Mathematics Level 10

Extended tasks

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Contents

Task

Task X1 — Mathematical modelling · Extended task · 20 marks · Chapters 3 and 4 (3C and 4C) · Level 10

> This is a school-designed paper. It is not a VCAA instrument. Achievement in the Victorian Curriculum is reported against the Level 10 achievement standard, not against a mark on this paper.

Codes: VC2M10A15 (Option A) and VC2M10M04 (Option B), both assessed in full · draws on 2E (VC2M10A14), 3B (VC2M10A11) and 4C (VC2M10M04)

> *use mathematical modelling to solve applied problems involving inverse proportion, growth and decay, including in financial contexts to establish the compound interest formula as repeated applications of simple interest; formulate problems, choosing to apply linear, quadratic or exponential models; interpret solutions in terms of the situation; evaluate and modify models as necessary and report assumptions, methods and findings* — VC2M10A15
>
> *use mathematical modelling to solve practical problems involving direct and inverse proportion and scaling of objects; formulate problems and interpret solutions in terms of the situation, including the impact of measurement errors on the accuracy of results; evaluate and modify models as necessary, and report assumptions, methods and findings* — VC2M10M04

Task X1 is a modelling task. It is not a test. You choose one real situation, turn it into a **model** — a rule that stands in for the situation — solve two questions with it, and then judge whether the model is a good description of real life. You follow the same five steps you learned in 3C and 4C, shown in Figure 1. Your work is marked with a **rubric** — a marking guide written as things you can be seen doing — printed at the end of this task.

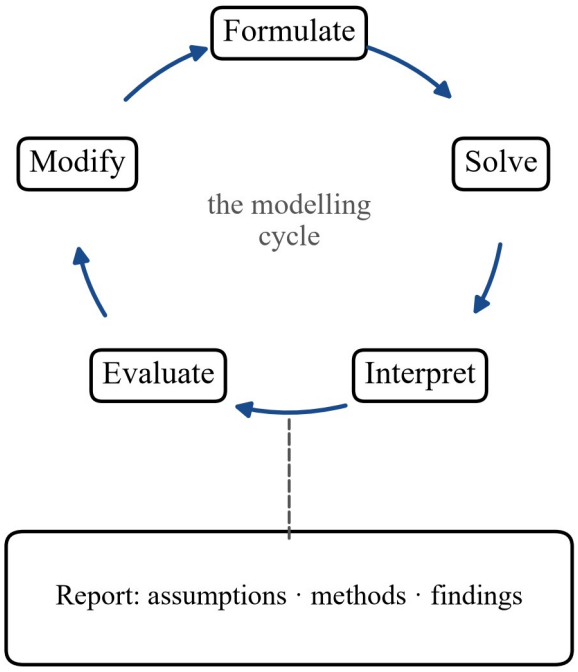


Figure 1. A flow chart of five boxes in a ring, Formulate, Solve, Interpret, Evaluate and Modify, joined by arrows running clockwise back to the start, with the words the modelling cycle in the middle; below the ring, a box reading Report: assumptions, methods and findings is joined to the ring by a dashed line.

This is the full version of the task announced in 3C. Your data must be your own — generated by measuring or counting, or sourced by you from a published table — and your findings are written for a reader you name.

The brief

Choose **one** option and run the full modelling cycle — formulate, solve, interpret, evaluate and modify, report — on data you generate or source yourself. Collect at least four pairs of values, record how they were obtained, and report your assumptions, methods and findings in one page or one slide deck. This task is teacher-marked against the rubric below and is not counted in the test totals.

Option A — growth, decay or inverse proportion (`VC2M10A15`). Choose a situation in which a quantity grows or decays by a roughly constant percentage per step (a population, a resale value, a cooling temperature), or two quantities in inverse proportion (a trip's time and speed, a light's brightness and distance). Formulate a model, choosing linear, quadratic or exponential as the diagnostic below directs; solve two questions — one *evaluate* question and one *solve* question; interpret both in the situation; evaluate the model against a data point you did not use to build it, and modify it if the fit is poor; report.

