# Mathematics Level 9

## Extended tasks



**Aboriginal and Torres Strait Islander content** has been excluded as accuracy cannot be guaranteed, and it is better to be respectful than cover the entire curriculum inaccurately.

Significant effort has been made to ensure this content is legal. Please send any areas of concern to admin@vwx.au with appropriate document/legal references so errors can be verified and changes be made.

### Contents

## Task

**Extended task X1 — Statistical investigation · Host 6E · Chapter 6 — Statistics · Level 9 · 20 marks**

**Content description `VC2M9ST05` (word for word):** *plan and conduct statistical investigations involving the collection and analysis of different kinds of data; report findings and discuss the strength of evidence to support any conclusions*

**Achievement standard anchor (AS 17):** *They explain how sampling techniques and representation can be used to support or question conclusions or to promote a point of view.*

**Elaboration ids for linkage:** `VC2M9ST05.E01`, `VC2M9ST05.E02`, `VC2M9ST05.E03`, `VC2M9ST05.E04`

**Draws on:** 6A (comparing distributions), 6B (choosing and justifying a data display), 6C (reading survey reports), 6D (sampling methods and sample-to-sample variation) and 6E (the investigation cycle). The chapter's terms and methods are used here, not re-taught.

**Note on `VC2M9ST05.E04` (exclusion recorded):** the Aboriginal and Torres Strait Islander material of this elaboration is excluded from this book under CONTENT_POLICY Rule 1 (recorded as ACCEPTED; see the note in 6E). The content description is delivered in full via the remaining elaborations and the complete cycle of this task.

**Standing:** This is a school-designed paper. It is not a VCAA instrument. Achievement in the Victorian Curriculum is reported against the Level 9 achievement standard, not against a mark on this paper. The task is teacher-marked and is not counted in the Topic test T6 totals.

**Timing, equipment and calculator rules**

| Rule | This task |
|---|---|
| Timing | Run over about two to three lessons. Your teacher sets the checkpoints: plan approval, data collection, report due. |
| Equipment | See the Equipment section after the task sheet. Bring your approved planning frame to every collection lesson. |
| Calculator and digital tools | `VC2M9ST05` does not name a digital tool in its content description, so tools are permitted where they help, not required. Permitted tool classes: scientific calculator, spreadsheet, graphing tool — your teacher nominates the tool. No CAS — a CAS is a VCE tool and is not used at Level 9. |

## The brief

Plan and conduct one statistical investigation of your own, report the findings, and discuss the strength of your evidence. The data must be **student-generated or student-sourced**: primary data you collect yourself (a survey, an experiment, direct measurement), or secondary data you take from a published source you cite — or both. The free online databases of the Australian Bureau of Statistics and the Bureau of Meteorology are the right default for secondary data (`VC2M9ST05.E01`): large, carefully collected, and free to cite.

Work through the six steps of the investigation cycle:

1. **Pose one statistical question.** Its answers must be expected to vary, and the variation is what you study. The question must name the **population** (the whole group the question is about), the **variable** (what you record for each member) and **how the variable is measured** (the exact question asked or measurement taken, so two collectors would record the same kind of answer).

2. **Plan.** Complete the planning frame below before any data is collected. Name the **sampling method** — the way the members to be measured or asked are chosen — and write down its limitations before you collect. Your teacher approves the frame before collection starts (see the Safety section).
3. **Collect.** Gather the data as planned — at least 30 values if the data are numerical. If you collect from people, keep the three duties: taking part is optional, no names are asked, and results are reported as a group, never as individuals.
4. **Organise and analyse.** Choose at least one honest display that suits the kind of data. Where the data are numerical, summarise with the mean, median and range, and show your working. Name any **outlier** — a value far away from the rest — and show what it does to the statistics.
5. **Report.** Write the report in the seven parts listed below, for the audience you named in the frame. State every finding in context with its units, and write a source line — publisher, title, year, retrieval date — for every secondary data set.
6. **Discuss the strength of your evidence.** Run the four checks: was the method fair? Was the sample large enough? Are the results consistent? Could something else explain them? Then write a conclusion that does not run further than the evidence allows.

**The seven parts of the report:** title and question · method and data source · analysis · findings · limitations · strength of the evidence · conclusion.

### Planning frame

| Part | What you write |
|---|---|
| Question | the statistical question, worded exactly, with the population, the variable and the measure named |
| Population | the whole group the question is about, with its size if knowable |
| Sample and method | the size, the sampling method by name, and how the choice is made fair — or how its lean is named |
| What is recorded | each variable, and its kind: categorical (nominal or ordinal) or numerical (discrete or continuous) |
| Display and statistics | the display chosen and why it suits the data; the mean, median and range where they suit |
| Bias to watch | who the method cannot reach, who may not answer, what may lean the answers |
| Sources | for secondary data: publisher, title, year, retrieval date |
| Audience | who the report is written for — for example, your class, the canteen committee or the school council |

### Data-quality checklist — run it before you report

- The question names the population, the variable and the measure.
- The sampling method is named, and its limitations were written down before collecting.
- There are at least 30 values for numerical data.
- The display suits the kind of data and shows it honestly — bars start at zero, no axis is cut to flatter a difference.
- If the data lean, the median is reported alongside the mean.
- Every outlier is named, and its effect on the mean and the range is shown.
- Every secondary data set carries a source line: publisher, title, year, retrieval date.
- At least one limitation is named in the report.
- The conclusion stays inside what the evidence can carry.

## EXEMPLAR — practice, not the task

The report below is fully worked on a supplied data set — the Bureau of Meteorology's daily maximum temperatures for July 2026 — so you can see all seven parts in action. **Your task is your own question and your own data.** A submission that reworks this question or these data is not the task and cannot score.

*Title and question (audience: the class).* How did the daily maximum temperatures of July 2026 compare between Ballarat and Melbourne?

*Method and data source.* Secondary data from the Bureau of Meteorology: the daily maximum temperature on every day of July 2026 at Ballarat Aerodrome (station 089002) and at Melbourne Olympic Park (station 086338). All 31 days at each station are included — a census of the month, not a sample, so there is no sampling step to lean. The data are numerical, continuous.

Source: Bureau of Meteorology, *Daily Weather Observations, Ballarat Aerodrome, station 089002 (product IDCJDW3005.202607), July 2026*, prepared 14 August 2026. Retrieved 20 August 2026. Source: Bureau of Meteorology, *Daily Weather Observations, Melbourne Olympic Park, station 086338 (product IDCJDW3033.202607), July 2026*, prepared 14 August 2026. Retrieved 20 August 2026.

*Analysis.* Back-to-back stem-and-leaf plot, Ballarat on the left and Melbourne on the right. The plot keeps every one of the 62 values, so each statistic can be checked value by value.

```
Daily maximum temperature (°C), July 2026
Leaf unit: 0.1 °C — on stem 12, leaf 5 reads 12.5 °C

   Ballarat  | stem | Melbourne
     8 8 5   |   8  |
 8 7 7 3 1 1 |   9  |
 9 7 7 4 0 0 |  10  |
     9 9 8 6 |  11  | 0 8
9 7 6 6 5 5 1 |  12  | 6 8
   6 6 3 2 1 |  13  | 2 6 6 7 8 9 9
             |  14  | 1 3 3 4 6
             |  15  | 2 3 4 4 9 9 9
             |  16  | 0 4 4 6
             |  17  | 0 1
             |  18  | 4
             |  19  | 5
```

Ballarat: mean 11.2 °C, median 11.6 °C, range 5.1 °C. Melbourne: mean 14.9 °C, median 14.6 °C, range 8.5 °C. Difference of the means: $14.9 - 11.2 \approx 3.7$ °C.

*Findings.* Melbourne's daily maximum temperatures in July 2026 ran about 3–4 °C warmer than Ballarat's (mean difference ≈ 3.7 °C; median difference 3.0 °C), and they varied more — range 8.5 °C against 5.1 °C. Both displays and all three statistics point the same way.

*Limitations.* One month at two stations only; maximum temperatures say nothing about rainfall, wind or minimum temperatures; and the two stations are an aerodrome and a park site, so the values may differ from street-level readings in other parts of each city.

*Strength of the evidence.* Check 1, method: every day of the month is included at both stations, so the method is fair by design and there is no sampling lean. Check 2, size: 31 days each is the whole population of July 2026 days, so size is not a limit. Check 3, consistency: mean, median and the shape of the stem-and-leaf plot all agree. Check 4, other explanation: both sets sit on one axis with the same leaf unit, so no display trick could manufacture the gap. The evidence is strong — for July 2026.

