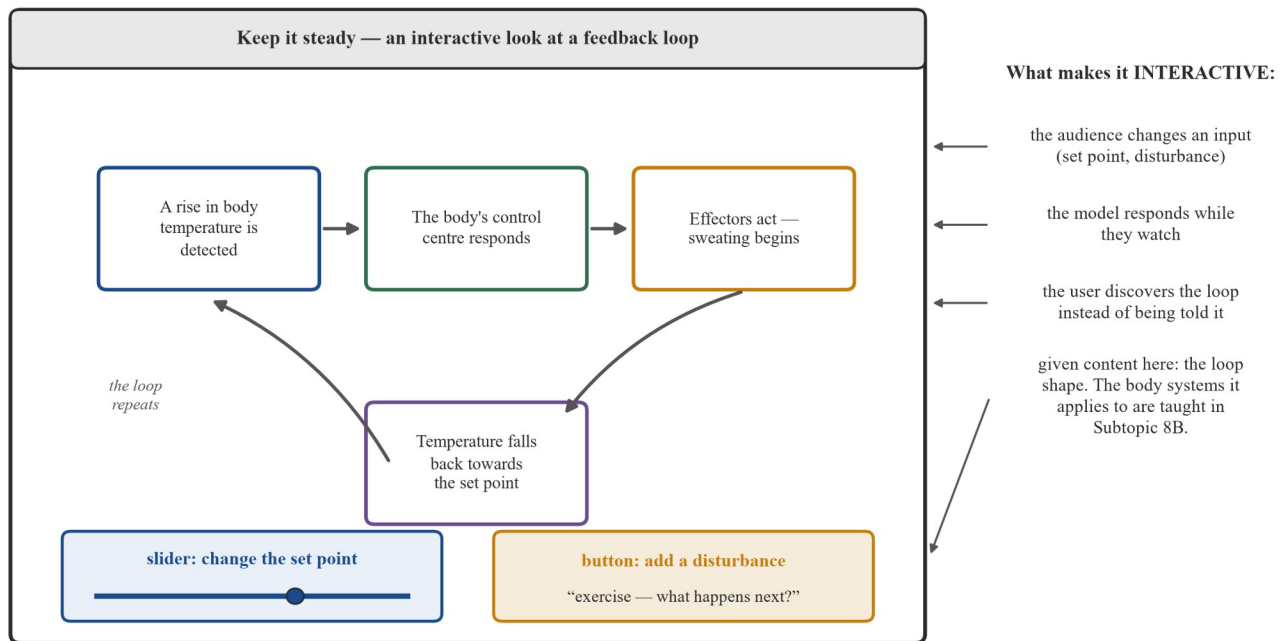
everything on one screen or page, for an audience that gives it seconds



A labelled specimen infographic inside a white card, with five numbered callouts on the right. 1 · a blue title band reading “Twice the force, twice the acceleration” — the title IS the claim, one message in plain words. 2 · two big numbers with units: “2.0 kg — mass of the trolley” and “5.0 N — force at 2.5 m/s²”. 3 · one simple graph: five points on a rising line, x-axis “Acceleration (m/s²)” ticks 0 and 2.5, y-axis “Force (N)” ticks 0 and 5 — axes labelled with units. 4 · one takeaway sentence beside the graph: “Same trolley: every extra newton of force adds 0.5 m/s² of acceleration.” 5 · a grey source box: “Data: class investigation, simulated data for practice. Relationship: force = mass × acceleration (see Subtopic 15B)” — the source of every number, always. Header: an infographic (elaboration VC2S10I08.E02) — everything on one screen or page, for an audience that gives it seconds.

Notice what the infographic does *not* do: it does not show the whole table, and it does not teach the relationship (that is 15B’s job). It picks one claim the data carries — double the acceleration, double the force — and spends every element on that one message, with a source line so any number can be checked. That is the whole art: one message, one graph, a few numbers with units, one takeaway sentence, and the source of every number.

Elaboration E03 — an interactive presentation on feedback loops (content supplied). Elaboration VC2S10I08.E03 asks for an interactive presentation that shows feedback loops in human body systems. The loop itself — receptor, control centre, effector — is taught in Subtopic 8B; here the loop shape is supplied and the task is the word **interactive**. A presentation is interactive when the audience changes something and watches the model respond.



Elaboration VC2S10I08.E03: developing an interactive presentation that shows feedback loops in human body systems.

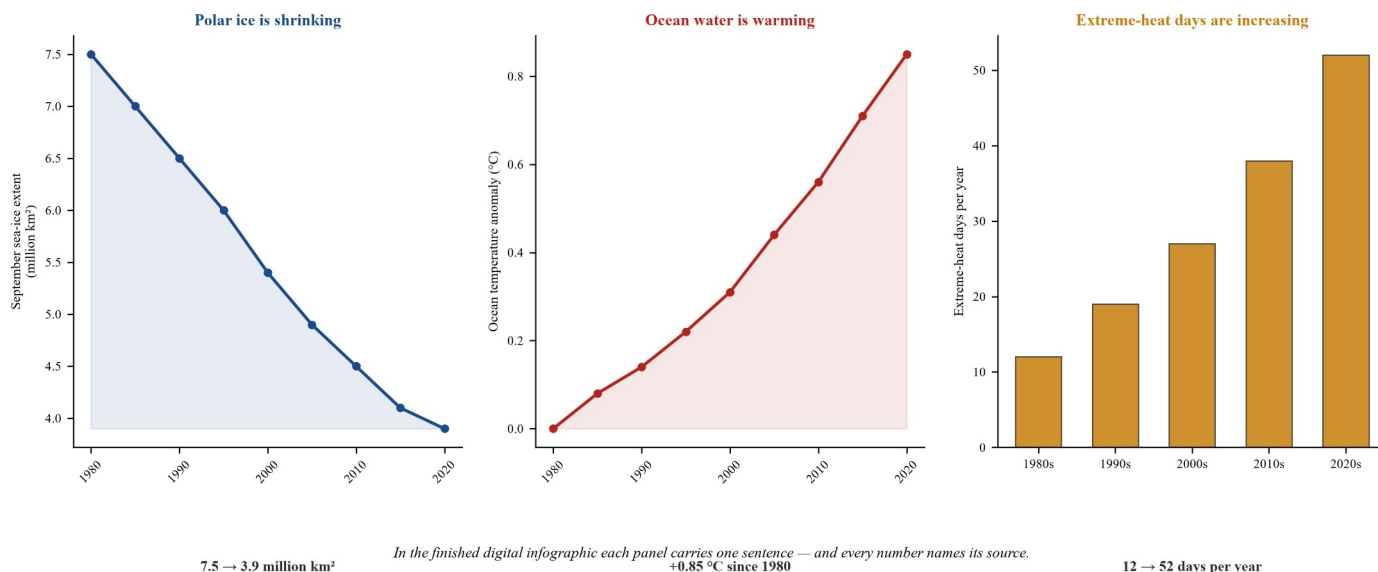
A screen wireframe titled “Keep it steady — an interactive look at a feedback loop”. Inside, four boxes joined in a circle: “A rise in body temperature is detected” → “The body’s control centre responds” → “Effectors act — sweating begins” → “Temperature falls back towards the set point” → back to the first box, with the note “the loop repeats”. Along the bottom, two control boxes: a blue slider labelled “slider: change the set point” and an amber button labelled “button: add a disturbance — ‘exercise — what happens next?’”. A right-hand column headed “What makes it INTERACTIVE:” lists: the audience changes an input (set point, disturbance); the model responds while they watch; the user discovers the loop instead of being told it; given content here: the loop shape — the body systems it applies to are taught in Subtopic 8B. Footnote: elaboration VC2S10I08.E03 — developing an interactive presentation that shows feedback loops in human body systems.

The slider and the button are what make it interactive: the user moves the set point or adds a disturbance, the on-screen model responds while they watch, and the user *discovers* the loop instead of being told it. An interactive presentation is the right choice when the purpose is that the audience feels how a system behaves — no static slide can do that job.

Elaboration E04 — three lines of climate evidence as one digital infographic (content supplied). Elaboration VC2S10I08.E04 asks for a digital infographic that highlights the lines of evidence — polar ice, ocean temperatures and extreme weather — for how climate change is impacting Earth. The science and the real, sourced data are taught in Subtopic 12C; here simulated data is drawn to show the real qualitative pattern, and the task is to see three datasets as one message.

Three lines of evidence for one message (elaboration VC2S10I08.E04)

Simulated data for practice, drawn to show the real qualitative pattern — the evidence with sources is studied in Subtopic 12C.

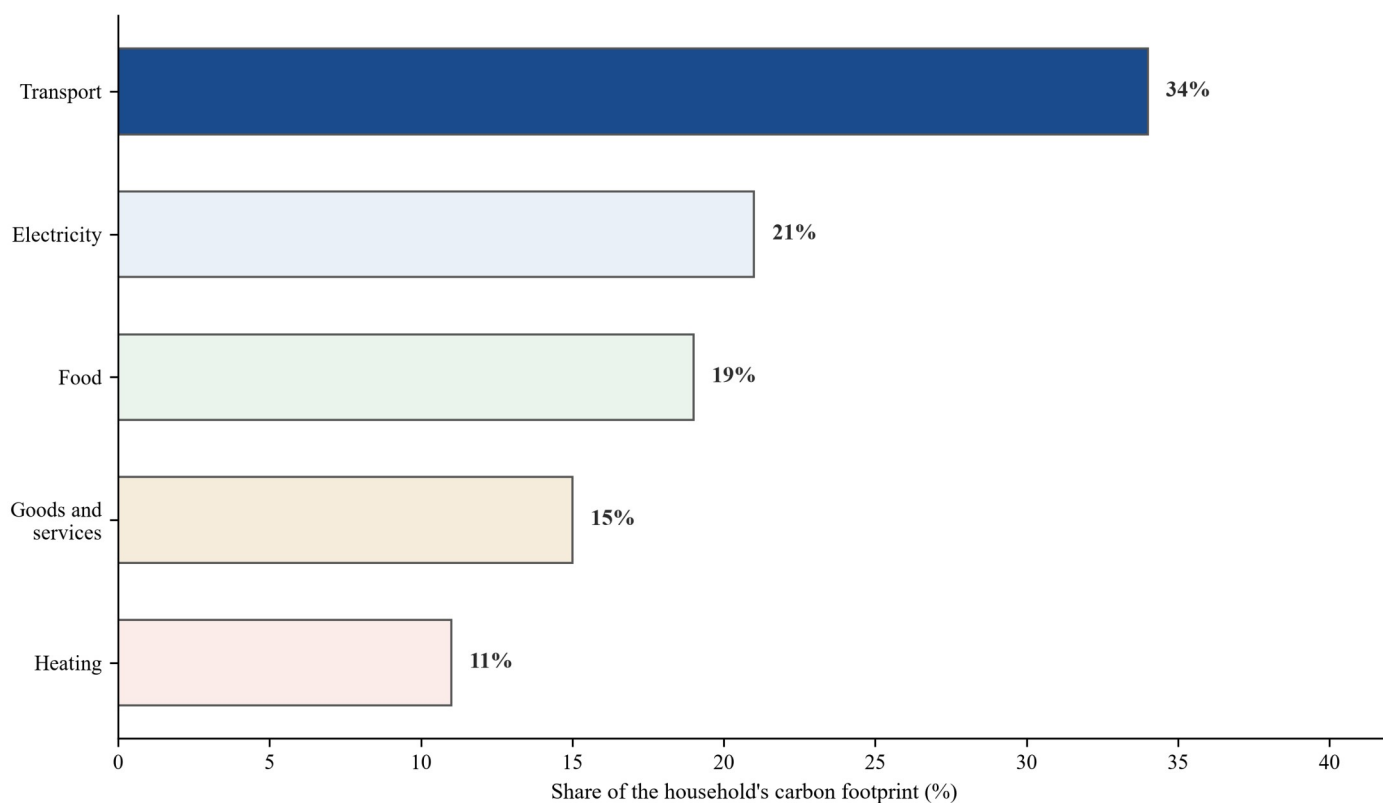


Three infographic panels side by side, under the title “Three lines of evidence for one message (elaboration VC2S10I08.E04)” and the note “simulated data for practice, drawn to show the real qualitative pattern — the evidence with sources is studied in Subtopic 12C”. Panel 1, blue, “Polar ice is shrinking”: a falling line of September sea-ice extent (million km²) from 7.5 in 1980 to 3.9 in 2020, summary “7.5 → 3.9 million km²”. Panel 2, red, “Ocean water is warming”: a rising line of ocean temperature anomaly (°C) from 0.00 in 1980 to 0.85 in 2020, summary “+0.85 °C since 1980”. Panel 3, amber, “Extreme-heat days are increasing”: rising bars of extreme-heat days per year from 12 in the 1980s to 52 in the 2020s, summary “12 → 52 days per year”. Footnote: in the finished digital infographic each panel carries one sentence — and every number names its source.