Option B — scaling and proportion (`VC2M10M04`). Choose a situation that draws on 4C's proportional reasoning — a map's scale, a recipe scaled up, a photo enlarged, a model's scale factor — and measure how the modelled values compare with measured ones, including the size of any errors. Formulate the proportional model, solve two questions — one *evaluate* question and one *solve* question — interpret both in the situation, evaluate against measurement, modify, and report.

Some starting points, offered under the elaborations carried by 3C and 4C (D11 — these are illustrations, not a checklist; a different situation that fits the option is equally valid):

- the value of one real car model at ages 0, 1, 2, 3, … years, sourced from published resale guides (`VC2M10A15.E01` growth and decay in financial contexts);
- the time a fixed trip takes at a range of average speeds (`VC2M10A15.E01`, inverse proportion);
- a population growing by a roughly constant percentage each year, sourced from the Australian Bureau of Statistics (`VC2M10A15.E03`);
- a savings balance under a real published interest rate, compounded yearly (`VC2M10A15.E04` — authenticate with the source line and the *as at* date);
- the scale factor of a model or a map, checked against several measured lengths (`VC2M10M04.E04`);
- a recipe or a prototype scaled up by a constant factor, with measured and modelled values compared (`VC2M10M04.E03`);
- a plan drawing converted to actual measurements, with the errors in the measurements included (`VC2M10M04.E02`, `.E01`).

Choosing the model — the diagnostic

Read your table of values with equally spaced inputs the way 3C §2 does (Figure 2):

- **Constant first differences** (each value changes by the same *amount*) mean the pattern is **linear**.
- **Constant second differences** (the differences of the differences are constant) mean the pattern is **quadratic**.
- **A constant ratio** (each value is the same *multiple* of the one before) means the pattern is **exponential**.
- **A constant product** (one quantity times the other is always the same number) means the two quantities are in **inverse proportion** (4C §3).
- **A constant quotient** (one quantity divided by the other is always the same number) means the two quantities are in **direct proportion** (4C §2).

Real data rarely fit perfectly: the differences and ratios will be *roughly* constant. Part of the task is saying how close is close enough.