*Conclusion.* In July 2026, Melbourne was the warmer and more variable of the two cities. Because one month is one run of the weather, the result cannot support "every July" or "always" — repeating the comparison for other months or years is the natural next loop of the cycle.

## Equipment

**For every student**

- Writing equipment, a ruler, and graph paper or a workbook page for displays
- The planning frame and the data-quality checklist from the task sheet

**If the plan uses primary data (data you collect yourself)**

- Survey sheets or response slips — with no name asked anywhere on the sheet
- A clipboard or folder for recording
- The measuring tools your variable needs — for example, a metre ruler or tape measure for lengths, a stopwatch or timer for times

**If the plan uses secondary data (data someone else collected)**

- A device with internet access through the school network
- A spreadsheet or a graphing tool, as nominated by your teacher
- A scientific calculator

**Calculator and tool rules:** a scientific calculator, a spreadsheet and a graphing tool are all permitted where they help; the content description for this task does not name a digital tool, so no tool is compulsory. No CAS — a CAS is a VCE tool and is not used at Level 9. Tools are named by class only; your teacher nominates the tool your class uses.

## Safety

Controls for this task. The teacher checks each one when approving the planning frame, and again if the plan changes.

**1. Plan approval gate.** No collection starts until the teacher has approved the planning frame — question, population, sampling method, and every question asked or measurement taken. A changed plan is re-approved before it runs.

**2. Data from people — privacy and respect.** Taking part is always optional, and anyone can stop at any time. Do not ask for names, addresses or anything that identifies a person; record only the variables the question needs. Report results for the group only, never for one person. Questions about health, money or family need teacher approval before they are asked — a question people cannot answer honestly is not worth asking.

**3. Where you collect.** Collect on school grounds, or at a place the teacher approves. Never collect beside a road, in a car park or near water. Collect in pairs or small groups, and stay where the teacher can see you when collection runs outside the classroom. Outdoors in warm weather: hat, sunscreen and water.

**4. Equipment.** Use measuring tools as intended — nothing is thrown, swung or used on another student. Carry, do not drag; return everything at the end of the lesson.

**5. Working online.** Use school accounts on the school network only, and stay on the official source the plan names (for example, the Australian Bureau of Statistics or Bureau of Meteorology sites). Do not upload your data anywhere or share it outside the class. Tell your teacher about anything online that feels wrong or upsetting.

**6. Teacher checks.** Approve each planning frame for privacy and physical safety before collection; supervise collection outside the classroom; keep completed response slips stored safely, and recycle them once reports are finished; arrange permission before students survey anyone outside their own class.

## Marking guide

**Total: 20 marks — five criteria at 4 marks each.** Award whole marks 0–4 per criterion, using the best-fit descriptor. Every descriptor is written as an observable action: mark what the marker can see in the submitted planning frame, working and report — not what the student says they meant.

**Achievement-standard mapping (§7.4).** The criteria are written in the language of the Level 9 achievement standard as corrected in §4. AS 17 — *They explain how sampling techniques and representation can be used to support or question conclusions or to promote a point of view.* — carries Criteria 4 and 5. AS 16 — *Students compare and analyse the distributions of multiple numerical data sets, choose representations, describe features of these data sets using summary statistics and the shape of distributions, and consider the effect of outliers.* — carries Criteria 2 and 3, the 6A–6B tools the task draws on. This is a school-designed instrument, not a VCAA instrument.

### Criterion 1 — Formulate: assumptions and variables stated (4 marks)

| Mark | The student's work shows |
|---|---|
| 4 | A statistical question that expects variation and names the population, the variable and how it is measured; each variable classified correctly by kind (categorical — nominal or ordinal — or numerical — discrete or continuous); and at least one assumption written in the planning frame before collection. |
| 3 | The question names the population, the variable and the measure and expects variation, but the data-kind classification or the stated assumption is missing or incomplete. |
| 2 | The question is statistical, but one of population, variable or measure is missing; or the frame is complete yet the question cannot be answered from the data planned. |
| 1 | A question is written, but it has one fixed answer, or population, variable and measure are all missing. |
| 0 | No statistical question, or no plan. |

### Criterion 2 — Solve: the mathematics is correct and shown (4 marks)

| Mark | The student's work shows |
|---|---|
| 4 | The sampling method named by name (a random method — simple random, systematic, stratified or cluster — or a non-random method — convenience, quota, judgement or voluntary response); data collected as planned, at least 30 values for numerical data; at least one honest display that suits the data kind; and correct means, medians and ranges where they suit, with working shown and any outlier named. |
| 3 | The same, with one slip: one statistic wrong, a display that does not suit the data well, or the method not named by name. |
| 2 | Data collected as planned, and either one correct statistic or one honest display — but not both; working sparse. |
| 1 | Data are recorded, but there is no display and no |

| Mark | The student's work shows |
|---|---|
| | correct statistic. |
| 0 | No data collected, or no mathematics on the data. |

### Criterion 3 — Interpret: the answer is read back into the situation, with units (4 marks)

| Mark | The student's work shows |
|---|---|
| 4 | Findings stated in context with units; the display and the statistics read correctly — centre, spread and, where they suit, shape (symmetric, positive skew, negative skew, bi-modal) described; and the findings answer the question actually posed. |
| 3 | Findings stated in context with units, but one reading — of the display, of a statistic, or of the shape — is missing or not fully correct. |
| 2 | Findings stated without units or context, or a statistic misread from the display. |
| 1 | Numbers only, with no reading of what they show. |
| 0 | No findings stated. |

### Criterion 4 — Evaluate: the method is tested and limitations named (4 marks)

This criterion is where the task is won — `VC2M9ST05` requires the strength of the evidence to be discussed, and X1's rubric requires the sources, the sampling method and its limitations to be named (`VC2M9ST05`, `VC2M9ST02`).

| Mark | The student's work shows |
|---|---|
| 4 | The strength of the evidence discussed with the four checks (fair method; sample large enough; results consistent; no other likely explanation); the sampling method named together with at least one of its limitations; at least one limitation of the method, the data or the display named; every secondary data set cited by source; the conclusion kept inside the evidence; and the report explains how the sampling technique or the choice of representation could support or question the conclusion. |
| 3 | The four checks are used and a limitation is named, but one of the source citation, the sampling method's limitation, or the keep-inside-the-evidence step is missing. |
| 2 | The evidence is discussed, but with fewer than two of the four checks; or a limitation is named with no check applied. |
| 1 | The report says the evidence is strong or weak with no check and no named limitation. |
| 0 | No discussion of the evidence. |

### Criterion 5 — Report: methods and findings communicated to the stated audience (4 marks)

| Mark | The student's work shows |
|---|---|
| 4 | All seven report parts present (title and question; method and data source; analysis; findings; limitations; strength of the evidence; conclusion); a reader able to repeat the investigation from the method as written; source lines in the R1 form (publisher, title, year, retrieval date) for every secondary data set; and the report addressed to the audience named in the planning frame. |
| 3 | All seven parts present, but one of repeatability, the R1 source form or the stated audience is missing. |
| 2 | Five or six of the seven parts present, or the report is not aimed at any audience. |
| 1 | Three or four parts present. |
| 0 | Fewer than three parts, or no report. |

**Marking notes**

1. **Reasoning is marked separately from the answer.** A correct number with no stated reason does not score full marks — the reason is where Criteria 3 and 4 are earned.
2. **Level 9 ceiling.** The only summary statistics in play are the mean, the median and the range. Quartiles, the interquartile range, boxplots, scatterplots, lines of good fit and two-way tables for association are Level 10 content: they earn no marks here and are not required. A student who includes them is not penalised, but the Level 9 analysis must still be present and correct.
3. **The exemplar is practice, not the task.** A submission that reworks the exemplar's question or data set cannot earn Criterion 1, and earns Criterion 2 only for its own arithmetic.
4. **Individual marking.** Students may collect data in pairs or small groups, but each student submits their own report and is marked on their own work.
5. **Plan approval is a safety requirement, not a mark.** A student who collects before approval is referred to the Safety controls; the work submitted is still marked on these criteria.