Three separate graphs, three separate quantities — and one message: independent lines of evidence all point the same way. That is what makes the infographic honest *and* strong: it does not lean on one graph, it shows three independent trends agreeing. In the finished version each panel carries exactly one sentence, and every number names its source — for climate data above all, the audience must be able to check where a number came from.

Elaboration E06 — a social media campaign on carbon footprints (content supplied). Elaboration VC2S10I08.E06 asks for a social media campaign to encourage young people to reduce their carbon footprints. The mitigation science is taught in Subtopic 12D; here the supplied content is one simulated household footprint. A **carbon footprint** is a way of adding up the greenhouse gases a household’s choices produce, and the figure breaks one household’s footprint into five shares.

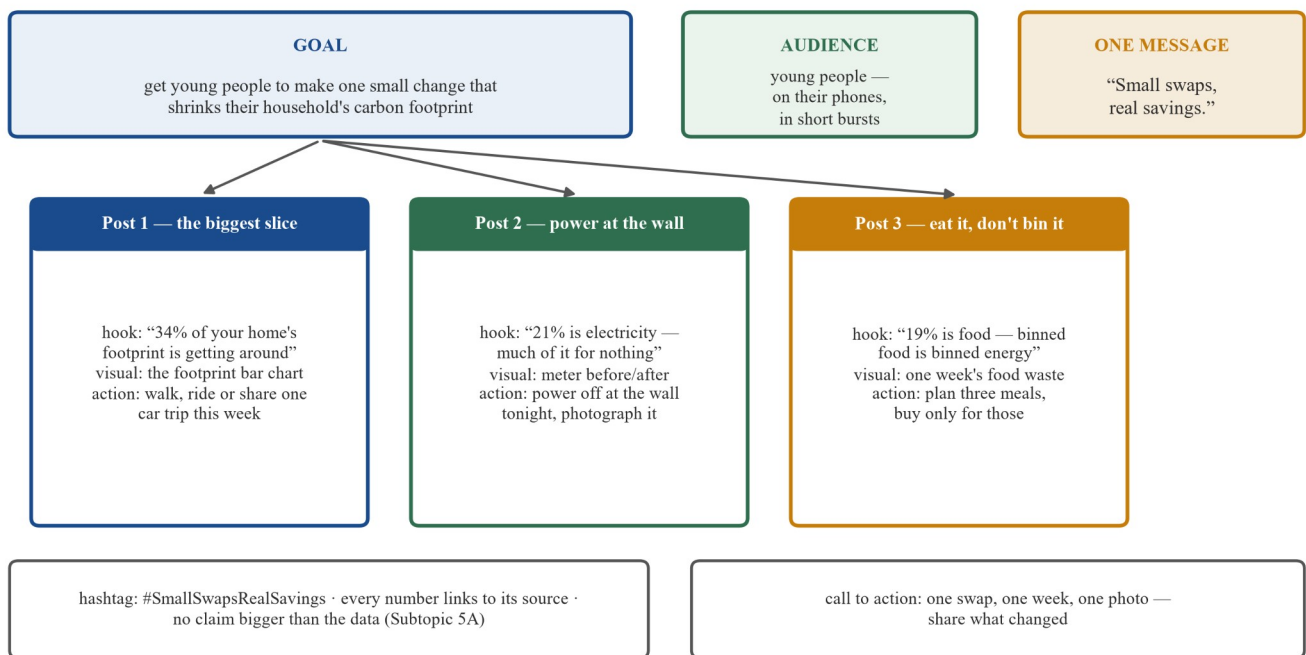
A household's carbon footprint, by category — simulated data for practice



Content supplied for the campaign of elaboration VC2S10I08.E06 — the biggest slice names the first post.

A horizontal bar chart titled “A household’s carbon footprint, by category — simulated data for practice”, x-axis “Share of the household’s carbon footprint (%)” from 0 to 40. Bars, largest to smallest: Transport 34% (dark blue), Electricity 21%, Food 19%, Goods and services 15%, Heating 11%. Footnote: content supplied for the campaign of elaboration VC2S10I08.E06 — the biggest slice names the first post.

A **campaign** is not one post; it is a run of short posts that repeat *one message* to *one audience* until it lands, each post ending in a **call to action** — one small thing the audience is asked to do. The plan below builds three posts from the three biggest slices of the supplied footprint.



A campaign repeats ONE message to ONE audience until it lands — three posts, three slices of the same footprint.

A campaign plan. Top row: GOAL — get young people to make one small change that shrinks their household's carbon footprint; AUDIENCE — young people, on their phones, in short bursts; ONE MESSAGE — "Small swaps, real savings." Three post cards hang from the message: Post 1 — the biggest slice (hook: "34% of your home's footprint is getting around"; visual: the footprint bar chart; action: walk, ride or share one car trip this week); Post 2 — power at the wall (hook: "21% is electricity — much of it for nothing"; visual: meter before/after; action: power off at the wall tonight, photograph it); Post 3 — eat it, don't bin it (hook: "19% is food — binned food is binned energy"; visual: one week's food waste; action: plan three meals, buy only for those). Bottom strips: hashtag #SmallSwapsRealSavings, every number links to its source, no claim bigger than the data (Subtopic 5A); call to action: one swap, one week, one photo — share what changed. Caption: a campaign repeats ONE message to ONE audience until it lands — three posts, three slices of the same footprint.

Check the plan against the purpose: every post is a call to action (change what people *do*), every hook leads with a number from the supplied data, and the same message and hashtag tie the posts together. Check it against the audience: short, phone-sized, one swap at a time. And check it against Subtopic 5A: "no claim bigger than the data" — a campaign that exaggerates loses the trust it was built to win.

Before you send: the checklist. Every format, representation and tool in this subtopic comes down to the same eight checks, run before anything is sent, viewed or presented.

☒	Audience and purpose	named, not guessed — who will read this, and what should it do for them?
☒	Format	fits the audience and the purpose (a decision, not a habit)
☒	One clear message	the audience could repeat it back in one sentence
☒	Representations	the right type, labelled: axes with units, captions, readable without the text
☒	Honest scales	no axis trick that makes a small difference look big (Subtopic 4C)
☒	Claim ↔ evidence	the claim is no stronger than the data under it (Subtopic 5A)
☒	Attribution	every number and image names its source — referencing conventions in 6A
☒	Tested on the audience	someone like the real audience has read or used it, and you fixed what they stumbled on

Run the checklist over your own work before it is sent, viewed or presented — and over anyone else's communication you are asked to judge.

A checklist of eight ticked boxes: Audience and purpose — named, not guessed: who will read this, and what should it do for them? Format — fits the audience and the purpose (a decision, not a habit). One clear message — the audience could repeat it back in one sentence. Representations — the right type, labelled: axes with units, captions, readable without the text. Honest scales — no axis trick that makes a small difference look big (Subtopic 4C). Claim ↔ evidence — the claim is no stronger than the data under it (Subtopic 5A). Attribution — every number and image names its source, referencing conventions in 6A. Tested on the audience — someone like the real audience has read or used it, and you fixed what they stumbled on. Caption: run the checklist over your own work before it is sent, viewed or presented — and over anyone else's communication you are asked to judge.

The checklist is also how you judge *other* people's communication — a poster at the fair, a post in your feed, an infographic in a news feed. Ask the eight questions and the communication either stands or shows you exactly where it is weak.

Activities

Activity 1 — One finding, three formats. Use the insulation finding of the first figure (drop 24.0 °C with no layers, 4.5 °C with four). Working alone, write three versions of it: (1) a poster title plus a one-line caption for the key graph, for classmates at the science fair; (2) a one-sentence social post for family and friends; (3) a one-line bottom line for a factsheet for the school council, which is deciding whether to insulate the school's hot-water system. Then, in pairs, compare your three versions and answer: what stayed the same in all three, what changed, and which version was hardest to write — and why the hard one was hard.

Activity 2 — Repair the justification. In pairs, use the claim–evidence–reasoning figure. One of you reads each broken justification below; the other names the fault in one word (missing evidence / missing reasoning / claim too strong) and repairs it in one spoken sentence. (i) “More layers reduce heat loss — trust me.” (ii) “The drops were 24.0, 15.0, 9.5, 6.5 and 4.5 °C.” (iii) “Our four layers cut the drop from 24.0 °C to 4.5 °C, so insulation will keep anything warm forever.” Swap roles and repeat with a finding of your own from a Chapter 3 or 4 investigation.

Activity 3 — Plan post 4 (elaboration VC2S10I08.E06). The campaign figure plans posts for the transport, electricity and food slices. Using the footprint chart, draft post 4 for the heating slice (11%): write the hook (one line, leading with the number), describe the visual in one sentence, and give the call to action (one small do-able change).

Then run your draft through three items of the before-you-send checklist — one clear message, claim ↔ evidence, attribution — and fix anything that fails. Note which item of the three was hardest to pass, and why.

Worked examples

Datasets in this section are simulated data for practice.

Example 1 — scaffolded

A class has the trolley data of the E02 figure (2.0 kg trolley; forces 1.0–5.0 N at accelerations 0.5–2.5 m/s²). Choose and justify a format for each situation, using the two questions of the format-choice figure.

- (a) Year 7 students at the science fair, who have never met force and acceleration.
- (b) Another class's teacher, who needs to check every step before repeating the investigation.
- (c) A student chooses a social media campaign to show the full method and all five data points with uncertainty. Judge the choice.

Working	Comment
(a) Purpose: inform an audience new to the idea. A short video or animation, or an infographic, shows the pattern — double the acceleration, double the force — in seconds, with no table to decode	Format matches purpose (inform) and audience (younger, visual).
(b) Purpose: let someone check and repeat. Only the written report carries the full method, every data point, the uncertainty and the references (6A)	The checking audience needs the detail only a report keeps.
(c) A campaign is short posts with one message each; the full method and all data points will not fit the format, and the audience for a method is not a scrolling feed	The format fails both questions: it cannot carry the content, and the audience is wrong.

The same data takes a video or infographic for (a), a report for (b), and refuses the campaign in (c). The data never changed — the audience and the purpose did.

Example 2 — scaffolded

Two claims are made about the insulation data (drops 24.0, 15.0, 9.5, 6.5, 4.5 °C for 0–4 layers). Judge each against the claim–evidence–reasoning figure.

Claim A: “In our test, more layers reduced the heat lost, with a smaller benefit for each added layer.” Claim B: “Four layers of anything will keep anything warm forever.”