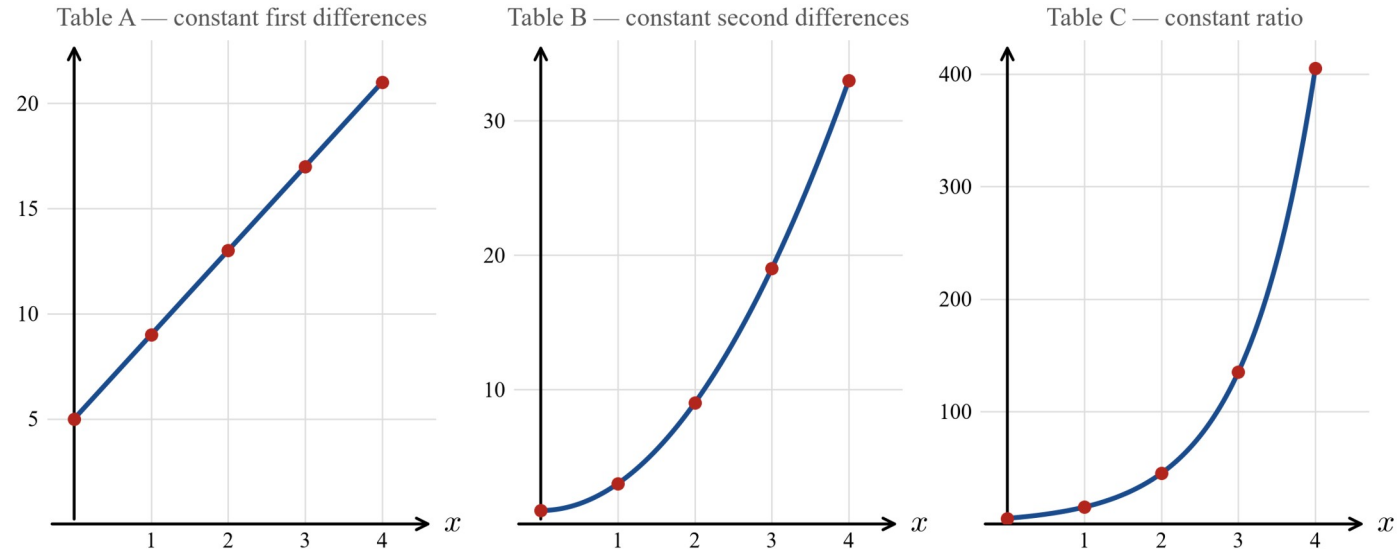


Figure 2. Three graphs side by side of the three patterns: a straight line rising from (0, 5) to (4, 21); a curve rising from (0, 1) to (4, 33); and a steep curve rising from (0, 5) to (4, 405). The three look alike for small x and part apart sharply afterwards.

What your report must show

Your report has five parts, one for each step of the cycle. Each part is worth **4 marks**. Write your report on separate paper or in a slide deck, as your teacher directs.

Part 1 — Formulate. State the situation and the question your model answers. Name both variables with their units. State your assumptions — what you are holding constant, and what you are ignoring. Choose the model type with the diagnostic above, and write the rule with its numbers found from your own data.

Part 2 — Solve. Solve two questions with your rule.

- The *evaluate* question substitutes a value into the rule and asks for the result — *what is the value after 5 years?* or *what is the real length when the plan reads 3 cm?*
- The *solve* question sets the rule equal to a value and finds the input — *when does the value halve?* or *what plan length stands for 2 m?* Solve it numerically, by trap and refine (2E), or graphically, by reading an intersection (3B).

Show every step of the working, one step per line.

Part 3 — Interpret. Read each answer back into the situation, in words, with units and rounding that suit it — $t \approx 5.4$ years means *during the sixth year*, and a balance rounds to the cent.

Part 4 — Evaluate and modify. Test the model against a spare data point — one you did not use to build the rule — or against a fresh measurement. Say how far the prediction is from the actual value; for Option B, include the size of the measurement errors (4C). Name at least one limitation of the model or of the way you collected the data. Modify the model where the test shows it is needed, or say clearly over what range the model is reliable.

Part 5 — Report. Communicate the assumptions, the method and the findings to the reader you named. Include your source lines (below). One page, or one slide deck.

Planning frame

Step	Record
Formulate	Situation; variables and units; assumptions (what is held constant); model type and rule; where the data comes from
Solve	The two questions and the full working
Interpret	Each answer read back into the situation, with units and

Step	Record
	sensible rounding
Evaluate	Model checked against a spare data point; limitations named; model modified where needed
Report	One page or deck for a stated reader, carrying assumptions, method and findings

Data-quality checklist

Before solving, check: at least four pairs of values; units recorded with every value; the source or measuring method written down; a spread of values wide enough to show the pattern; outliers noticed and explained; and, for sourced data, the date it applies (*as at* month and year).

Source lines. Every sourced value carries a source line in the house format (R1):

Source: Reserve Bank of Australia, Statistical Table F4, 2026. Retrieved 23 August 2026.

Anything presented as current — an interest rate, a price, a population — carries an *as at* stamp (R3): *as at July 2026*. For data you measure yourself, write who measured, where, and when.

Equipment and rules

You will need:

- this brief, and separate paper or a slide deck for your report;
- a pencil, a ruler and grid paper;
- a scientific calculator (permitted throughout);
- for primary collection, as your situation needs and your teacher approves: a tape measure, a stopwatch, a thermometer or scales;
- for sourced data: a device, or a teacher-prepared printed copy of a published table with its source line already written.

A spreadsheet or a graphing tool is **optional** — DIGITAL TOOL: this task assumes a spreadsheet or graphing tool only where your teacher nominates one. Your teacher will nominate the tool. No CAS. Everything in this task can be done by hand: a hand-calculated, hand-drawn response is a complete response.