**Mark schedule**

| Criterion | Marks |
|---|---|
| 1 Formulate — assumptions and variables stated | 4 |
| 2 Solve — mathematics correct and shown | 4 |
| 3 Interpret — answer read back into the situation, with units | 4 |
| 4 Evaluate — method tested, limitations named | 4 |
| 5 Report — methods and findings communicated to the stated audience | 4 |
| **Total** | **20** |

## Task X2 — Modelling with direct proportion: the spring force meter

**Task X2 · Host subtopic: 5E · Chapter 5 — Measurement · Level 9**

This is a school-designed paper. It is not a VCAA instrument. Achievement in the Victorian Curriculum is reported against the Level 9 achievement standard, not against a mark on this paper.

**Content description `VC2M9M05` (word for word):** *use mathematical modelling to solve practical problems involving direct proportion, rates, ratio and scale, including financial contexts; formulate the problems and interpret solutions in terms of the situation; evaluate the model and report methods and findings*

**Achievement standard anchor (AS 12, per §4 — the transposition in the authority file corrected per D7):** *They use mathematical modelling to solve practical problems involving direct and indirect proportion, ratio and scale, evaluating the model and communicating their methods and findings.* This task assesses **direct** proportion only: inverse proportion belongs to Level 10 (`VC2M10M04`, `VC2M10A15`) and is not modelled here (D3.12). The Marking guide is written in this sentence's language, as corrected, not the raw authority-file field.

**Elaboration ids for linkage:** `VC2M9M05.E01` (Hooke's law — the calibration context of Parts 1–3 and of the exemplar). `VC2M9M05.E02`, `.E03`, `.E04` are taught in subtopic 5E. `VC2M9M05.E05` is not used in this book (CONTENT_POLICY Rule 1: Aboriginal and Torres Strait Islander content is excluded).

**Draws on:** 4B — scale factor, and the result that lengths scale by $k$ while areas scale by $k^2$ (used in Part 4) — and 5C — scale and ratio (§7.2). Assumes the modelling cycle, the table test and the straight-line-through-the-origin graph of direct proportion taught in 5E.

**Data:** Part 1 data is collected by the student — no external data set is supplied, and none is needed. The exemplar data set is composed for this book (R2). The convention "a 100 g mass gives a 1 N load" is a stated task assumption; the physical value is 0.98 N.

**Digital tools:** none required (D9). A scientific calculator is permitted; a spreadsheet or graphing tool may be used for the Part 2 graph only if the teacher nominates it. No CAS anywhere in this book.

| | |
|---|---|
| **Task** | X2 — Modelling with direct proportion: the spring force meter |
| **Assesses** | `VC2M9M05` — the full modelling cycle: formulate, solve, interpret, evaluate, report |
| **Marks** | **20** — five criteria at 4 marks each (Marking guide, below). Rubric marks are not counted in the topic-test totals (§7.2). |
| **Timing** | A classroom task, not an exam. Run over about two to three lessons (§7.2). Suggested split: lesson 1 — Part 1; lesson 2 — Parts 2 and 3; lesson 3 — Parts 4 and 5. |
| **Equipment** | Supplied by the school — list below. Work in pairs or threes. |
| **Calculators** | Scientific calculator permitted. CAS is not permitted (D9). |

**The brief.** SCENARIO: the school science lab is making simple force meters for Year 7 students. A **force meter** is an instrument that measures a pull, in newtons (N) — the newton is the unit of force. Your group's job is to build a force meter from a spring, **calibrate** it (calibration means finding how far the spring stretches for each newton of load), test your calibration model, and make the instruction card at scale 1:2. Your report goes to the Year 7 students who will use the force meter and to the lab technician who will make more.

The mathematics is direct proportion: if the extension of the spring doubles when the load doubles, then extension $E$ and load $L$ are related by a rule $E = k\,L$, and the whole task is to find, test and report that rule.

## Equipment

Per group:

- One light spiral spring.
- One **retort stand** — a tall metal stand with a horizontal arm to hang things from — with a boss and clamp.
- One G-clamp, to fix the stand to the bench.
- One **hanger** — a small hook that hangs from the spring and holds the masses — and five 100 g **slotted masses** — metal masses that slot onto the hanger. In this task, treat each 100 g mass as a load of exactly 1 N.
- One ruler with millimetre marks, fixed upright beside the spring.
- One object of unknown load, supplied by the teacher (for example, a key ring or a small bag of washers).
- One pair of safety glasses per student while the spring is loaded.

Shared or per student:

- Graph paper for the Part 2 graph; 1 cm grid paper for the Part 4 drawing.
- A scientific calculator. A spreadsheet or graphing tool only if the teacher nominates it.

## Safety — at point of use

- Fix the stand to the bench with the G-clamp **before** anything is hung from it.
- Wear safety glasses while the spring is loaded.
- Slide masses onto the hanger gently. Never drop a mass onto the hanger, and keep feet clear of hanging masses.
- Do not hang more than five 100 g masses. An overloaded spring can stretch out of shape and snap back.
- Do not pull the spring by hand away from the stand, and never bring a loaded spring near anyone's face.
- If the spring slips or breaks, step back and tell the teacher. Do not try to catch falling masses.
- Pack masses back into their box at the end of the lesson — they are heavy enough to hurt a foot if dropped.

## Part 1 — Build and calibrate

1. Hang the spring from the arm of the stand and fix the ruler upright beside it.
2. Hang the empty hanger from the spring. The **pointer** — the part you read on the ruler — is the bottom hook of the hanger. Wait until the pointer is still, then read the ruler with your eyes level with the pointer. Record this reading as the 0 N position. Reading from above or below gives a **parallax** error — a wrong reading caused by looking at the pointer from an angle instead of level with it.
3. Add one 100 g slotted mass. Treat the load as 1 N. Wait until the pointer is still, read with your eyes level, and record the pointer position.
4. The **extension** is how far the pointer has moved down from the 0 N position. Compute it for this load.
5. Add masses one at a time, up to five masses (5 N), repeating step 3 and step 4 for each load.
6. Remove all masses. Check that the pointer returns to the 0 N position. If it does not, the spring has been stretched past its **elastic limit** — the load beyond which a spring does not return to its starting length. Record this for your evaluate, and repeat with a fresh spring.

Record your readings here:

| Load $L$ (N) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Pointer position (cm) | | | | | | |
| Extension $E$ (cm) | | | | | | |
| $E \div L$ (cm/N) | — | | | | | |

## Part 2 — Find the model

1. Complete the $E \div L$ row of your table — the table test of 5E.
2. If the quotient is the same (or nearly the same) in every row, the extension is in **direct proportion** to the load: $E = k\,L$. The number $k$ is the **constant of proportionality**. Here $k$ is a **rate** — centimetres of extension per newton of load.
3. Find $k$ from your data, with its units, and write your model.
4. On graph paper (or with the nominated graphing tool), plot $E$ on the vertical axis against $L$ on the horizontal axis. The graph of a direct proportion is a straight line through the origin.
5. Use your model to predict the extension at 3.5 N — a load you did not hang.

### Part 3 — Test the model

1. Set your 4 N reading aside. Use your model to predict the extension at 4 N, then compare the prediction with the reading you set aside: difference = measured − predicted. Show the calculation.
2. Hang the object your teacher supplied. Measure its extension, then use your model to find the load of the object.
3. Is this load inside the range you tested (0–5 N)? In one sentence, say why your answer matters for how much the reading can be trusted.

### Part 4 — The instruction card at scale 1:2

The instruction card shows the face of the force meter, so a Year 7 student can see where the marks go.

1. The card face is 10 cm tall and 4 cm wide, real size. Draw it full size, and mark the 0, 1, 2, 3, 4 and 5 N positions, spaced by your measured extension per newton.
2. Now draw the card at **scale** 1:2. A **scale drawing** multiplies every length by the same scale factor; the **ratio** of drawing length to real length is 1:2, so every length is multiplied by $1/2$.
3. Write the dimensions of the drawing, and the spacing of the newton marks on the drawing.
4. Compute the area of the real card face and the area of the drawing. By what factor was the area multiplied? Check your factor against the result of 4B: lengths scale by $k$, areas by $k^2$.

### Part 5 — Report

Write a short report for your two readers: the Year 7 students who will use the force meter, and the lab technician who will make more. Your report must include:

- what you built and what you measured — the method;
- your model, with your value of $k$ and its units — the finding;
- the range of loads the model can be trusted for, and what the model does outside that range;
- how to read the force meter, with the instruction card drawing attached;
- one closing sentence that states your conclusion.