Working	Comment
A: the evidence is the falling drops; the reasoning is that each added layer made the drop smaller; the claim says no more than “in our test”	Every link present; the claim is no stronger than the evidence.
A: the savings 9.0, 5.5, 3.0, 2.0 °C are exactly the “smaller benefit” the claim names	The claim even reports the limit of the benefit — honest.
B: the evidence is one beaker, one material, 10 minutes	The evidence exists, but it is thin.
B: the claim jumps from one material in one 10-minute test to “anything ... forever”	The claim is stronger than the evidence — the reasoning link cannot carry the jump.

Claim A is a justification: claim, evidence and reasoning all present, claim sized to the data. Claim B is an overclaim: the same starting data, but a conclusion the data cannot carry (Subtopic 5A).

Example 3 — unscaffolded

Use the two-panel figure of the insulation data drawn twice. Explain which panel fits which audience, what the newsletter version fairly drops, and the two things that may never be dropped for any audience.

The left panel — points, uncertainty bars, full axes with units, a caption — fits the class report and any checking audience (6A’s conventions live there). The right panel — plain bars with the numbers written in — fits the school newsletter, whose readers want the pattern in three seconds, not the machinery. What the newsletter fairly drops is the *detail a checking audience alone needs*: the uncertainty bars and the point-by point scatter, because the newsletter is not where the data is checked. What may never be dropped, for any audience, is honesty of the scales (an axis starting part-way up would make the layer differences look bigger than they are — Subtopic 4C) and the units: “24.0” with no °C tells the newsletter reader nothing. Same numbers, different detail — but never different honesty.

Example 4 — unscaffolded

A draft infographic for the trolley data has: a title reading “FORCE IS EVERYTHING”; a graph with numbers on the axes but no axis labels and no units; and no source line. Judge the draft against the five parts of the infographic anatomy, and fix it.

The draft fails three of the five parts. Part 1: the title is not a claim the data carries — “FORCE IS EVERYTHING” says nothing the table shows; the fix is a title that is the message, such as “Twice the force, twice the acceleration”. Part 3: the graph has numbers but no labels or units, so an acceleration of 2.5 cannot be told from a force of 2.5; the fix is axis labels with units, m/s² and N. Part 5: with no source line, no number can be checked; the fix is one line naming the data (class investigation, simulated data for practice) and, where a relationship is stated, where it is taught (Subtopic 15B). Parts 2 and 4 (big numbers with units; one takeaway sentence) the draft may keep. An infographic is at its best when every element spends its budget on one honest, checkable message.

Practice questions

Scaffolded questions

Question 1 Use the one-finding figure (insulation finding, four audiences). (a) Name the format matched to “other scientists” and the format matched to “family and friends”. (b) State what does not change between the four boxes. (c) List the three things that do change with the audience.

Question 2 Use the format-choice and format-gallery figures. (a) A social media campaign sits under which purpose? (b) Which format is described as “one page for a decision-maker: bottom line, cost, recommendation”? (c) Explain in one sentence why no format is best in itself.

Question 3 Use the claim–evidence–reasoning figure. (a) Name the three links of a justification. (b) Which link is broken by the overclaim “Four layers of anything will keep anything warm forever”? (c) State which link scientists check hardest, and which link a general audience usually tests.

Question 4 Use the two-panel same-data figure (drops 24.0, 15.0, 9.5, 6.5, 4.5 °C). (a) Read the drop for 2 layers from either panel. (b) Give two differences between the two representations. (c) Explain why dropping the uncertainty bars for the newsletter is fair, while dropping the units would not be.

Question 5 Use the conventions figure. (a) Name two conventions of the written report that Subtopic 6A delivers. (b) Name one convention of the infographic and one of the oral presentation. (c) Explain in one sentence what breaking a format’s conventions costs.

Question 6 Use the before-you-send checklist. (a) Which checklist item sends you back to Subtopic 4C, and what does it forbid? (b) Which item sends you back to Subtopic 5A, and what does it require? (c) Which item can only be passed by someone other than you?

Unscaffolded questions

Question 7 A group must communicate the trolley data (2.0 kg; forces 1.0–5.0 N) to three audiences: a science newsletter for parents, an oral talk to their own class, and a poster for the science fair. (a) Match each audience to a format from the gallery, with a one-line reason each. (b) The group lets the spreadsheet’s default chart choose the graph type, axis range and colours for all three. State what the tools figure says about this, and name two choices the group must still make itself.

Question 8 Use the E02 force data (trolley mass 2.0 kg; accelerations 0.5, 1.0, 1.5, 2.0, 2.5 m/s²; forces 1.0, 2.0, 3.0, 4.0, 5.0 N). (a) Read the force needed at 1.5 m/s². (b) Write the one-line pattern the table shows, in plain words. (c) State which part of the infographic anatomy that one line becomes.

Question 9 A student's draft infographic for the trolley data has a claim title, two big numbers with units, one graph with labelled axes and units, and a takeaway sentence — but no source line. (a) Name the anatomy part that is missing. (b) Explain why an infographic without that part fails the checklist item “attribution”. (c) The same student says “the takeaway sentence is my opinion, so it does not need checking”. Judge the statement against the checklist.

Question 10 Use the interactive feedback-loop figure. (a) Name the two controls that make the presentation interactive. (b) Explain what “the user discovers the loop instead of being told it” means. (c) The body systems behind the loop are taught in Subtopic 8B. Does that mean this presentation cannot be made before 8B is taught? Answer using the idea of supplied content.

Question 11 Use the three climate panels (ice 7.5 → 3.9 million km²; ocean +0.85 °C since 1980; heat days 12 → 52 per year). (a) State, in one sentence each, what the three panels show. (b) State the single message the three panels share. (c) Explain why the finished infographic must name the source of every number, and where the sourced evidence is studied in this book.

Question 12 Use the footprint chart (Transport 34%, Electricity 21%, Food 19%, Goods and services 15%, Heating 11%). (a) Show that the five shares form a whole. (b) Name the slice that names post 1 of the campaign, and why. (c) A post claims “getting around is nearly half of everything”. Judge the claim against the data.

Question 13 Use the campaign plan. Post 2's hook reads “21% is electricity — much of it for nothing”. (a) State which part of the hook the supplied footprint data carries. (b) State which part it does not carry, and what the campaign must do with that part before posting. (c) Name the checklist item that catches the fault.

Question 14 A campaign post reads: “Walk for one week and you will halve your household's carbon footprint.” The supplied data gives transport 34% of the footprint. (a) Even if walking removed the whole transport share, what is the biggest saving the data allows? (b) Judge the post's claim against that number, naming the fault in Subtopic 5A's language. (c) Rewrite the hook so the evidence carries it.

Question 15 The insulation finding (drop 24.0 °C with no layers, 4.5 °C with four) must be communicated twice. (a) Write it as a one-sentence report-style conclusion. (b) Write it as a one-sentence social post for family and friends. (c) State what changed between the two sentences, and the one thing that must not change.

Question 16 Audit this communication against the before-you-send checklist: a poster titled “SAVE THE PLANET”, carrying one pie chart with no labels and no source, and the line “scientists say it's true”. Name three checklist items the poster fails, and fix the worst one in a single rewritten line.

Answers

Question 1 (a) report (6A) for other scientists; video or post for family and friends; (b) the finding; (c) the format, the detail kept, and the words used. **Question 2** (a) call to action — change what people do; (b) factsheet / briefing; (c) each format is best FOR a particular audience and purpose, so “best” only makes sense once those are named.

Question 3 (a) claim, evidence, reasoning; (b) the reasoning link cannot carry the jump from one beaker, one material, 10 minutes to “anything ... forever” — the claim is stronger than the evidence; (c) scientists check the evidence (and the method); a general audience usually tests whether the reasoning makes sense to them. **Question 4** (a) 9.5 °C; (b) any two — left has points and a line, right has bars; left has uncertainty bars, right does not; left has a caption and full report conventions, right has the numbers written in and plain labels; (c) the newsletter is not where the data is checked, so the checking detail (uncertainty bars) can go; units may never go, because a number with no unit tells the reader nothing. **Question 5** (a) any two — numbered figures with captions, units on every axis, past tense, reference list; (b) infographic: the source of every number shown (units on the graph); oral: say what each graph shows as it appears (define a term before using it; invite questions); (c) the audience’s trust — attention goes to the hunt instead of the science. **Question 6** (a) “honest scales” — it forbids an axis trick that makes a small difference look big; (b) “claim ↔ evidence” — the claim must be no stronger than the data under it; (c) “tested on the audience” — someone like the real audience must read or use it. **Question 7** (a) newsletter for parents → factsheet or short plain-language post (one page, bottom line); oral talk to their class → oral presentation with slides (the audience can question you); science fair → poster (one standing page, discussed in person); (b) the tool never chooses for you — defaults keep default axes, colours and types; the group must still choose the representation/graph type and the honest axis range (and the format, audience match, and honesty of the claim). **Question 8** (a) 3.0 N; (b) double the acceleration, double the force (force rises in equal 1.0 N steps as acceleration rises in equal 0.5 m/s² steps); (c) the title — the title IS the claim, one message in plain words. **Question 9** (a) part 5 — the source line; (b) “attribution” requires every number to name its source; with no source line no number in the infographic can be checked; (c) wrong — a takeaway sentence is a claim about the data, so it must be no stronger than the data (claim ↔ evidence); opinions dressed as takeaways still need checking. **Question 10** (a) the slider (change the set point) and the button (add a disturbance); (b) the user changes an input and watches the model respond, so they work out the loop’s shape themselves instead of reading it off a slide; (c) no — the loop shape is supplied content; 6B’s task is the communication choice (what makes it interactive), while 8B later teaches the body systems the loop applies to. **Question 11** (a) sea-ice extent falls from 7.5 to 3.9 million km² over 1980–2020; ocean temperature rises by 0.85 °C over the same years; extreme-heat days rise from 12 to 52 per year from the 1980s to the 2020s; (b) independent lines of evidence all point the same way — Earth is warming; (c) so the audience can check where each number came from (climate claims lean on trust in sources); the sourced evidence is studied in Subtopic 12C. **Question 12** (a) 34 + 21 + 19 + 15 + 11 = 100%; (b) transport, 34% — the biggest slice names the first post; (c) not carried: 34% is not “nearly half” (half is 50%) — the claim makes the share sound bigger than it is, though a fair hook could say “more than a third”. **Question 13** (a) “21% is electricity” — the data gives that share; (b) “much of it for nothing” — the supplied data says nothing about how much electricity is wasted; the campaign must source that part (a number with a named source) or cut it; (c) claim ↔ evidence (and attribution). **Question 14** (a) 34% — removing the whole transport share saves at most 34%, not 50%; (b) the claim is stronger than the evidence — an overclaim, in 5A’s language the claim outruns the data; (c) e.g. “Getting around is 34% of your footprint — walk one trip this week and start there.” **Question 15** (a) e.g. “Adding layers of insulation reduced the mean temperature drop of the beaker in 10 minutes from 24.0 °C to 4.5 °C, with a smaller saving for each added layer.”; (b) e.g. “Wrapping the hot-water bottle in four layers kept it 20 degrees warmer in 10 minutes — layers work!”; (c) changed: the words, the detail kept, the format’s conventions; must not change: the finding itself — and its honesty (no claim bigger than the data). **Question 16** Fails (any three): one clear message (“SAVE THE PLANET” cannot be repeated back as a finding); representations (pie chart with no labels, unreadable without the text); attribution (no source for the chart, “scientists say it’s true” names nothing); claim ↔ evidence (no evidence shown under the claim); tested on the audience. Fix, e.g.: replace the title with the claim the chart carries — “Our school’s waste audit: food is the biggest slice — 38% (source: term-2 waste audit, 5B)”.