This task is worth 20 marks, in five parts of 4 marks each. It is a classroom task, not an exam, and it is not timed; your teacher will set the deadline. It is marked against the rubric below and is **not counted in the test totals**.

How X1 will be marked

Shown to students before the task begins.

X1 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:

1. **Formulate** — variables, assumptions and model type all stated; the rule fits the data.
2. **Solve** — the mathematics correct and fully shown, for both questions.
3. **Interpret** — both answers read back into the situation, with units and sensible rounding.
4. **Evaluate** — the model tested against a spare point, limitations named, the model modified where needed.
5. **Report** — assumptions, method and findings communicated clearly to the reader you named.

Your teacher scores only what they can see in your report, or hear you say. The full rubric, written as the observable actions that earn each mark, is printed after this task for your teacher; the five lines above are the student version of it.

Words you need

Every word here was introduced in Chapter 3 or Chapter 4. This is a quick look-back, plus the few new words this task uses.

- A **model** is a rule, a table or a graph that stands in for a situation (3C, 4C).
- To **formulate** is to turn the situation into mathematics: name the variables, state the assumptions, choose the model type and write the rule (3C §5, 4C §1).
- An **assumption** is something you take to be true so the model can work — what is held constant, what is ignored (3C §5).
- The **diagnostic** reads a table of values: constant first differences mean linear, constant second differences mean quadratic, a constant ratio means exponential (3C §2); a constant product means inverse proportion, a constant quotient means direct proportion (4C §2, §3).
- To **evaluate** a rule is to substitute a value and calculate the result (3C §5). To **solve** is to set the rule equal to a value and find the input, numerically by trap and refine (2E) or graphically by reading an intersection (3B).
- A **spare data point** is a recorded value you keep out of the rule-building, so the model can be tested against it (3C §5).
- The **scale factor** is the constant multiple that connects a model and the real object (4C).
- A **source line** is one sentence that names where the data came from and when, in the format above (R1).
- 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.

EXEMPLAR — practice, not the task

One fully-worked response on a supplied data set, so you can see what the five parts look like. This data set is supplied for practice — it is not the task, and you may not submit it.

Supplied data: a van is bought for $\$32\,000$; its trade-in value is recorded as $\$27\,200$ after 1 year, $\$23\,120$ after 2 years and $\$19\,652$ after 3 years.

Formulate. The ratios are $\frac{27\,200}{32\,000}=0.85$, $\frac{23\,120}{27\,200}=0.85$, $\frac{19\,652}{23\,120}=0.85$ — a constant ratio, so exponential decay: $V=32\,000\times0.85^{t}$, assuming the van keeps losing 15% of its value each year.

Solve. Evaluate: $V(5)=32\,000\times0.85^{5}=32\,000\times0.4437053125=14\,198.57$, so $\$14\,198.57$. Solve: $V=16\,000$ (half the purchase price) needs $0.85^{t}=0.5$; $0.85^{4}\approx0.522$ and $0.85^{5}\approx0.444$, so the value halves between $t=4$ and $t=5$, about $t\approx4.3$ years.

Interpret. On this model the van is worth about $\$14\,198.60$ after 5 years, and it halves in value in about 4.3 years — during its fifth year.

Evaluate. The model fits the three recorded values exactly (constant ratio 0.85), but it assumes the same 15% fall forever; in practice old vans stop falling in value, so after about 8–10 years the model would be modified to hold a floor value.

Report. "A van bought for $\$32\,000$ loses about 15% of its value each year; the exponential model $V=32\,000\times0.85^{t}$ matches the recorded trade-in values, predicts about $\$14\,200$ after five years, and is reliable only while the percentage fall holds."

Total for this task: □ out of 20 marks

How to run X1

Teacher-facing. X1 is a classroom task, not an exam.