## Planning frame

Write your task up under the five headings of the modelling cycle. Prompts for each heading:

**Formulate.**

- The two variables, each with its unit.
- At least two assumptions — for example, about the load each mass gives, about how the spring behaves, or about how readings are taken.
- The shape of the model you will test: $E = k\,L$, with $k$ to be found.

**Solve.**

- Your results table from Part 1, with the $E \div L$ row completed.
- Your value of $k$, with units, and your model.
- Your predictions: the extension at 3.5 N; the set-aside 4 N check; the load of the unknown object. One step per line.
- Your scale-drawing calculations from Part 4: lengths, mark spacing, areas, area factor.

**Interpret.** Complete each sentence in your own words.

- Each newton of load stretches the spring by …
- At 3.5 N, the extension is …
- The unknown object has a load of …
- The instruction card is drawn at scale …, so every length on the card is …

**Evaluate.**

- The difference at the set-aside reading: measured − predicted = …
- Where your model fits the data well, and where it fits less well.
- At least one limitation of the model.
- At least one limitation of your method, or one improvement you would make.

**Report.**

- Name your two readers, and check your report against the Part 5 list.

## Data-quality checklist

Tick each box before you start Part 2. If you cannot tick a box, fix the data, or record the problem under evaluate.

- ☐ All six rows are present: 0, 1, 2, 3, 4 and 5 N.
- ☐ Every column heading carries its unit: N, cm, cm/N.
- ☐ Every reading was taken with the pointer still and with your eyes level with it.
- ☐ Every reading is recorded to the smallest mark your ruler can show.
- ☐ Each extension was computed as pointer position − 0 N position, with at least one shown in full.
- ☐ The pointer returned to the 0 N position after all masses were removed.

## Exemplar — practice, not the task

**EXEMPLAR — practice, not the task.**

This fully-worked exemplar runs the whole cycle on a supplied data set. It is practice for the task, not the task: your spring, your data and your $k$ will differ. The data set is composed for this book.

**The supplied data set.** A spring is loaded in 1 N steps and the extension of the pointer is recorded:

| Load $L$ (N) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Extension $E$ (cm) | 0 | 1.8 | 3.6 | 5.4 | 7.2 | 9.6 | 12.6 |

The card face is 10 cm tall and 4 cm wide, and the unknown object stretches the spring by 2.7 cm.

**Formulate.** Variables: load $L$ in newtons, extension $E$ in centimetres. Assumptions: the extension per newton stays the same over the loads tested; each 100 g mass gives a load of exactly 1 N; the spring has not been overloaded before. Model shape: if the table test passes, $E = k\,L$.

**Solve.** Table test — the quotients $E \div L$:

| $L$ (N) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| $E \div L$ (cm/N) | 1.8 | 1.8 | 1.8 | 1.8 | 1.92 | 2.1 |

The quotient is constant at 1.8 up to 4 N, so for loads up to 4 N the extension is directly proportional to the load: $k = 1.8$ cm/N and the model is $E = 1.8\,L$.

Predictions from the model. (The task sets the 4 N reading aside; this data set sets the 5 N reading aside instead, because that is where the check has something to show.)

- At 3.5 N: $E = 1.8 \times 3.5 = 6.3$ cm.
- Set-aside check at 5 N: the model predicts $E = 1.8 \times 5 = 9.0$ cm; the table records 9.6 cm; difference $= 9.6 - 9.0 = 0.6$ cm.

- At 6 N: the model predicts $E = 1.8 \times 6 = 10.8$ cm; the table records 12.6 cm; difference $= 12.6 - 10.8 = 1.8$ cm.
- Unknown object: measured extension 2.7 cm, so $L = 2.7 \div 1.8 = 1.5$ N.

Scale drawing at 1:2:

- Card face: $10 \times 1/2 = 5$ cm tall, $4 \times 1/2 = 2$ cm wide.
- Real area: $10 \times 4 = 40$ cm²; drawing area: $5 \times 2 = 10$ cm²; factor $10 \div 40 = 1/4 = (1/2)^2$ — areas scale by $k^2$, as 4B says.
- Newton-mark spacing: $1.8 \times 1/2 = 0.9$ cm on the drawing.

**Interpret.** The spring stretches 1.8 cm for each newton of load, up to 4 N. At 3.5 N the extension is 6.3 cm. The unknown object has a load of 1.5 N — inside the range the model was tested on, so the reading can be trusted. The instruction card drawing is half real size in every length.

**Evaluate.** The model fails from 5 N up: the measured extension sits above the prediction, by 0.6 cm at 5 N and by 1.8 cm at 6 N. The spring is stretching more than the proportion allows — it has been taken past its elastic limit — so the model can be trusted only up to 4 N. Limitations: readings were read to the nearest millimetre, one trial only, and the convention "100 g gives 1 N" rounds the true 0.98 N up to 1.00 N, so every load is labelled about 2% high. The set-aside check is the test that exposed the breakdown: a model that is never checked against a reading it has not seen can fail silently.

**Report.** *To the Year 7 students and the lab technician.* This force meter is a spring with a pointer that moves down a marked card as load is added. Each newton of load stretches the spring 1.8 cm, so the marks are 1.8 cm apart and the rule is $E = 1.8\,L$. Use it for loads up to 4 N only: above 4 N the spring stretches too far and the marks no longer line up, so readings above 4 N cannot be trusted. To read it, hang the object on the hook, wait for the pointer to be still, and read the mark level with the pointer, with your eyes level to avoid parallax. The attached instruction card is drawn at scale 1:2 — every length on it is half the real size. ∴ Build the marks 1.8 cm apart, print the card at half size, and label the meter "0–4 N only".

Graph of extension against load for the exemplar data set: the points up to 4 N lie on the line E equals 1.8 L through the origin, while the 5 N point at (5, 9.6) sits 0.6 cm above the line's value of 9.0 and the 6 N point at (6, 12.6) sits 1.8 cm above the line's value of 10.8

*Graph of extension against load for the exemplar data set: the points up to 4 N lie on the line E equals 1.8 L through the origin, while the 5 N point at (5, 9.6) sits 0.6 cm above the line's value of 9.0 and the 6 N point at (6, 12.6) sits 1.8 cm above the line's value of 10.8*

## Marking guide

**Task X2 — Modelling with direct proportion: the spring force meter. Total: 20 marks.**

The criteria are written in the language of the achievement-standard sentence this content description answers to, as corrected in §4 (D7) — the authority file's per-CD field is transposed and must not be used:

- **AS 12:** "They use mathematical modelling to solve practical problems involving direct and indirect proportion, ratio and scale, evaluating the model and communicating their methods and findings."

At Level 9 the task models **direct** proportion only (D3.12): inverse proportion belongs to Level 10 and no Level 10 outcome is assessed here. The five criteria are the cycle verbs of the content description itself — formulate, solve, interpret, evaluate, report — scored at 4 marks each (§7.2).

Award 0–4 marks per criterion. Each level is awarded when **all** the observable actions listed for that level are present in the student's work. Record what you can see in the write-up, not an impression. Follow-through applies across criteria: a calculation slip in solve does not cancel interpret or evaluate marks earned from work that correctly follows the student's own earlier values.

### Criterion 1 — Formulate (4 marks)

| Marks | Observable student actions |
|---|---|
| 4 | All four of: names both variables with units — load $L$ in N, extension $E$ in cm; states at least two assumptions before measuring — for example, "each 100 g mass gives a 1 N load", "the extension per newton stays the same", "readings are taken with the pointer still"; writes the model shape $E = k\,L$ with $k$ to be found; states the scale 1:2 of the instruction card and records that drawing lengths are real lengths $\times 1/2$. |
| 3 | Three of the four actions. |
| 2 | Two of the four actions. |
| 1 | One of the four actions. |
| 0 | None of the four. |

### Criterion 2 — Solve (4 marks)

| Marks | Observable student actions |
|---|---|
| 4 | All four of: a results table with all six rows (0–5 N), extensions computed correctly from the recorded pointer positions; the $E \div L$ quotients computed correctly from the student's own data; the value of $k$, the predictions at 3.5 N, at the set-aside 4 N reading and for the unknown object all correct for the student's own model, with working shown one step per line; the scale-drawing calculations correct — lengths and mark spacing $\times 1/2$, areas computed, area factor $1/4$ — and the drawing made to those dimensions. |
| 3 | Three of the four actions. |
| 2 | Two of the four actions. |
| 1 | One of the four actions. |
| 0 | None of the four. |

Note for criterion 2: "correct" means correct for the data the student actually recorded — follow-through, not comparison with another group's spring. Messy but honest data is not penalised here; inconsistency between the student's own table and the student's own arithmetic is.