Fully-worked solutions

Question 1 (a) Other scientists get the written report (its structure and conventions are 6A’s); family and friends get the short video or social post. (b) The finding — “adding layers reduced the drop from 24.0 °C to 4.5 °C” — is identical in all four boxes. (c) The format, the detail kept, and the words used.

Question 2 (a) Call to action — change what people do (a campaign asks its audience to act). (b) The factsheet / briefing. (c) The gallery’s test is “best FOR”: each format serves a particular audience and purpose, so a format can only be judged once the audience and purpose are named — the report that is perfect for checking is hopeless for a scrolling feed.

Question 3 (a) The claim, the evidence, and the reasoning that links them. (b) The claim outruns the evidence: the reasoning link is asked to carry a jump from one beaker, one material and ten minutes to “anything ... forever”, which it cannot — so the chain breaks at claim ↔ evidence via faulty reasoning. (c) Scientists check the evidence (and the method behind it) hardest; a general audience usually tests whether the reasoning makes sense to them.

Question 4 (a) 9.5 °C in both panels — same numbers, two representations. (b) Any two: the left is a line-and-point graph, the right a bar chart; the left carries uncertainty bars, the right does not; the left has a caption and full report conventions, the right writes the numbers in with plain labels. (c) The uncertainty bars are checking detail — the newsletter is not where the data is checked, so dropping them changes the detail, not the honesty. Units are different: “9.5” with no °C is not simpler, it is meaningless, so units may never be dropped for any audience.

Question 5 (a) Any two of: numbered figures with captions; units on every axis; past tense; a reference list. (b) Infographic: the source of every number shown (and units on the graph). Oral presentation: say what each graph shows as it appears (or define a term before using it; invite questions). (c) Trust — a reader who must hunt for what the format normally shows spends attention on the hunt, not on the science.

Question 6 (a) “Honest scales”, which forbids any axis trick that makes a small difference look big (the Subtopic 4C checks). (b) “Claim ↔ evidence”, which requires that the claim be no stronger than the data under it (the Subtopic 5A rule). (c) “Tested on the audience” — it needs someone like the real audience to read or use the piece, and you to fix what they stumbled on.

Question 7 (a) Parents’ newsletter → a factsheet or short plain-language post: one page, bottom line, plain words. Oral talk to their own class → oral presentation with slides: spoken, and the audience can question you at the end. Science fair → scientific poster: one standing page with the question, key graph and conclusion, discussed in person. (b) The tools figure says the tool never chooses for you: a default chart keeps its default axes, colours and types. The group must still make the choices the tool cannot: the representation (graph type for each audience), an honest axis range, and — above the tool — the format, the audience match and the honesty of the claim.

Question 8 (a) 3.0 N. (b) Double the acceleration, double the force — force climbs in equal 1.0 N steps as acceleration climbs in equal 0.5 m/s² steps (a straight line through the origin). (c) The title: in an infographic the title IS the claim, one message in plain words.

Question 9 (a) Part 5 — the source line, “the source of every number, always”. (b) The checklist item “attribution” requires every number and image to name its source; with no source line, none of the infographic’s numbers can be checked, so the item fails. (c) The statement fails the checklist. A takeaway sentence is a claim about the data, so “claim ↔ evidence” applies to it: it must be no stronger than the data under it. An opinion wearing the takeaway’s position still gets checked.

Question 10 (a) The slider (“change the set point”) and the button (“add a disturbance — exercise, what happens next?”). (b) The user changes an input and the model responds while they watch, so the loop’s shape — rise, response, correction, repeat — is something the user works out, not something read off a slide. (c) No. The loop shape is supplied content for the communication task: what 6B teaches and assesses is the presentation choice (what makes it interactive), while the receptor–control centre–effector biology the loop describes is taught later, in Subtopic 8B.

Question 11 (a) Polar panel: September sea-ice extent falls from 7.5 to 3.9 million km² across 1980–2020. Ocean panel: ocean temperature rises by 0.85 °C over the same years. Heat panel: extreme-heat days rise from 12 per year in the 1980s to 52 in the 2020s. (b) Independent lines of evidence — ice, ocean, weather — all point the same way: Earth is warming. (c) Because a climate message stands or falls on whether its numbers can be checked; naming every source lets the audience (and 12C’s later, sourced treatment) verify each one. The evidence with sources is studied in Subtopic 12C.

Question 12 (a) 34 + 21 + 19 + 15 + 11 = 100 — the five shares are the whole footprint. (b) Transport (34%): the campaign’s first post takes the biggest slice, because the biggest share is the strongest honest hook. (c) The claim is

not carried: half would be 50%, and 34% is a third-and-a-bit, not “nearly half”. The hook makes the share sound bigger than it is — a fair version would say “more than a third”.

Question 13 (a) “21% is electricity” — the supplied footprint gives electricity a 21% share, so the number is carried. (b) “Much of it for nothing” — the supplied data says nothing about how much of that electricity is wasted. Before posting, the campaign must either attach a sourced number to that part or cut it. (c) “Claim ↔ evidence” — the claim is stronger than the supplied data — together with “attribution”, because the wasted-share part names no source.

Question 14 (a) 34%. Even removing the entire transport share saves 34% of the footprint; a half (50%) is beyond anything the data allows. (b) The claim is stronger than the evidence — an overclaim. In 5A’s language, the claim outruns the data: “halve” promises 50% where the biggest honest saving is 34%. (c) For example: “Getting around is 34% of your home’s footprint — walk, ride or share one trip this week.” The number is the data’s, the action is small, and the claim fits the evidence.

Question 15 (a) For example: “Adding layers of insulation reduced the mean temperature drop of the beaker in 10 minutes from 24.0 °C to 4.5 °C, with a smaller saving for each added layer.” (b) For example: “Wrapped the hot bottle in four layers and it stayed 20 degrees warmer in 10 minutes — layers work!” (c) What changed: the words (technical to plain), the detail kept (full drops and the per-layer pattern to one vivid number), and the conventions (report past tense and units-everywhere to a post’s shorthand). What must not change: the finding itself — both sentences must stay inside what the data says, with no claim bigger than the evidence.

Question 16 Three failures, e.g.: (i) “one clear message” — “SAVE THE PLANET” cannot be repeated back as a finding; (ii) “representations” — a pie chart with no labels and no units cannot be read without the text; (iii) “attribution” — no source names where the chart came from, and “scientists say it’s true” attributes nothing checkable. (Also acceptable: “claim ↔ evidence”, since no evidence shown sits under the claim; and “tested on the audience”.) The worst is the missing attribution/evidence pair, and a one-line fix rewrites the claim to something the data carries: “Our school’s waste audit: food is the biggest slice — 38% (source: term-2 waste audit).” The line is a claim sized to one dataset, with its source named.

Where this leads: Subtopic 6A completes this chapter — the written report’s structure, conventions, scientific vocabulary and referencing (elaborations .E01 and .E05) are the other half of VC2S10I08. The supplied contexts return with their science taught: force and acceleration in Subtopic 15B, feedback loops in 8B, the sourced climate evidence in 12C, and footprint and mitigation science in 12D. And the whole skill is assessed where it matters: the written report to a stated audience in SIT-2, and the Chapter 4–6 test (T2), both of which ask you to choose a format and representations for an audience and to justify the choice — exactly the two questions this subtopic begins with.

Test A

Topic test T2 — Data, evidence and communication · Chapters 4–6 · Covers subtopics 4A, 4B, 4C, 5A, 5B, 6A and 6B

What this test is — Topic test T2 from the assessment plan (§7): *data, evidence and communication*. It covers Chapters 4–6 — Processing, modelling and analysing; Evaluating; Communicating — and assesses the five inquiry content descriptions taught there: VC2S10I04 (4A and 4B), VC2S10I05 (4C), VC2S10I06 (5A), VC2S10I07 (5B) and VC2S10I08 (6A and 6B). Like SIT-1, T2 is hosted by Chapter 6 and is sat **after Ch6, before the knowledge chapters** — on purpose, nothing in it needs Ch7–16 content. It is inquiry, assessed as inquiry (D7). **Administration** — **a school instrument, not a VCAA exam**. Levels 9 and 10 carry no VCAA examination and no external assessment. This paper is a school-based assessment instrument of this book’s own design, graded against the achievement-standard extracts of VC2S10I04, VC2S10I05, VC2S10I06, VC2S10I07 and VC2S10I08 (quoted at the end of the marking guide). **Completion is untimed**: the suggested time is a guide only, and a student may take all the time they need. **Reading support**: the plan specifies none for this paper, so students may use the reading support their classroom normally provides — for example, a teacher reading a question aloud. Reading is not being assessed. **Marks: 40** — Test A 10 marks, Test B 30 marks. All 40 marks are inquiry-strand (paper minimum: 6, D7).

About this test

Covers	Chapter 4 — Processing, modelling and analysing; Chapter 5 — Evaluating; Chapter 6 — Communicating; subtopics 4A, 4B, 4C, 5A, 5B, 6A and 6B
Content descriptions	VC2S10I04 (4A and 4B) · VC2S10I05 (4C) · VC2S10I06 (5A) · VC2S10I07 (5B) · VC2S10I08 (6A and 6B)
Total marks	40 — Test A 10 marks, Test B 30 marks
Inquiry marks	40 of 40 — every item on this paper is inquiry-strand (paper minimum: 6, D7)
Calculator	Not permitted — scientific calculators are permitted for T4, T5 and T6 only (§7)
Suggested time	50 minutes

How to run this test

- A scientific calculator is **not** permitted for this paper — §7 permits calculators for T4, T5 and T6 only. Every calculation on this paper is short enough to do by hand. No formula sheet. No reading time.
- **Untimed completion** — the suggested time is a guide only. A student may take all the time they need.
- **Reading support** — any item may be read aloud to a student who asks. Reading is not being assessed.
- Answer every question in the spaces provided. Show your working wherever you calculate.
- For Q11(d), students draw their graph on grid paper supplied by the teacher.

Choose the best answer for each of the 10 questions. Each question is worth 1 mark.

Q1. The MEDIAN of {2, 5, 7, 9, 12} is: (1 mark)

- A. 7
- B. 9
- C. 6
- D. 12

Q2. The range of {3, 8, 15, 20} is: (1 mark)

- A. 3
- B. 11
- C. 17
- D. 20

Q3. If your measured value differs from a published reference, the FIRST step is to: *(1 mark)*

- A. Reject published
- B. Reject your data
- C. Republish
- D. Check experimental method, calibration, and conditions

Q4. A student plots sunspot activity and Earth's average surface temperature for 1900–2020 on the same axes. From 1900 to about 1970, the two lines rise and fall together. After 1970, the temperature keeps climbing while the sunspot cycle continues as before. Which conclusion do the data best support? *(1 mark)*

- A. Sunspot activity is the main cause of the change in temperature, because the two lines move together
- B. Earth's temperature controls sunspot activity, because the temperature kept climbing after 1970
- C. The two variables show a correlation, but the divergence after 1970 means the data do not establish that sunspot activity causes the change
- D. There is no relationship of any kind between sunspot activity and temperature

Q5. A RANDOM error: *(1 mark)*

- A. Is the same as systematic
- B. Is repeatable
- C. Always biases one way
- D. Varies unpredictably and tends to average out

Q6. A SYSTEMATIC error: *(1 mark)*

- A. Cancels out
- B. Biases results consistently in one direction
- C. Is rare
- D. Is random

Q7. To verify a claim about atmospheric CO₂ levels, the BEST source is: *(1 mark)*

- A. An anonymous blog
- B. A single tweet
- C. An advert
- D. Peer-reviewed monitoring data (e.g. Mauna Loa)

Q8. A news headline reads: 'New study proves that a popular soft drink causes poor sleep.' The study it reports surveyed 400 teenagers about the drinks they have and their sleep. Which is the strongest reason to question the word 'causes' in the headline? *(1 mark)*

- A. A survey of 400 teenagers is too large to be trusted

- B.** The study was a survey — it can show an association but not a cause
- C.** Sleep cannot be studied scientifically
- D.** The headline does not name the company that makes the drink

Q9. A student writes up an investigation of the bounce height of a ball. Which sentence belongs in the discussion section of the report rather than in the method, results or conclusion? (1 mark)

- A.** “Bounce height was about 0.7 times the drop height, as predicted.”
- B.** “The ball was dropped from heights of 0.50, 1.00, 1.50 and 2.00 m.”
- C.** “Mean bounce height at the 1.00 m drop: 0.72 m.”
- D.** “As drop height increased, bounce height increased.”

Q10. A group has finished an investigation of heat loss through different insulating materials. They want to persuade the school council to pay for better insulation, and they have one page and one short meeting. Which format best suits this audience and purpose? (1 mark)

- A.** A full written report with every trial and every reference
- B.** A peer-reviewed journal article
- C.** A one-page factsheet with the bottom line, the cost and a recommendation
- D.** A ten-minute video about the history of insulation

Test B

Answer every question in the spaces provided. Show your working wherever you calculate. Questions 11–15 are worth 30 marks.

The investigation

Another group in your school has run an investigation and handed you their write-up. Your job is to read it, process it, and say what it actually shows.

Their question. *Does the mass of clay stirred into water change how deeply light penetrates?* The depth at which the light sensor's reading falls to a set value is called the **penetration depth**.

Their setup. The group worked at the lab bench with five identical clear containers, a lamp clamped 10 cm above the water surface, a light sensor, a ruler with centimetre marks taped vertically beside the container, a balance, a stirring rod and powdered clay. Each trial used 1 L of water taken from the same source. The light sensor had not been calibrated — it had not been checked against a known light level — and the group used it as found. The lamp was clamped once at the start of the investigation and never checked again. Safety: spills wiped up at once so nobody slips; nobody looks directly at the lamp; glass handled with care.

Their method, as they wrote it:

1. Weigh out the mass of clay to be tested — 0 g, 2 g, 4 g, 6 g or 8 g — on the balance.
2. Pour 1 L of water into a clean container and stir in the clay until the water looks evenly cloudy.
3. Place the container under the lamp.
4. Lower the light sensor slowly into the water until its reading falls to the set value, and read the penetration depth from the ruler at eye level. Record the depth to the nearest cm.
5. Repeat steps 1–4 two more times at the same mass, using fresh water and fresh clay each time.
6. Move to the next mass. Test the masses from smallest to largest.

Their results (simulated data for practice):

Clay mass (g)	Depth, trial 1 (cm)	Depth, trial 2 (cm)	Depth, trial 3 (cm)	Mean depth (cm)
0	84	84	81	
2	63	61	62	
4	48	30	45	
6	37	35	36	
8	30	28	29	

The group stopped before they processed their data. The mean column is empty — filling it is your first job.

Answer all five questions. The questions are worth 30 marks in total:

Question	Assesses	Marks
11	Processing and representing the data set (VC2S10I04)	10
12	The trend, the relationship and the estimate from the line (VC2S10I05)	5
13	Error, validity and reproducibility (VC2S10I06)	5
14	A justified conclusion and an assessed claim (VC2S10I07)	6
15	Format and section choice for an audience (VC2S10I08)	4

Question	Assesses	Marks
	Total	30

Q11. Processing and representing the data set (10 marks)

- (a) Calculate the mean penetration depth at 0 g, 2 g, 6 g and 8 g. Record each mean to the nearest 0.1 cm. (Mean = sum of the trials ÷ number of trials.) (2 marks)
- (b) One reading in the table does not fit the pattern. Identify it, and give one piece of evidence from the table that shows it does not fit. (2 marks)
- (c) Calculate the mean penetration depth at 4 g, handling that reading the way you think is right, and give your reason in one line. (1 mark)
- (d) On the grid paper your teacher gives you, construct a scatter plot of the processed data: clay mass on the horizontal axis (the independent variable goes on the horizontal axis), mean penetration depth on the vertical axis. (5 marks)
- (e) Label both axes with the quantity and its unit, and give the graph a title. (1 mark)
- (ii) Choose an even scale for each axis that uses most of the grid. (1 mark)
- (iii) Plot the five means you calculated in parts (a) and (c). (2 marks)
- (iv) Draw a line of good fit — a smooth line, straight or curved, that follows the pattern of all your points as closely as possible. (1 mark)

Q12. The trend and the relationship (5 marks)

- (a) Describe the trend your graph shows. Name both variables in your sentence. (1 mark)
- (b) Is the fall in mean depth the same for each extra 2 g of clay? Support your answer with two numbers from your processed table. (1 mark)
- (c) Use your line of good fit to estimate the mean penetration depth at 5 g of clay. (1 mark)
- (d) The group says their result is causal — the clay itself makes the change happen — rather than a correlation. Do you agree? Justify your answer in one or two lines. (2 marks)

Q13. Error, validity and reproducibility (5 marks)

- (a) Identify one random error in this investigation — an effect that pushes readings both ways — and give your reason. (1 mark)
- (b) Identify one systematic error in this investigation — an effect that pushes every reading the same way — and give your reason. (1 mark)
- (c) A second group in the school followed the written method exactly and found a mean penetration depth of 55 cm at 2 g. Calculate the percentage difference between the two groups' means at 2 g, relative to the first group's mean, to the nearest 1%. (Percentage difference = difference ÷ first group's mean × 100.) (1 mark)
- (d) Using your value from (c) and one flaw in the written method, state whether the method is reproducible, and justify your answer in one or two lines. (1 mark)
- (e) State one change that would make the comparison fairer — one way to improve the validity of the investigation. (1 mark)

Q14. A justified conclusion and an assessed claim (6 marks)

- (a) Write a statement that answers the investigation question, covering only what was actually tested. (1 mark)
- (b) Justify your statement with specific numbers from your processed data. (1 mark)
- (c) The school newsletter runs a headline about the investigation: 'Tests prove any clay at all will kill every plant in our creeks.' Identify two ways this claim goes beyond what the evidence shows. (2 marks)

- (d) The group wants to include a published diagram of how light travels through cloudy water in their display. State the ethical requirement they must meet before they use it. *(1 mark)*
- (e) State one thing the group could do to make their evidence stronger. *(1 mark)*

Q15. Format and section choice for an audience *(4 marks)*

- (a) The group wants to share their finding with students at the nearby primary school. Which format suits that audience best — a full written report, a short video or animation, a peer-reviewed journal article, or a spreadsheet of every trial? Give your reason in one line. *(2 marks)*
- (b) The group sorts two sentences into their report. Which section does each sentence belong in — results or discussion?
- (c) “The mean penetration depth of light at 2 g of clay was 62 cm.” *(1 mark)*
- (ii) “The penetration depth of light fell as the mass of clay rose, as we predicted.” *(1 mark)*

Marking guide

This guide is written so a teacher without a science background can mark the paper. Accept the student's own words wherever the meaning matches the answer given here. Spelling and grammar are not marked. Test A (the multiple-choice paper) is marked in "Section A — answers" below; Test B (the short and structured response paper) is marked in "Section B — answers and marking". Every item traces to the achievement-standard extracts of the five CDs in §4's rows for VC2S10I04, VC2S10I05, VC2S10I06, VC2S10I07 and VC2S10I08; all items on this paper are inquiry-strand items (D7). Where a later question builds on an earlier answer (Q11(d) on Q11(a)–(c); Q12 on Q11; Q13(d) on Q13(c)), mark the later question on the student's own processed values, not on the model's.

Inquiry-strand marks on this paper: 40 of 40 — all five CDs assessed are inquiry-strand CDs. The paper minimum is 6 (D7).

Section A — answers

Six items are drawn from the MCQ bank L9-10_Science.csv, keyed to this paper's content descriptions; the bank item ids keep the §4 join. In the bank, all six carry the key at A; the option order for Q2, Q3, Q5, Q6 and Q7 was shuffled at print, changing no option text and no key. Two typographic normalisations, changing no key and no code: Q2's bank stem ("Range of {3, 8, 15, 20}:" is printed as a full sentence; Q7 prints CO₂ with a true subscript per the house rules. Four items are authored against the same CD — never a neighbouring code — where the bank cannot supply an item at the right difficulty; each is documented in the table and in the provenance note below. Difficulty mix: four easy (D1), four medium (D2), two hard (D3).

Q	Answer	CD	Item provenance
1	A — 7	VC2S10I04	bank VC2S10I04.E02.S01.D1.V01 (printed as in the bank)
2	C — 17	VC2S10I04	bank VC2S10I04.E02.S01.D2.V01 (option order shuffled at print; stem normalised)
3	D — Check experimental method, calibration, and conditions	VC2S10I05	bank VC2S10I05.E01.S01.D1.V01 (option order shuffled at print)
4	C — The two variables show a correlation, but the divergence after 1970 means the data do not establish that sunspot activity causes the change	VC2S10I05	authored (hard) — the sunspot–climate case of VC2S10I05.E06, taught in 4C
5	D — Varies unpredictably and tends to average out	VC2S10I06	bank VC2S10I06.E02.S01.D1.V01 (option order shuffled at print)
6	B — Biases results consistently in one direction	VC2S10I06	bank VC2S10I06.E02.S01.D2.V01 (option order shuffled at print)
7	D — Peer-reviewed monitoring data (e.g. Mauna Loa)	VC2S10I07	bank VC2S10I07.E02.S01.D1.V01 (option order shuffled at print; CO ₂

Q	Answer	CD	Item provenance
			printed with a true subscript)
8	B — The study was a survey — it can show an association but not a cause	VC2S10I07	authored (medium) — the headline checks taught in 5B (VC2S10I07.E01)
9	A — “Bounce height was about 0.7 times the drop height, as predicted.”	VC2S10I08	authored (hard) — the report anatomy taught in 6A (VC2S10I08.E01)
10	C — A one-page factsheet with the bottom line, the cost and a recommendation	VC2S10I08	authored (medium) — the format gallery taught in 6B (CD text)

Section B — answers and marking

Q11 (10 marks) — inquiry: processing and representing the supplied data set (VC2S10I04; rehearses VC2S10I04.E02 — means and the effect of outliers). Means via the D11 interlock VC2M10ST01; the scatter plot and line of good fit via VC2M10ST02.

- (a) (2 marks) Means to the nearest 0.1 cm: 0 g → 83.0 cm, 2 g → 62.0 cm (1 mark); 6 g → 36.0 cm, 8 g → 29.0 cm (1 mark). Unrounded values (83, 62, 36, 29) are accepted.
- (b) (2 marks) The reading is 30 cm — trial 2 at 4 g (1 mark), with one piece of evidence from the table (1 mark): the other two trials at 4 g are 48 cm and 45 cm; or every trial at 6 g — more clay — is 37 cm or less, and more clay should let less light through, so the 4 g depth cannot sit below the 6 g depths; or the means elsewhere fall smoothly as the clay mass rises, and 30 cm breaks the smooth fall.
- (c) (1 mark) The handling, with a reason. Preferred: exclude the 30 cm reading and average the two trials that agree with each other and with the pattern: $(48 + 45) \div 2 = 46.5$ cm. Also accepted: keep it, giving $(48 + 30 + 45) \div 3 = 41.0$ cm, if the student says the odd reading pulls the mean below where the pattern puts it. A choice with no reason earns no mark here.
- (d) (5 marks)
- (e) (1 mark) Both axes labelled with quantity and unit — clay mass (g) horizontal, mean penetration depth (cm) vertical — and a title (e.g. *Mean penetration depth of light against clay mass in water (simulated data for practice)*).
- (ii) (1 mark) Even scales that use most of the grid — e.g. steps of 1 g or 2 g on the horizontal axis (0–8 g) and 5 cm or 10 cm on the vertical axis (0–90 cm). Starting at zero is expected at this band but not enforced if the graph still reads clearly.
- (iii) (2 marks) The five means from the student’s own parts (a) and (c) plotted accurately: four correct (1 mark), five correct (2 marks). Allow half a small square either way. Raw trials plotted instead of means earn at most 1 mark here.
- (iv) (1 mark) A line of good fit — a smooth line, straight or curved, falling as the clay mass rises, passing close to all five of the student’s plotted points with the points lying near the line on both sides. A point-to-point join is not a line of good fit and earns no mark here.