### Criterion 3 — Interpret (4 marks)

| Marks | Observable student actions |
|---|---|
| 4 | All four of: states $k$ in words in context — for example, “the spring stretches 2.1 cm for each newton of load”; every answer is written back as an answer to the question asked, carrying its unit — extensions in cm, loads in N; rounding matches the precision of the data, or the rounding is stated; the scale drawing is labelled with the scale 1:2 and at least one real dimension, and one sentence says what the drawing stands for. |
| 3 | Three of the four actions. |
| 2 | Two of the four actions. |
| 1 | One of the four actions. |
| 0 | None of the four. |

### Criterion 4 — Evaluate (4 marks)

This criterion is where the task is won (§7.2): all five cycle verbs are assessed, and a write-up that stops at the answer cannot deliver the content description.

| Marks | Observable student actions |
|---|---|
| 4 | All four of: computes the difference measured − predicted at the set-aside reading and states it with units; compares the quotients, or the fit of the line, across the data and says where the model holds and where it does not — “holds for all six loads” counts if the student’s data supports it; names at least one limitation of the model — for example, overloading past the elastic limit, the “1 N per 100 g” convention, a zero error if the pointer did not return to 0; names at least one limitation of the method, or states the range of loads the model can be trusted for, or proposes one specific improvement — repeat readings, a finer ruler, re-checking the 0 N position after unloading. |
| 3 | Three of the four actions. |
| 2 | Two of the four actions. |
| 1 | One of the four actions. |
| 0 | None of the four. |

Note for criterion 4: a prediction-versus-measurement comparison that is set up but not computed earns the action only once the difference is stated. General praise or blame of the model — “it was accurate” — without a number or a named cause earns no action.

### Criterion 5 — Report (4 marks)

| Marks | Observable student actions |
|---|---|
| 4 | All four of: the report is addressed to the two stated readers — the Year 7 students and the lab technician — by name or in language they could read; states the method — what was built and what was measured; states the finding — the rule $E = k\,L$ with the student’s value of $k$ and its units, and the range of loads the model can be trusted for; is connected text rather than a list of numbers, includes the instruction card drawing, and |

| Marks | Observable student actions |
| --- | --- |
| | closes with a sentence that states the conclusion. |
| 3 | Three of the four actions. |
| 2 | Two of the four actions. |
| 1 | One of the four actions. |
| 0 | None of the four. |

### Score

| Criterion | Marks |
| --- | --- |
| Formulate | 4 |
| Solve | 4 |
| Interpret | 4 |
| Evaluate | 4 |
| Report | 4 |
| **Task X2 total** | **20** |

A student who states assumptions and variables, builds and solves $E = k\,L$, reads the answers back into the situation with units, tests the model against readings it has not seen and names where it breaks, and tells the Year 7 students and the technician what was built and how to use it, is a student who "uses mathematical modelling to solve practical problems involving … proportion, ratio and scale, evaluating the model and communicating their methods and findings" (AS 12, per §4).

## Task

*Task X3 — Modelling change: a linear or quadratic model, including simple interest · Extended task · 20 marks · Level 9 · Chapter 3 (3C, drawing on 2A and 3A)*

**Codes:** `VC2M9A06` (`.E01`, `.E02`, `.E03`, `.E04`, `.E05`) · draws on `VC2M9A03` (2A) and `VC2M9A05` (3A) · `VC2M9A06.E06` is excluded under CONTENT_POLICY Rule 1, consistent with 3C

> *use mathematical modelling to solve applied problems involving change, including financial contexts involving simple interest; formulate problems, choosing to use either linear or quadratic functions or other simple variations; interpret solutions in terms of the context; evaluate the model and report methods and findings* — VC2M9A06
>
> **Achievement standard anchor (AS 5, corrected per §4/D7):** *Students use mathematical modelling to solve problems involving change, including simple interest in financial contexts and change in other applied contexts, choosing to use linear and quadratic functions.*
>
> **Standing notice.** This is a school-designed paper. It is not a VCAA instrument. Achievement in the Victorian Curriculum is reported against the Level 9 achievement standard, not against a mark on this paper.

**Task X3** is a modelling task. It is not a test. You choose one real situation in which something is changing, collect or source the data yourself, build a linear or quadratic model — a simple-interest model is a linear model — solve it, read your answers back into the situation, judge the model, and report your findings to a stated **audience** (the person or group the report is written for). You follow the same five-stage **modelling cycle** you learned in 3C, shown below.

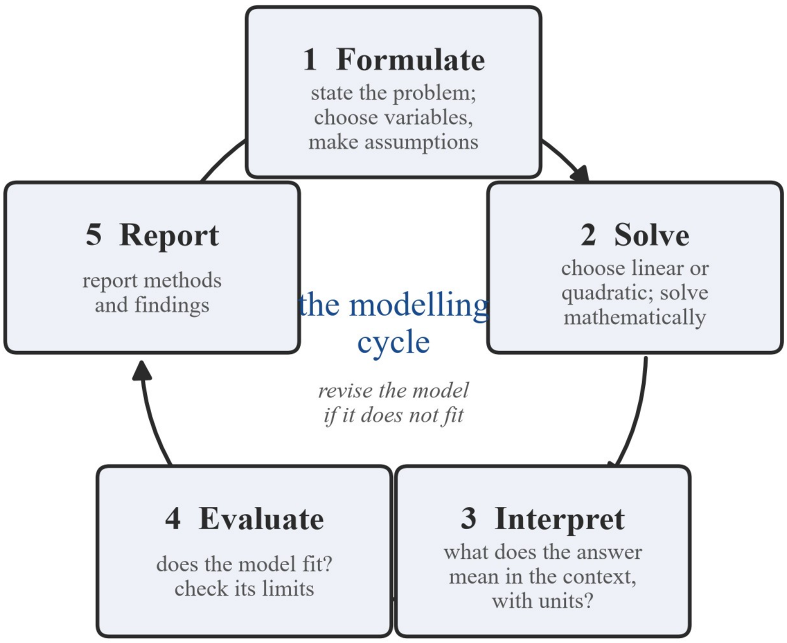


*Diagram of the modelling cycle as five rounded boxes joined in a loop by arrows: 1 formulate, 2 solve, 3 interpret, 4 evaluate, 5 report, with a note in the centre to revise the model if it does not fit*

Choose one of the three **briefs** on the next pages — a brief is a short description of what to investigate, how to get the data, and who the report is for — or take the one your teacher gives you. Your data must be your own: **generated** by you (your own measurements) or **sourced** by you from a named, dated publication, with a **source line** — one sentence that says where the data came from, and when.

**This task is worth 20 marks, in five parts of 4 marks each.** It runs over about two to three lessons, and nothing in it is timed: lesson 1 for choosing your brief and completing the planning frame, the time between lessons for collecting or sourcing your data (as homework if you need it), and lessons 2 and 3 for Parts A to E. X3 is marked by your teacher, and it is not counted in the topic-test totals.

**Equipment and rules.** You will need the spaces in Parts A to E (they are your record sheets), a pencil, a ruler and grid paper. A scientific calculator is permitted. A spreadsheet or a graphing tool is permitted for tables and graphs where you choose one; a fully hand-drawn and hand-calculated task is also a complete task. No other software or calculator may be used. The full equipment list and the safety rules are with your teacher.

## How X3 will be marked

*Shown to students before the task begins.*

X3 is marked with a **rubric** — a marking guide that describes what you must do to earn each mark. It has five **criteria** (parts that are marked separately), 4 marks each. Your teacher scores only what they can see you do or hear you say.

1. **Formulate** — Part A (4 marks). To *formulate* is to state the problem in maths: the question, the variables, the family of the model and the assumptions.
2. **Solve** — Part B (4 marks). To *solve* is to do the mathematics: record the data, find the rule or the curve, calculate, and draw the graph.
3. **Interpret** — Part C (4 marks). To *interpret* is to read the answer back into the situation, with units.
4. **Evaluate** — Part D (4 marks). To *evaluate* the model is to test it against your data and name what it leaves out.
5. **Report** — Part E (4 marks). To *report* is to communicate your method and your findings to your audience — including the limits you found in Part D.