Q12 (5 marks) — inquiry: analysing the processed data (VC2S10I05; rehearses VC2S10I05.E06 — causal versus correlational).

- (a) (1 mark) The trend names both variables: as the mass of clay stirred into the water increases, the penetration depth of light decreases. “It gets shallower” without both variables named earns no mark.

-
- (b) (1 mark) No — each extra 2 g of clay removes less depth than the one before. With the preferred means: from 0 to 2 g the mean falls 83.0 → 62.0 cm, a fall of 21.0 cm; from 6 to 8 g it falls 36.0 → 29.0 cm, a fall of only 7.0 cm. Mark on the student's own processed values; any correct pair of steps that shows the shrinking fall earns the mark.
-
- (c) (1 mark) About 41 cm — accept roughly 36–44 cm read from the student's own line at 5 g (about 35–40 cm if the student kept the anomaly in the 4 g mean).
-
- (d) (2 marks) Causal (1 mark), with a justification (1 mark): only the mass of clay changed between trials — the same water source, the same containers, the same lamp position — so the comparison is fair, and there is a mechanism: clay particles suspended in the water block the light on its way down, so more clay means less light gets through. A justification that only says the two variables move together describes a correlation, not a cause, and earns no justification mark.

Q13 (5 marks) — inquiry: evaluating the method (VC2S10I06; rehearses VC2S10I06.E01 and .E02). The percentage difference is the D11 interlock VC2M9M04.

-
- (a) (1 mark) One random error belonging to this method, with a reason. Accept list: judging the moment the sensor's reading settles at the set value — the call comes a little early on one trial and a little late on the next; small differences in the mass of clay actually transferred — some powder clings to the balance paper or the stirring rod; reading the depth while the water is still swirling after stirring. Errors must belong to this method — generic answers (“human error”, “not careful enough”) earn no mark.
-
- (b) (1 mark) One systematic error belonging to this method, with a reason. Accept list: the light sensor was never calibrated — if it reads, say, low, every recorded depth is pushed the same way; the lamp was clamped once and never checked — if it sagged or dimmed part-way through the run, every later reading is pushed the same way.
-
- (c) (1 mark) 11%. Working: $(62 - 55) \div 62 \times 100 = 11.29\ldots\% \rightarrow 11\%$. Award the mark for correct substitution and answer; accept “about 11%”.
-
- (d) (1 mark) Not reproducible as written — the second group's mean at 2 g (55 cm) is 11% below the first group's (62 cm), far larger than the scatter of the trials themselves (61–63 cm), and the method leaves room for it: “stir in the clay until the water looks evenly cloudy” never says how long or how hard to stir, so two groups doing exactly what is written stir differently. The justification must use both the value from (c) and a named flaw in the written method.
-
- (e) (1 mark) One change that makes the comparison fairer. Accept list: check the lamp's distance and brightness before each trial — or test the masses in a random order — so a drifting lamp cannot change together with the clay mass; state a fixed stirring time and rate so every trial is stirred the same way; calibrate the light sensor before the first trial.

Q14 (6 marks) — inquiry: constructing and assessing claims (VC2S10I07; rehearses VC2S10I07.E04 — a conclusion justified from primary data — and the citation limb of VC2S10I07.E05).

-
- (a) (1 mark) A statement answering the question, scoped to what was tested: for this water in these containers, over the range 0–8 g of clay, the more clay stirred into the water, the less deeply light penetrates.
-

- (b) (1 mark) Specific processed numbers cited: the means fall 83.0, 62.0, 46.5 (or 41.0), 36.0 and 29.0 cm as the clay mass rises in equal 2 g steps (mark on the student's own processed values).
-
- (c) (2 × 1 mark) Any two of: “any clay at all” — nothing below 2 g was tested; “kill every plant” — the investigation measured penetration depth of light, not plant survival; “prove” — one school investigation with one water source cannot prove a general claim; “our creeks” — the evidence comes from containers of one water source, not from any creek.
-
- (d) (1 mark) Cite the source the diagram comes from — name it so it can be found again (the author or organisation and the title); accept also: seek permission first where the source requires it. Using the diagram without attribution earns no mark.
-
- (e) (1 mark) One way to strengthen the evidence. Accept list: another group repeats the investigation independently and the results agree; test more clay masses (for example 1 g, 3 g, 5 g) or a wider range; measure the penetration depth with a second instrument or method; compare the results with published measurements of light in water carrying suspended soil; write the method up in enough detail for others to check it.

Q15 (4 marks) — inquiry: selecting formats and sections for an audience (VC2S10I08; rehearses VC2S10I08.E01 and 6B's format gallery).

-
- (a) (2 marks) The short video or animation (1 mark), with a reason tied to the audience (1 mark): primary-school students are not the audience for a written report, a journal article or a spreadsheet of trials — a short video carries the finding in pictures and plain spoken words for an audience that will not read a technical report.
-
- (b) (2 marks) Sentence (i) belongs in the results — it reports what was measured, with no argument (1 mark). Sentence (ii) belongs in the discussion — it argues from the results and compares them with the prediction (1 mark).

Section B subtotal: 30 marks. Total: 10 + 30 = 40 marks.

Data provenance and sources. Every multiple-choice item is drawn from the MCQ bank L9-10_Science.csv keyed to VC2S10I04–VC2S10I08 or is authored against the same CD where the bank cannot supply — never a neighbouring code. The six bank items are printed with their bank ids above; the ids keep the §4 join. Q4 is authored because the bank's remaining clean VC2S10I05 slot (VC2S10I05.E02.S01.D2.V01) carries options that do not grammatically complete its stem, and the other VC2S10I05 slots fail distractor audit. Q8 is authored because the remaining VC2S10I07 slots fail distractor audit. Q9 and Q10 are authored because the bank's only clean VC2S10I08 slot (VC2S10I08.E02.S01.D1.V01) tests recall of Newton's second law — Chapter 15 content (15B) that students have not reached when T2 is sat after Ch6 — and the remaining VC2S10I08 slots fail distractor audit. The clay-and-light investigation is an original teaching scenario; the readings in the results table are **simulated data for practice**, labelled as such in the paper — they are teaching data, not measurements, carry no source claim, and no real group, school, waterway or measurement is represented.

- Victorian Curriculum and Assessment Authority, *Victorian Curriculum F–10 Version 2.0, Science, Levels 9 and 10*, content descriptions VC2S10I04, VC2S10I05, VC2S10I06, VC2S10I07 and VC2S10I08 and their elaborations, 2026. vcaa.vic.edu.au — retrieved 2026-08-22.

Elaboration contexts drawn on: VC2S10I04.E02 (sample properties — mean, median, range — with uncertainties and the effects of outliers acknowledged), VC2S10I05.E01 (experimental data compared with published reference data), VC2S10I05.E06 (causal versus correlational relationships — sunspot activity and climate change), VC2S10I06.E01 (the strength of the conclusion a data set supports), VC2S10I06.E02 (random and systematic errors and how they affect results), VC2S10I07.E01 (the validity of media reports judged against the study's method), VC2S10I07.E02 (a claim verified against the quality of its evidence), VC2S10I07.E04 (a conclusion

justified from primary data), the citation limb of VC2S10I07.E05 (acknowledging sources of secondary data — the protocol limb only; no Aboriginal or Torres Strait Islander cultural knowledge is authored, per D10), and VC2S10I08.E01 (report sections and conventions) with 6B's format gallery (CD text). The D11 maths interlocks carry the processing: means and descriptive statistics (VC2M10ST01), the scatter plot and line of good fit (VC2M10ST02), and the percentage difference between the two groups' means (VC2M9M04).

Teacher-facing note (not student text). T2 is sat after Ch6, so the paper is deliberately content-neutral: no Ch7–16 knowledge is assumed or assessed. Marking is strictly point-based per §7: every mark above is tied to a stated point, and no holistic judgement is applied at any level. A scientific calculator is not permitted on this paper — §7 permits calculators for T4, T5 and T6 only — and every calculation is short enough to do by hand. Graphing demand is capped by D11: the scatter plot and line of good fit is the VC2M10ST02 interlock; gradients and curve-linearisation sit beyond the interlock list — neither is required here, and neither is penalised if a student produces one. Q11(d) requires grid paper, supplied by the teacher. This test carries no Aboriginal and Torres Strait Islander content: VC2S10I07.E05 is drawn on at Q14(d) only through its citation limb, and VC2S10I08.E07 is not drawn on at all (D10).

Traceability

Item	Marks	CD	Achievement-standard evidence	Inquiry
Q1–Q2	2	VC2S10I04	data processed: median and range calculated from a sample	2
Q3–Q4	2	VC2S10I05	experimental data compared with published data; a correlation distinguished from a cause	2
Q5–Q6	2	VC2S10I06	random and systematic errors distinguished	2
Q7–Q8	2	VC2S10I07	claims verified against the quality of their evidence	2
Q9–Q10	2	VC2S10I08	report sections and a presentation format matched to purpose and audience	2
Q11	10	VC2S10I04 (+ VC2M10ST01, VC2M10ST02)	the supplied data set processed — means, anomaly handled — and represented as a scatter plot with a line of good fit	10
Q12	5	VC2S10I05	trend described, unequal falls shown, estimate read from the line, causal claim judged	5
Q13	5	VC2S10I06 (+ VC2M9M04)	random and systematic error identified;	5

Item	Marks	CD	Achievement- standard evidence	Inquiry
Q14	6	VC2S10I07	reproducibility judged with a percentage difference; one validity improvement named a scoped conclusion justified with processed numbers; an over-reaching claim assessed; a secondary source cited ethically; one way to strengthen evidence named	6
Q15	4	VC2S10I08	a format matched to audience and purpose; sentences sorted into report sections	4
Total	40			40

Achievement-standard extracts served (D14), verbatim from the authority file: VC2S10I04 — “*They select and construct a range of appropriate representations to organise, process and summarise data and information.*”; VC2S10I05 — “*They analyse and compare a variety of data and information to identify and explain qualitative and quantitative patterns, trends, relationships, assumptions and anomalies.*”; VC2S10I06 — “*They evaluate the validity and reproducibility of investigation methods including ways to improve the quality of data, and the validity of conclusions and claims.*”; VC2S10I07 — “*They provide evidence-based explanations for findings and construct logical arguments based on the evaluation of multiple sources of evidence to justify conclusions and assess claims.*”; VC2S10I08 — “*They select and use appropriate presentation formats, scientific content, vocabulary, models, conventions, formulas and other representations to achieve their purpose when communicating and justifying their ideas, findings, arguments and proposals to diverse audiences.*”

SIT-1 Designing and analysing

What this task is — Scientific Investigation Task 1 (SIT-1) from the assessment plan (§7): *designing and analysing*. A group's method and data set are supplied, whole. The student's job is to read them the way Chapters 2–6 taught the reading: identify the hypothesis and the variables and find the flaws in the design (VC2S10I01, VC2S10I02), process and represent the data (VC2S10I04), describe the trend, test the prediction and handle the reading that does not fit (VC2S10I05), evaluate validity, error and reproducibility (VC2S10I06), and justify a conclusion from the evidence (VC2S10I07). SIT-1 is printed in the Chapter 6 booklet and is sat **after Ch6, before the knowledge chapters** — on purpose, nothing in it needs Ch7–16 content. It is inquiry, assessed as inquiry (D7). **Achievement-standard extracts served (D14)**. From the authority file, for the six CDs this task assesses: VC2S10I01 — *“Students formulate and refine questions and hypotheses to make reasoned predictions, test relationships and develop explanatory models when investigating scientific questions, problems and claims.”*; VC2S10I02 — *“They plan a range of valid, reproducible and safe scientific investigations and explain how they have addressed any ethical and cultural considerations when generating or using primary and secondary data.”* (the ethical and cultural limb of VC2S10I02 is assessed through SIT-2's risk assessment and ethics statement, not here); VC2S10I04 — *“They select and construct a range of appropriate representations to organise, process and summarise data and information.”*; VC2S10I05 — *“They analyse and compare a variety of data and information to identify and explain qualitative and quantitative patterns, trends, relationships, assumptions and anomalies.”*; VC2S10I06 — *“They evaluate the validity and reproducibility of investigation methods including ways to improve the quality of data, and the validity of conclusions and claims.”*; VC2S10I07 — *“They provide evidence-based explanations for findings and construct logical arguments based on the evaluation of multiple sources of evidence to justify conclusions and assess claims.”* **Administration** — a school instrument, not a VCAA exam. Levels 9 and 10 carry no VCAA examination and no external assessment. This task is a school-based assessment instrument of this book's own design, graded against the achievement-standard extracts above. **Completion is untimed**: students may take the time they need, over more than one session if the school chooses. **Reading support**: the plan specifies none for this task, so students may use the reading support their classroom normally provides — for example, a teacher reading a question aloud. Calculations may be done by hand or with a scientific calculator. **Marks: 30**. The point-based marking guide and the full model response follow the questions — there is no holistic rubric anywhere in this task.

The investigation you are reading

Another group in your school has run an investigation and handed you their write-up. Your job is to read it, process it, and say what it actually shows.

Their question. *How does the temperature of water affect the time it takes a fizzy vitamin tablet to dissolve?*

Their setup. The group worked at the lab bench with one 250 mL beaker, one measuring cylinder, one thermometer, one stopwatch, one stirring rod and a tube of fizzy vitamin tablets — tablets that fizz and disappear when dropped into water. They measured each volume of water to the nearest mL, and they recorded every time to the nearest second, even though the stopwatch display shows hundredths of a second. The thermometer had not been calibrated — it had not been checked against a known temperature — and the group used it as found. Safety: no water hotter than 50 °C was used; the teacher poured the hot water; beakers stood on a heatproof mat; the solutions were not tasted or drunk; and hands stayed clear of hot glass until it cooled.

Their method, as they wrote it:

1. Measure 100 mL of tap water into the beaker.
2. Warm or cool the water until the thermometer reads one of the five test temperatures: 10 °C, 20 °C, 30 °C, 40 °C, 50 °C. Record the temperature just before adding the tablet.
3. Drop one fizzy vitamin tablet into the water and start the stopwatch at the same moment.
4. If the tablet seems to be dissolving slowly, stir gently with the stirring rod.
5. Stop the stopwatch when no more bubbles can be seen rising from the tablet.
6. Record the dissolving time.

7. Repeat steps 1–6 two more times at the same temperature, so there are three trials, reusing the same beaker. Then move to the next temperature. Test the temperatures in order, coldest first.

Their results (simulated data for practice):

Water temperature (°C)	Time, trial 1 (s)	Time, trial 2 (s)	Time, trial 3 (s)	Mean time (s)
10	58	62	60	
20	41	38	40	
30	31	23	29	
40	24	22	23	
50	18	17	18	

The group stopped before they processed their data. The mean column is empty — filling it is your first job.

Answer all seven questions. Show your working wherever you calculate. The questions are worth 30 marks in total:

Question	Assesses	Marks
1	The hypothesis and the variables (VC2S10I01, VC2S10I02)	5
2	Flaws in the method (VC2S10I02)	4
3	Processing the data — means, the odd reading and uncertainty (VC2S10I04)	5
4	Representing the data — scatter plot and line of good fit (VC2S10I04)	5
5	The trend and the prediction (VC2S10I05)	4
6	Error, validity and reproducibility (VC2S10I06)	4
7	A conclusion justified from the evidence (VC2S10I07)	3
	Total	30

Question 1 — the hypothesis and the variables (5 marks)

- Write the hypothesis this investigation is testing — a testable statement predicting the relationship between the two variables. (1 mark)
- Identify the independent variable — the variable the group changed on purpose. (1 mark)
- Identify the dependent variable — the variable the group measured. (1 mark)
- Identify two controlled variables — two things the method keeps the same on purpose. (2 marks)

Question 2 — flaws in the method (4 marks)

- Identify two features of the method that reduce the validity of the investigation — two ways the comparison is made less fair. (2 marks)
- Choose one of your features and say, in one line, what effect it has on the data. (1 mark)
- Name one detail of the method that makes it hard for another group to reproduce the investigation, and one change that fixes that detail. (1 mark)

Question 3 — processing the data (5 marks)

- Calculate the mean dissolving time at 10 °C, 20 °C, 40 °C and 50 °C. Record each mean to the nearest 0.1 s. (Mean = sum of the trials ÷ number of trials.) (2 marks)
- One reading in the table does not fit the pattern. Identify it, and give one piece of evidence from the table that shows it does not fit. (1 mark)
- Calculate the mean dissolving time at 30 °C, handling that reading the way you think is right, and give your reason in one line. (1 mark)
- The group recorded their times to the nearest second, even though the stopwatch display shows hundredths of a second. Explain, in one or two lines, why the times are not really known to a hundredth of a second. (1 mark)

Question 4 — representing the data (5 marks)

Construct a scatter plot of the processed data: water temperature on the horizontal axis (the independent variable goes on the horizontal axis), mean dissolving time on the vertical axis.

- Label both axes with the quantity and its unit, and give the graph a title. (1 mark)
- Choose an even scale for each axis that uses most of the grid. (1 mark)
- Plot the five means you calculated in Question 3. (2 marks)
- Draw a line of good fit — a smooth line, straight or curved, that follows the pattern of all your points as closely as possible. (1 mark)

Question 5 — the trend and the prediction (4 marks)

- Describe the trend your graph shows. Name both variables in your sentence. (1 mark)
- Is the fall in mean time the same for each 10 °C rise in temperature? Support your answer with two numbers from your processed table. (1 mark)
- The group had predicted: “each 10 °C rise in temperature will halve the dissolving time.” Use your processed data to decide whether this prediction is supported. Show one line of working. (1 mark)
- Use your line of good fit to estimate the mean dissolving time at 25 °C. (1 mark)

Question 6 — error, validity and reproducibility (4 marks)

- Identify one random error in this investigation — an effect that pushes readings both ways — and give your reason. (1 mark)
- Identify one systematic error in this investigation — an effect that pushes every reading the same way — and give your reason. (1 mark)
- A second group in the school followed the written method exactly and found a mean dissolving time of 48.5 s at 20 °C. Calculate the percentage difference between the two groups’ means at 20 °C, relative to the first group’s mean, to the nearest 1%. (Percentage difference = difference ÷ first group’s mean × 100.) (1 mark)
- Using your value from (c) and one flaw from Question 2, state whether the written method is reproducible, and justify your answer in one or two lines. (1 mark)

Question 7 — a conclusion justified from the evidence (3 marks)

- Write a statement that answers the investigation question, covering only what was actually tested. (1 mark)
- Justify your statement with specific numbers from your processed data. (1 mark)
- State one thing this evidence does not show — one limit of the investigation. (1 mark)

Sources

- Victorian Curriculum and Assessment Authority, *Victorian Curriculum F–10 Version 2.0, Science, Levels 9 and 10*, content descriptions VC2S10I01, VC2S10I02, VC2S10I04, VC2S10I05, VC2S10I06 and VC2S10I07 and their elaborations, 2026. vcaa.vic.edu.au — retrieved 2026-08-22.

The fizzy-tablet method is an original teaching scenario and the readings in the results table are **simulated data for practice**, labelled as such above; they are teaching data, not measurements, and carry no source claim. No real group, school or measurement is represented.

Elaboration contexts drawn on: VC2S10I01.E03 (temperature as a factor affecting how fast a change happens, with a reasoned prediction to test), VC2S10I02.E03 (planning an investigation with a stated methodology), VC2S10I02.E06 (determining the reproducibility of another group's method), VC2S10I04.E02 (means and the effect of outliers, with uncertainties acknowledged), VC2S10I05.E06 (a causal claim judged against a method that did not hold everything constant), VC2S10I06.E01 (the strength of the conclusion a data set supports), VC2S10I06.E02 (random and systematic error and how they affect results) and VC2S10I07.E04 (a conclusion justified from primary data). The D11 maths interlocks carry the processing: the scatter plot and line of good fit (VC2M10ST02), the percentage difference between the two groups' means (VC2M9M04) and the ratio test of the halving prediction (VC2M9M05).

Teacher-facing note (not student text). SIT-1 is sat after Ch6, so the task is deliberately content-neutral: no Ch7–16 knowledge is assumed or assessed, and the scenario is everyday chemistry read through the inquiry spine. It is a paper task — no practical is conducted for it; the one safety block sits in the supplied method itself, where 3B models safety at point of use. Marking is strictly point-based per §7: every mark above is tied to a stated point, and no holistic judgement is applied at any level. Graphing demand is capped by D11: the scatter plot and line of good fit is the VC2M10ST02 interlock; gradients of curved lines and re-plotting as $1 \div \text{time}$ sit beyond the interlock list — neither is required here, and neither is penalised if a student produces one. SIT-1 carries no Aboriginal and Torres Strait Islander content; D10's protocol limb is assessed through SIT-2's risk assessment and ethics statement, as §7 specifies. The model response that follows shows a full-mark standard; annotations in parentheses carry the mark points from the guide.

Marking guide

Point-based marking: every mark is a stated point below, and there is no holistic rubric. Award each point on its own; accept any answer listed, or any answer of the same standard. Spelling and grammar do not lose marks unless a word cannot be read. Where a later question builds on an earlier answer (Questions 4 and 5 on Question 3), mark the later question on the student's own processed values, not on the model's. **Total: 30 marks.**

Question 1 — 5 marks

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- (a) (1 mark) A testable statement predicting the relationship: the higher the temperature of the water, the shorter the dissolving time (the faster the tablet dissolves). Accept “if the water is hotter, then the tablet takes less time to dissolve”. No mark for restating the question or for a prediction with no direction.
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- (b) (1 mark) The temperature of the water.
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- (c) (1 mark) The dissolving time — the time from when the tablet is dropped in until it has dissolved.
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- (d) (2 × 1 mark) Any two things the method actually keeps the same: the volume of water (100 mL each time); one tablet of the same brand and type each time; the same beaker; the same thermometer; the same stopwatch. No mark for “the same amount of stirring” — the method does not keep stirring the same (that is Question 2's business); the distinction is part of what is being assessed.