Part D is where this task is most often won and most often lost: the content description itself says *evaluate the model and report methods and findings*, and a task that stops at the answer has not finished the cycle. Its descriptors are written out in full here:

- **D a.** You check your model against one value — you substitute into your rule, or read from your graph, and compare with a value you actually recorded.
- **D b.** You say how well the model fits, pointing to evidence in your data or your graph — for example, that the first differences are nearly constant, or that the points sit close to your curve.
- **D c.** You name one limitation: something your assumptions ignored, and how that could change your answer.
- **D d.** You say one improvement you could make, or the range of values over which your model can be trusted.

## Words you need

Most of these words were introduced in 3C. This is a quick look-back, plus the few new words this task uses.

- A **model** is a mathematical stand-in for a real situation: it keeps the parts that matter and drops the parts that do not (3C).
- The **modelling cycle** is the five-stage loop: formulate, solve, interpret, evaluate, report (3C).
- A **variable** is a quantity that changes; the **assumptions** are the things the model chooses to ignore; the **domain** is the set of values of the variable for which the model means anything (3C).
- A **linear** model adds the same amount each step — its first differences are constant. A **quadratic** model rises then falls, or falls then rises — its graph is a **parabola**, and its second differences are constant (3C, 3A).
- In **simple interest**, interest is paid only on the starting amount: the **principal** $P$, at a yearly **rate** $r$ written as a decimal, over $t$ years, earns $I = P r t$; the **balance** is $A = P + I$. The balance grows by the same amount each year, so it is a linear model (3C).
- The **rate of change** of a linear model is the fixed amount added, or lost, each step — the gradient of its line (2B, 3C).
- A **brief** is a short description of what to investigate, how to get the data, and who the report is for. A **data set** is a collection of data recorded together. A **source line** names the source of the data and the date. An

**audience** is the person or group a report is written for. A **criterion** is one part of a task that is marked separately; a **rubric** is a marking guide written as things you can be seen doing.

## The three briefs

### *Brief A — water leaving a container (linear)*

A container drains at a steady rate. **How long until it is empty — and can a linear model be trusted to say?** This is the water-tank context of `VC2M9A06.E01`.

- **Data you generate.** Use the draining container your teacher sets up. Record the volume remaining (or collected) every 10 seconds, until the flow nearly stops. Take at least 8 readings.
- **Your model.** Volume $V$ (mL or L) against time $t$ (s). Compute the first differences; if they are roughly constant, write the linear rule $V = V_0 - r\,t$, where $V_0$ is the starting volume and $r$ is the rate of draining.
- **What to find.** The rate of draining, with its unit; the time when the container is empty; the domain of your model.
- **Report to** the person who looks after the school garden, or the audience your teacher names.

### *Brief B — the height of a tossed ball (quadratic)*

A ball is tossed straight up. **How high does it go, and when does it come back down?** This is the projectile context of `VC2M9A06.E03`.

- **Data you generate.** Toss a soft ball straight up beside a marked wall, or use a slow-motion video your teacher records. Read the height at equal time intervals. Take at least 6 readings, from the release to the catch (or the landing).
- **Your model.** Height $h$ (m) against time $t$ (s). Draw a smooth, symmetric curve — a parabola — through your points. Where your readings do not give whole-number answers, read from the graph; that is the Level 9 route (3A).
- **What to find.** The greatest height and the time it happens; the time the ball returns to its starting height; the height at one more time your teacher chooses.
- **Report to** a PE teacher, or a Year 7 science class.

### *Brief C — savings over time (simple interest, linear)*

\$2000 is saved at simple interest for 5 years. **How does the balance grow, when does it reach a target, and how does a second option compare?** This is the financial context of `VC2M9A06.E04`.

- **Data you source.** Obtain one published interest rate yourself — from the Reserve Bank of Australia, ASIC Moneysmart, or another source your teacher approves — and write its source line. This chapter already carries two dated rates you may use: the RBA cash rate target of **4.35% p.a., as at 11 August 2026** (label it SCENARIO when you use it as a deposit rate), and the **5% p.a.** rate from ASIC Moneysmart's simple-interest example (page updated 11 August 2026).
- **Your model.** Balance $A$ (dollars) against time $t$ (years): $A = P + (Pr)t$ — linear, because the same interest is added every year. Build a table of balances for $t = 0$ to 5, and a second table for one other simple-interest option (a different principal, a different rate, or both).
- **What to find.** The interest earned each year; the balance after 5 years; the time the balance first reaches a target you state; and, from your tables and one pair of axes, where the comparison between the two options stands or changes — read any crossing point from the graph or the table, not by solving the two rules together (that is Level 10 work).
- **Report to** a family member choosing where to save.

## Planning frame

*Draft your plan here before any data is collected. Your marked copies of these decisions go in Parts A and B.*

**Brief chosen:** …….. (A, B or C)

**My question, in my own words:**

……………………………………………………………………..

……………………………………………………………………..

**My variables** — the quantity I change or watch, and the quantity that depends on it — with units:

……………………………………………………………………..

**My family, and why:** Circle one: linear · quadratic

……………………………………………………………………..

**At least one assumption — something my model will ignore:**

……………………………………………………………………..

**My data plan** — what I will record, how many readings or values, and how:

……………………………………………………………………..

**My source line.** For sourced data (Brief C), name the publisher, the title and the date, and the date you retrieved the data, in this form:

*Source: Reserve Bank of Australia, "Statement by the Monetary Policy Board: Monetary Policy Decision", 2026; retrieved 3 September 2026.*

For data you generate yourself (Briefs A and B), name who collects them, where, and when, in this form:

*Data collected by …, in the school science room, on 3 September 2026.*

……………………………………………………………………..

**My audience** — who the report is for:

……………………………………………………………………..

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## Data-quality checklist

*Before you start modelling, check your data. A model built on weak data inherits the weakness.*

- I have enough values: at least 8 readings (Brief A), at least 6 readings (Brief B), or balances for $t = 0$ to $5$ (Brief C).
- Every value was recorded as it happened, with its unit — nothing was reconstructed afterwards.
- Every value is possible in the real situation — no negative volumes, no heights above the ceiling, no rates written as percentages inside a formula.
- My values cover the range my question asks about — for Brief A, past the point where the container is nearly empty; for Brief B, from release to landing.
- For sourced data: my source line names the publisher, the title and the date, and I retrieved the data myself.
- For my own data: the method, the place and the date are written on my planning frame.
- Any reading I repeated is kept, with a note saying why I repeated it.

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## EXEMPLAR — practice, not the task

This is one complete run of the modelling cycle on a supplied data set, so you can see what each part looks like. **It is practice, not the task** — your task runs on your own brief, with your own generated or sourced data.

**The supplied data set — SCENARIO.** A family has $2000 to save for 5 years. A bank offers two simple-interest options:

- **Option A** pays 4.35% p.a. — the Reserve Bank of Australia cash rate target as at 11 August 2026, used here as a SCENARIO deposit rate.
- **Option B** pays 5% p.a. — the rate from ASIC Moneysmart's simple-interest example (page updated 11 August 2026).

Source: Reserve Bank of Australia, *Statement by the Monetary Policy Board: Monetary Policy Decision*, Media Release 2026-19, 2026. Retrieved 20 August 2026.

Source: ASIC Moneysmart, *Compound interest*, 2026 (page last updated 11 August 2026). Retrieved 20 August 2026.

**Question.** Which option finishes ahead after 5 years, and when does Option B's balance first reach $2600?

**1 · Formulate.** Variables: $t$, the time in years from the start of the deposit, and the balances $A$ and $B$ in dollars. Interest for one year: Option A pays $2000 \times 0.0435 = \$87$; Option B pays $2000 \times 0.05 = \$100$. The same amount is added every year, so both balances are linear: $A = 2000 + 87t$ and $B = 2000 + 100t$. Assumptions: each rate stays fixed for the whole 5 years; interest is paid only on the starting $2000; there are no fees, no withdrawals and no deposits.

**2 · Solve.** Tables of values:

| $t$ (years) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| $A$ ($) | 2000 | 2087 | 2174 | 2261 | 2348 | 2435 |
| $B$ ($) | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 |

First differences: $87$ each year for $A$, $100$ each year for $B$ — constant, confirming both are linear. Balance after 5 years: $A = 2000 + 87 \times 5 = 2000 + 435 = 2435$; $B = 2000 + 100 \times 5 = 2500$. When does Option B reach $2600? $2000 + 100t = 2600$, so $100t = 600$ and $t = 6$.