Question 2 — 4 marks

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- (a) (2 × 1 mark) Any two features of this method that make the comparison less fair. Accept list: the stirring rule — step 4 stirs “if the tablet seems to be dissolving slowly”, so stirring effort changes from trial to trial, colder trials get more stirring, and stirred tablets dissolve faster, so a second factor changes together with the temperature; the end-point is a judgement — “when no more bubbles can be seen” is decided by eye, differently each time, and bubbles are harder to see in the colder, more slowly fizzing water; the temperature is recorded only before the tablet goes in — the water warms or cools during the run (the hotter water cools the most), so the intended temperature is not held steady; the beaker is reused without rinsing — liquid left from the previous trial gets into the next one; the method assumes every tablet in the tube is identical without checking. Must be a feature of this method — generic answers (“human error”, “not careful enough”) earn no mark.
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- (b) (1 mark) One line linking the named feature to its effect on the data. Example: the stirring rule pushes the cold-water times down, because the cold trials get the most stirring, so the effect of temperature looks smaller than it really is. Example: the judged end-point scatters the times, early on one trial and late on the next. Example: the unheld temperature means the hot trials actually run cooler than recorded, so the hot times come out longer than they should.
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- (c) (1 mark) One detail too vague to reproduce, with a matching fix. Example: “stir gently” never says how gently — fix: do not stir at all, or stir at a stated steady rate. Example: “no more bubbles can be seen” never says for how long — fix: stop the watch when the last solid piece of tablet disappears. Example: “warm or cool the water” never says how — fix: stand the beaker in a water bath set to each test temperature. The fix must match the named detail.

Question 3 — 5 marks

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- (a) (2 marks) Means to the nearest 0.1 s: 10 °C → 60.0 s, 20 °C → 39.7 s (1 mark); 40 °C → 23.0 s, 50 °C → 17.7 s (1 mark). Unrounded values (60, 39.666..., 23, 17.666...) are accepted.
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- (b) (1 mark) The reading is 23 s — trial 2 at 30 °C — with one piece of evidence from the table: the other two trials at 30 °C are 31 s and 29 s; or every trial at the hotter 40 °C is 24 s or less, and colder water should not dissolve the tablet faster than hotter water; or the means elsewhere fall smoothly as temperature rises, and 23 s breaks the smooth fall.
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- (c) (1 mark) The handling, with a reason. Preferred: exclude the 23 s reading and average the two trials that agree with each other and with the pattern: $(31 + 29) \div 2 = 30.0$ s. Also accepted: keep it, giving $(31 + 23 + 29) \div 3 = 27.7$ s, **if** the student says the odd reading pulls the mean below where the pattern puts it. A choice with no reason earns no mark here.
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- (d) (1 mark) Starting and stopping the watch are both judged by eye — the moment of the drop and the moment the last bubble disappears — and that judgement changes by far more than a hundredth of a second from trial to trial, so the hundredths on the display claim more than the measurement can deliver.

Question 4 — 5 marks

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- (a) (1 mark) Both axes labelled with quantity and unit — water temperature (°C) horizontal, mean dissolving time (s) vertical — and a title (e.g. *Mean dissolving time of a fizzy vitamin tablet against water temperature*).
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- (b) (1 mark) Even scales that use most of the grid — e.g. steps of 5 °C or 10 °C on the horizontal axis and 5 s or 10 s on the vertical. Starting at zero is expected at this band but not enforced if the graph still reads clearly.
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- (c) (2 marks) The five means from the student's Question 3 plotted accurately: four correct (1 mark), five correct (2 marks). Allow half a small square either way. Raw trials plotted instead of means earn at most 1 mark here.
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- (d) (1 mark) A line of good fit — a smooth line, straight or curved, falling as temperature rises, passing close to all five of the student's plotted points with the points lying near the line on both sides. A point-to-point join is not a line of good fit and earns no mark here.

Question 5 — 4 marks

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- (a) (1 mark) The trend names both variables: as the water temperature increases, the mean dissolving time decreases (the tablet dissolves faster). "It gets quicker" without both variables named earns no mark.
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- (b) (1 mark) No — each 10 °C rise removes less time than the one before. With the preferred means: from 10 to 20 °C the mean falls 60.0 → 39.7 s, a drop of 20.3 s; from 40 to 50 °C it falls 23.0 → 17.7 s, a drop of only 5.3 s. Mark on the student's own Question 3 values; any correct pair of steps that shows the shrinking fall earns the mark.
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- (c) (1 mark) Not supported, with one line of working. Example: halving predicts 30.0 s at 20 °C (half of 60.0 s), but the processed mean there is 39.7 s. Example: the ratio between neighbouring temperatures is about 0.66 to 0.77, not 0.5. Example: if the time halved at every step, the mean at 50 °C would be about 3.75 s, not 17.7 s.
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- (d) (1 mark) About 35 s — accept roughly 32–37 s read from the student's own line at 25 °C.

Question 6 — 4 marks

- (a) (1 mark) One random error belonging to this method, with a reason. Accept list: judging the exact moment the last bubble disappears — the call comes a little early on one trial and a little late on the next; starting the watch at the moment of the drop — the thumb is early or late by chance; a draught cooling some beakers a little more than others. Errors must belong to this method — generic answers (“human error”) earn no mark.
- (b) (1 mark) One systematic error belonging to this method, with a reason. Accept list: the thermometer was never calibrated — if it reads, say, 2 °C high, then every recorded temperature is 2 °C too high, the same shift every time; the stirring rule pushes the colder trials in one direction — a built-in push, not a chance scatter, accept if the student says so; the unrinsed beaker adds leftover solution to every later trial, the same way each time.
- (c) (1 mark) 22%. Working: $(48.5 - 39.7) \div 39.7 \times 100 = 22.17\ldots\% \rightarrow 22\%$. Award the mark for correct substitution and answer; accept “about 22%”.
- (d) (1 mark) Not reproducible as written — the second group’s mean at 20 °C (48.5 s) is 22% above the first group’s (39.7 s), far larger than the scatter of the trials themselves (38–41 s), and the method leaves room for it: a named Question 2 flaw such as “stir gently” or “no more bubbles can be seen” is never defined precisely, so two groups doing exactly what is written do different things. The justification must use both the value from (c) and a named Question 2 flaw.

Question 7 — 3 marks

- (a) (1 mark) A statement answering the question, scoped to what was tested: for this fizzy vitamin tablet in 100 mL of water, over the range 10–50 °C, the higher the water temperature, the shorter the dissolving time.
- (b) (1 mark) Specific processed numbers cited: the means fall 60.0, 39.7, 30.0, 23.0 and 17.7 s as the temperature rises in equal 10 °C steps (mark on the student’s own processed values).
- (c) (1 mark) One real limit: this one tablet brand and type only; this one volume of water (100 mL) only; the range 10–50 °C only, with nothing shown above 50 °C or below 10 °C; the stirring flaw means the size of the falls cannot be trusted, only the direction of the trend; one reading set aside as an anomaly. “We could be more careful” without a named limit earns no mark.

Total: 5 + 4 + 5 + 5 + 4 + 4 + 3 = 30 marks.

Model response

A full-mark response, written out in full so the standard is visible. Mark points from the guide are annotated in parentheses.

Question 1. (a) Hypothesis: *the higher the temperature of the water, the shorter the time it takes the fizzy vitamin tablet to dissolve* (1 mark). (b) Independent variable: the temperature of the water (1 mark). (c) Dependent variable: the dissolving time — the time from when the tablet is dropped in until it has dissolved (1 mark). (d) Controlled variables: the volume of water is 100 mL every time, and one tablet of the same brand and type is used every time (1 mark each; *the same beaker, the same thermometer and the same stopwatch also earn the marks*) (2 marks).

Question 2. (a) Two flaws. First, step 4 says to stir “if the tablet seems to be dissolving slowly”, so the amount of stirring changes from trial to trial — the colder trials get more stirring, and stirring makes the tablet dissolve faster, so a second factor changes together with the temperature. Second, the end-point is a judgement: “no more bubbles can be seen” is decided by eye, differently each time, and the bubbles are harder to see in the colder, more slowly fizzing

water (*1 mark each*). (b) The stirring flaw pushes the cold-water times down, because those are the trials that get the most stirring, so the effect of temperature comes out looking smaller than it really is (*1 mark*). (c) The method says “stir gently” but never says how gently, so two groups following it will stir differently; the fix is not to stir at all, or to stir at a stated steady rate (*1 mark*).

Question 3. (a) Means to the nearest 0.1 s: at 10 °C, $(58 + 62 + 60) \div 3 = 60.0$ s; at 20 °C, $(41 + 38 + 40) \div 3 = 39.7$ s; at 40 °C, $(24 + 22 + 23) \div 3 = 23.0$ s; at 50 °C, $(18 + 17 + 18) \div 3 = 17.7$ s (*2 marks*). (b) The reading that does not fit is 23 s — trial 2 at 30 °C. Evidence from the table: the other two trials at 30 °C are 31 s and 29 s, and every trial at the hotter 40 °C is 24 s or less — colder water should not dissolve the tablet faster than hotter water (*1 mark*). (c) I set the 23 s reading aside and average the two trials that agree with each other and with the pattern: $(31 + 29) \div 2 = 30.0$ s. One reading that fights its two partners and the whole pattern should not outweigh them (*1 mark*). (d) Starting and stopping the watch are both judged by eye — the moment of the drop and the moment the last bubble disappears — and that judgement changes by far more than a hundredth of a second from trial to trial, so the times are really known only to about a second, whatever the display shows (*1 mark*).

Question 4. The full-mark scatter plot (*5 marks*): title — *Mean dissolving time of a fizzy vitamin tablet against water temperature (simulated data for practice)*; horizontal axis — water temperature (°C), 0 to 60 °C in even steps of 10 °C; vertical axis — mean dissolving time (s), 0 to 70 s in even steps of 10 s; the five means plotted at (10, 60.0), (20, 39.7), (30, 30.0), (40, 23.0) and (50, 17.7), using the values from Question 3; and a smooth curved line of good fit falling steeply at first and levelling out, passing close to all five points. The points are not joined point to point.

Question 5. (a) As the water temperature increases, the mean dissolving time decreases — the tablet dissolves faster in hotter water (*1 mark*). (b) No — each 10 °C rise removes less time than the one before: from 10 to 20 °C the mean falls 60.0 → 39.7 s, a drop of 20.3 s, while from 40 to 50 °C it falls only 23.0 → 17.7 s, a drop of 5.3 s (*1 mark*). (c) Not supported. If the time halved at each 10 °C step, the mean at 20 °C would be 30.0 s — half of 60.0 s — but the processed mean there is 39.7 s; and 23.0 s at 40 °C is well above half of 39.7 s (*1 mark*). (d) From my line of good fit, the mean dissolving time at 25 °C is about 35 s (*1 mark*).

Question 6. (a) Random error: judging the exact moment the last bubble disappears — the call comes a little early on one trial and a little late on the next, so the times scatter both ways (*1 mark*). (b) Systematic error: the thermometer was never calibrated, so if it reads, say, 2 °C high, every recorded temperature is 2 °C too high — the same shift every time (*1 mark*). (c) Percentage difference = $(48.5 - 39.7) \div 39.7 \times 100 = 22.17\ldots\%$, so about 22% (*1 mark*). (d) The written method is not reproducible. The second group’s mean at 20 °C is 22% above the first group’s, far larger than the scatter of the trials themselves (38–41 s), and the method leaves room for it: “stir gently” and “no more bubbles can be seen” are never defined precisely, so two groups doing exactly what is written do different things (*1 mark*).

Question 7. (a) For this fizzy vitamin tablet in 100 mL of water, over the range 10–50 °C, the higher the temperature of the water, the shorter the time it takes the tablet to dissolve (*1 mark*). (b) The processed means fall — 60.0 s, 39.7 s, 30.0 s, 23.0 s and 17.7 s — as the temperature rises in equal 10 °C steps (*1 mark*). (c) The evidence covers only this one brand of tablet, this one volume of water and the range 10–50 °C — nothing is shown above 50 °C, and the stirring flaw means the size of the falls cannot be trusted, only the direction of the trend (*1 mark*).