**3 · Interpret.** After 5 years, Option B holds $2500 and Option A holds $2435 — Option B is ahead by $65. Option B pulls ahead by $13 every year ($100 - 87$), so it leads from year 1 onward, and the lead keeps growing. The $2600 target takes 6 years — one year longer than the family's 5-year plan, so the target is not reached inside the plan.

**4 · Evaluate.** Check at $t = 2$: the rule gives $A = 2000 + 87 \times 2 = 2174$, which matches the table. The fit is exact here because the rules built the tables; with measured data the points would sit *near* a line rather than exactly on it. Limitations: the model assumes one rate for the whole term, while real term deposits fix a rate for one term at a time; and many real accounts pay interest on the growing balance, not only on the starting amount — that would widen Option B's lead. The model also ignores fees and tax. Sensible domain: $0 \le t \le 5$, the length of the family's plan.

**5 · Report** (audience: the family). "Put the $2000 in Option B. At simple interest, Option B adds $100 a year where Option A adds $87, so after your 5 years Option B holds $2500 against Option A's $2435 — $65 more, and the gap grows by $13 each year. The $2600 target would take 6 years, which is beyond your plan. These figures assume both rates hold for all 5 years and that interest is paid only on the starting $2000; if either account pays interest on the growing balance, Option B's lead is larger still."

∴ Option B finishes ahead: $2500 against $2435 after 5 years; Option B reaches $2600 at $t = 6$ years, outside the family's 5-year plan.

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## How to run X3

*Teacher-facing. X3 is a classroom task, not an exam.*

- **When** — after subtopics 2A, 3A, 3B and 3C of Chapter 3 have been taught. X3 draws on 2A (linear graphs and equations) and 3A (quadratic graphs and the null factor law); 3C is the host and teaches the cycle.
- **Format** — each student takes one brief (their choice, or yours) and runs their own modelling cycle. Students may collect data in pairs or small groups, but the planning frame, the model, the calculations and the report are each student's own. Score what you see and hear as you move between students, and check each student's sheets at the end of the final lesson.

- **Timing** — nothing is timed; there is no time limit on the students. The guidance here is for your planning, per the assessment plan (§7.2): about two to three lessons — lesson 1 for the brief and the planning frame, the gap between lessons for finishing collection or sourcing (homework where needed), lessons 2 and 3 for Parts A to E.
- **Equipment** — the list below.
- **Calculator and software** — `VC2M9A06` does not name digital tools, so no tool is compulsory and a fully hand-drawn, hand-calculated task is a complete task (D9). A scientific calculator is permitted. A spreadsheet or graphing tool is permitted for tables and graphs where the student chooses one. No CAS.
- **Marking** — use the marking guide at the end of this file. X3 is teacher-marked and is not counted in the test totals (§7.2); Test T3 carries 3C's 4 test marks separately (§7.1).
- **If a student is absent** — `VC2M9A06` is assessed principally by this task (the T3 item is a short interpret-the-model item only), so run the task again at a makeup session.

## Equipment

*Teacher. One set per student, or per pair/group where noted.*

**Everyone**

- a printed copy of this task — the spaces in Parts A to E are the students' record sheets
- pencils, rulers, grid paper, and a scientific calculator (permitted)

**Brief A groups**

- a container that drains at a steady rate (or can be poured at a steady rate), a measuring cylinder, a stopwatch, and access to a sink or bucket
- paper towels and cloths

**Brief B groups**

- a soft ball, a measuring tape or a marked wall, and a device that records slow-motion video (yours)
- chalk or sticky notes to mark heights

**Brief C students**

- a device with access to the approved published sources (Reserve Bank of Australia, ASIC Moneysmart, or a source you have approved), or a teacher-prepared printed rate card with its source line already written (§6 format)

**All briefs**

- access to a spreadsheet or graphing tool for tables and graphs (permitted where chosen; students may also work entirely by hand)

## Safety

*Controls at the point of use. Read these to the class before the task starts.*

For students:

- **Water (Brief A).** Wipe up spills at once — a wet floor is slippery. Keep water away from bags, books and electrical devices, and carry containers with two hands.
- **Tossing (Brief B).** Use the soft ball only, toss straight up in the clear space your teacher shows you, and never throw at anyone. Stand clear of lights and fans, and watch for the ball on the way down.
- **Moving around.** Walk, stay in the areas your teacher has agreed to, and keep doorways and walkways clear while you measure.
- **Online (Brief C).** Use only the published sources your teacher names or approves. Never log in anywhere, and never enter personal details.

For the teacher:

- Approve each student's brief, method and collection place before lesson 1 ends, and keep all collection inside the school grounds.
- Set draining work over a sink or bucket, with cloths within reach; check the floor stays dry.
- Check Brief B's space for low lights, fans and hard edges before use.
- For Brief C, known published sources only — the Reserve Bank of Australia, ASIC Moneysmart, or a source you have approved; rate cards may be pre-printed with their source lines.
- Keep the school's first-aid kit with you.

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## Part A — Formulate (4 marks)

**a. Write your change question. (1 mark)**

Your question must name what is changing and what you want to find out.

My question: ………………………………………………………….

…………………………………………………………………….

**b. Name your variables, with units. (1 mark)**

The quantity I change or watch (for example, time) is ……………………

………………………., measured in ………………………. .

The quantity that depends on it is ……………………………………..,

measured in ………………………. .

**c. Choose your family, with a reason. (1 mark)**

Circle one: linear · quadratic

I chose this family because

…………………………………………………………………….

…………………………………………………………………….

**d. Write at least one assumption. (1 mark)**

An assumption is something the model chooses to ignore.

One thing my model will ignore: ………………………………………

…………………………………………………………………….

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## Part B — Solve (4 marks)

**a. Record your data in a table, with units on both columns. (1 mark)**

Record each value as it happens. Minimum: 8 rows for Brief A, 6 rows for Brief B, balances for $t = 0$ to $5$ for Brief C. Brief C: under your table, name your source and write your completed source line.

**b. Find your rule or your curve, with working shown. (1 mark)**

Brief A: compute the first differences, read the rate from them, and write the rule. Brief C: find the interest for one year, then write the balance rule. Brief B: draw a smooth, symmetric curve through your points, and mark the greatest point and the return to the starting height.

Working:

…………………………………………………………………..

…………………………………………………………………..

**c. Use your model to answer your brief's calculation questions. (1 mark)**

Show each substitution.

Working:

…………………………………………………………………..

…………………………………………………………………..

…………………………………………………………………..

**d. Draw the graph. (1 mark)**

Name both axes with units, choose a scale that uses the page, and draw the line or curve from your rule or your data. You may draw it by hand or build it with a spreadsheet or graphing tool.

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## Part C — Interpret (4 marks)

**a. State each answer with its unit. (1 mark)**

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**b. Say what the key feature means in the situation. (1 mark)**

The rate of change for Briefs A and C — what is added, or lost, each step — or the greatest point and the return time for Brief B.

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**c. Answer your question in context, in words. (1 mark)**

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**d. State a sensible domain for your model, with a reason. (1 mark)**

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## Part D — Evaluate (4 marks)

*The descriptors below are the ones you were shown before the task.*

**a. Check your model against one value. (1 mark)**

Substitute one value of your input variable into your rule — or read it from your graph — and compare with a value you actually recorded. Write the comparison here.

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**b. Say how well the model fits, with evidence. (1 mark)**

Point to your data or your graph — for example, that the first differences are nearly constant, or that the points sit close to your curve.

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**c. Name one limitation. (1 mark)**

Something your assumptions ignored, and how that could change your answer.

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**d. Say one improvement, or the range over which your model can be trusted. (1 mark)**

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## Part E — Report (4 marks)

*Write your report in the space below. Aim for half a page to a page.*

**a. Name your audience, and write for them. (1 mark)**

My audience: …………………………………………………..

Use words your audience will follow; explain any maths word you keep.

**b. Summarise your method, in order. (1 mark)**

What you changed or sourced, how you recorded the data, and how you built the model — enough for your audience to follow what you did.

**c. State your findings — the numbers, with units. (1 mark)**

**d. Put the limitation inside the report. (1 mark)**

Your report itself says what the model shows **and** what it leaves out — do not leave the evaluation in Part D only.

My report:

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**Total for this task: □ out of 20 marks**

## Marking guide

*Teacher-facing. Score only what you can see the student do, or hear the student say. Submissions will differ — mark each action against the student's own brief, data and model, not against any particular topic. A spoken answer counts the same as a written one. If you have to tell a student what to do before an action, do not give the mark for that action — record the prompt instead, so you know what to teach next.*

Task X3 carries 20 marks in the five criteria of the assessment plan (§7.2), 4 marks each: **formulate** (assumptions and variables stated) · **solve** (mathematics correct and shown) · **interpret** (answer read back into the situation, with units) · **evaluate** (model or method tested, limitations named) · **report** (methods and findings communicated to the stated audience). It assesses the full modelling cycle of `VC2M9A06`, drawing on `VC2M9A03` (2A) and `VC2M9A05` (3A). A submission that stops at the answer has not delivered the content description: the evaluate criterion is where X3 is actually won (§7.2), and criterion D's descriptors were shown to students in full before the task.

**Anchor.** This rubric is written against the corrected achievement- standard anchor. §4 (D7): the `achievement_standard` field carried on `VC2M9A06` in the authority file is transposed with `VC2M9M05` — the raw field carries sentence 12, which belongs to 5E. The corrected anchor for `VC2M9A06` is sentence 5, quoted below, and §4's `AS` column supersedes the raw field for every reporting and rubric job in this book.

> *Students use mathematical modelling to solve problems involving change, including simple interest in financial contexts and change in other applied contexts, choosing to use linear and quadratic functions.* — Level 9 achievement standard, sentence 5 (corrected per §4/D7)

**Criterion A — Formulate — 4 marks**

| Mark | What you can see the student do | Accept |
|---|---|---|
| a (1) | Writes a change question that names what is changing and what is to be found out. | Brief A: "How long does the container take to empty, and does the rate stay steady?" Brief B: "How high does the ball go, and when does it come back down?" Brief C: "How does the balance grow, and when does it reach the target?" A question with no changing quantity, or one answered by a single fixed number, does not qualify — redirect before collection. |
| b (1) | Names both variables, with units, and identifies which depends on which. | Time (s or years) against volume (mL or L), height (m) or balance ($). Units on both. |
| c (1) | Chooses linear or quadratic, with a reason tied to the situation or the data. | "The same amount leaves every 10 seconds, so linear." "The height goes up and then comes down, so quadratic." A bare choice with no reason ("because it is a line") does not. |
| d (1) | States at least one assumption — something the model will ignore. | Brief A: "the flow stays at the same rate." Brief B: "air resistance is ignored." Brief C: "the rate stays fixed for the whole term." |

**Criterion B — Solve — 4 marks**

| Mark | What you can see the student do | Accept |
|---|---|---|
| a (1) | Records the data in a table with units on both columns; Brief C names the | Minimum: 8 rows (A), 6 rows (B), balances for $t = 0$ to $5$ (C). Values |

| Mark | What you can see the student do | Accept |
|---|---|---|
| | source and completes the source line. | recorded as collected, not reconstructed afterwards. The source line names the publisher, the title and the date, with the retrieval date (§6 R1). A shortfall the student notices and tops up still earns the mark. |
| b (1) | Finds the rule or the curve, with working shown. | Linear briefs: first differences computed, rate read from them, rule written. Brief B: a smooth symmetric curve drawn through the points, with the greatest point and the return marked — fitting a formula is not required; reading from the drawn curve is the Level 9 route where readings do not give integer answers (3A, D3.1). Working visible, not asserted. |
| c (1) | Uses the model correctly for the brief's calculation questions, with substitutions shown. | Brief A: the rate and the emptying time. Brief B: the requested readings from the curve. Brief C: the yearly interest, the balance at 5 years, the time to the stated target. Solving stays in level: linear equations solved by back-tracking; a quadratic equation, where one arises, is monic with integer roots and solved by the null factor law (D3.1); intersections between two options are read from the table or the graph, never found by solving the two rules together (D3.3). |
| d (1) | Draws the graph correctly. | Both axes named with units; a scale that uses the page; the line or curve from the rule or the data. Hand-drawn or software-built both count. |

**Criterion C — Interpret — 4 marks**

| Mark | What you can see the student do | Accept |
|---|---|---|
| a (1) | States each answer with its unit. | "$2435", "36 seconds", "1.8 m". A bare number without its unit does not. |
| b (1) | Says what the key feature means in the situation. | Brief A: "the volume falls by 90 mL every 10 seconds." Brief B: "the greatest height is 1.9 m, at 1.4 seconds." Brief C: "$87 of interest is added every year." |
| c (1) | Answers the brief's question in context, in words. | One or two sentences about the container, the ball or the savings — not a restatement of the numbers alone. |
| d (1) | States a sensible domain, with a | Brief A: "$0 \leq t \leq 36$ s — after that |

| Mark | What you can see the student do | Accept |
|---|---|---|
| | reason. | the container is empty and the rule starts giving negative volumes.” Brief C: “$0 \le t \le 5$ — the family’s plan runs 5 years.” Brief B: from release to landing. |

**Criterion D — Evaluate — 4 marks**

*Descriptors shown to students in full before the task (§7.2). This is the criterion where X3 is won.*

| Mark | What you can see the student do | Accept |
|---|---|---|
| a (1) | Checks the model against one value, and writes the comparison. | Substitutes one input value into the rule and compares with a recorded reading, or reads one point from the graph and compares. |
| b (1) | Judges the fit, pointing to evidence in the data or the graph. | “My first differences are 88, 87, 87, 86, so a constant rate is a good description.” “The points sit close to the curve except the last one.” A bare “it fits” does not. |
| c (1) | Names one limitation — something the assumptions ignored — and its likely effect. | Brief A: “the flow slowed as the level dropped, so my emptying time is a little short.” Brief B: “air resistance is ignored, so the real greatest height is lower.” Brief C: “the rate is assumed fixed for the whole term, and real accounts may pay interest on the growing balance, which would widen the lead.” |
| d (1) | Says one improvement, or the range of values over which the model can be trusted. | “Use the model only for the first 30 s, while the flow is steady.” “Repeat the timing with video to cut down reading error.” “State the rate as fixed for one term at a time.” |

**Criterion E — Report — 4 marks**

| Mark | What you can see the student do | Accept |
|---|---|---|
| a (1) | Names the audience, and writes for them. | Plain words; any maths word kept (gradient, turning point, principal) is explained or unnecessary for that audience. |
| b (1) | Summarises the method, in order. | What was changed or sourced, how the data were recorded, and how the model was built — enough for the audience to follow. |
| c (1) | States the findings — the answers from Part C, in sentences, with units. | The numbers appear in the report itself, not only in Part C. |
| d (1) | Puts the limitation inside the report. | The report itself says what the model shows and what it leaves out — the evaluation is not left in Part D only. |

**How the marks map to the curriculum**

| Curriculum words (VC2M9A06; AS 5 corrected per §4/D7) | Marks |
|---|---|
| Formulate problems — assumptions and variables stated (§7.2) | A a, A b, A d |
| Choosing to use linear or quadratic functions (AS 5) | A c, B b |
| Solve — mathematics correct and shown (§7.2) | B a, B b, B c, B d |
| Interpret solutions in terms of the context (CD) | C a, C b, C c, C d |
| Evaluate the model (CD) | D a, D b, D c, D d |
| Report methods and findings (CD), to the stated audience (§7.2) | E a, E b, E c, E d |
| Simple interest in financial contexts (AS 5) | Brief C throughout; B b, B c |
| Data named and dated — source line (§6 R1) | A planning frame, B a |

**Teacher recording sheet**

| Part | Criterion | Marks | Action notes |
|---|---|---|---|
| A | Formulate — assumptions and variables stated | /4 | |
| B | Solve — mathematics correct and shown | /4 | |
| C | Interpret — answer read back into the situation, with units | /4 | |
| D | Evaluate — model or method tested, limitations named | /4 | |
| E | Report — methods and findings communicated to the stated audience | /4 | |
| | | **/20** | |

**What the marks say**

The marks use the words VCAA carries on `VC2M9A06` — *formulate problems, choosing to use either linear or quadratic functions ... interpret solutions in terms of the context; evaluate the model and report methods and findings* — against the corrected sentence 5 of the Level 9 achievement standard. A student who scores across all five criteria has run the whole modelling cycle on data of their own generating or sourcing — and has done the three things a timed written test cannot show: formulating, evaluating and reporting. A mark not scored here is a gap to teach next; `VC2M9A06` is assessed principally by this task (the T3 item is a short interpret-the-model item only; §7.2), so an absent student completes it at a makeup session.

**Record the total: □ out of 20**