- **When** — after subtopic 3C of Chapter 3 (both options) and subtopic 4C of Chapter 4 (Option B) have been taught. Within the book, X1 draws on 2E (every *solve* question is an exponential or proportional equation) and 3B (the graphical read of an intersection), per §7.3.
- **Format** — each student runs their own modelling cycle on data they generate or source. Students may collect data in pairs or small groups, but the plan, the working and the report are each student's own. Score what you see and hear as you move between students, and check each report at the end. A proposal with no workable data plan — or one that cannot produce at least four pairs of values — needs redirecting early.
- **Timing** — §7.3 sets no time limit for this task and none is imposed: it is untimed. For your planning: about one lesson to choose, approve and begin collection; the time between lessons for finishing collection (as homework if needed); and about one lesson to complete Parts 2 to 5 and submit the report.
- **Equipment** — the list below.
- **Calculator and tools** — a scientific calculator is permitted throughout. Neither `VC2M10A15` nor `VC2M10M04` names a digital tool, so no tool is required and the hand-calculated, hand-drawn response is a complete response. The task draws on 3B, whose CD (`VC2M10A11`) names a graphing tool, so a spreadsheet or graphing tool is permitted where you nominate one (D13). No CAS. Tools are named by class only, never by product.
- **Marking** — use the marking guide at the end of this file. It is written as observable student actions against the achievement-standard extracts carried in the authority file, so your judgement maps to the VCAA wording without translation.
- **If a student is absent** — the full cycle of `VC2M10A15` and `VC2M10M04` is assessed only here: T2 and T3 score those CDs as timed skills but cannot score the cycle (§7.3). 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 brief — the planning frame and the checklist are the working sheets
- separate paper or slide software for the report, as you direct
- pencils, rulers, grid paper, and scientific calculators (permitted)

Primary-collection students

- tape measures, stopwatches, thermometers and scales, as each approved situation needs
- warm water only, and never hotter than the hot tap delivers, for any cooling investigation

Sourcing students

- a device with access to published sources only — the Australian Bureau of Statistics, the Bureau of Meteorology, the Reserve Bank of Australia, ASIC Moneysmart, or another §6 source class you have approved — or a teacher-prepared printed copy of a published table with its source line already written (R1 format)

Both routes

- access to a spreadsheet or graphing tool where you nominate one (permitted, not required; students may also work and draw entirely by hand)
- grid paper for hand-drawn graphs and rough work

Safety

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

For students:

- **Measuring people.** Ask before you measure anyone, and measure everyone the same way. Anyone may say no — thank them and move on. Record values, not names.

- **Moving around the school.** Walk, stay in the areas your teacher has agreed to, and keep doorways and walkways clear while you measure.
- **Outdoors.** Hat on and sunscreen on before you go out — the sun can be strong even on cloudy days. Drink water, and stay off roads and out of car parks.
- **Timing trips.** Measure a fixed distance at walking pace in an approved area only. Never conduct a timing study on a road or near moving vehicles — the inverse-proportion model can be computed from given speeds without any traffic at all.
- **Cooling investigations.** Use warm water only — no hotter than the hot tap delivers — and carry containers carefully. Wipe up any spills straight away.
- **Rulers and equipment.** Carry rulers and tape measures pointing down, and never throw or swing them.

For the teacher:

- Approve each student's situation, data source and collection method before work begins, and keep all collection inside the school grounds.
- Check outdoor sites before use — glass, holes, and traffic at edges.
- Keep the school's first-aid kit with you, and know the school's sun protection policy.
- For internet use, students obtain data from known published sources only — the §6 source classes, or a source you have approved — and every sourced value carries its source line and retrieval date (R1), with an *as at* stamp on anything presented as current (R3).

Marking guide

Teacher-facing. Score only what you can see in the student's report, or hear the student say. Models will differ — mark the action against the student's own situation and data, 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 X1 carries 20 marks in the five criteria of the assessment plan (§7.3), 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, model modified where needed) · **report** (methods and findings communicated to the stated audience). It assesses the full modelling cycles of `VC2M10A15` (Option A) and `VC2M10M04` (Option B), drawing on 2E, 3B and 4C. Each action below scores 1 mark; the four actions within a criterion correspond to the criterion bands of the rubric printed in 3C — all four actions is the 4-mark band, about half is the 2-mark band, one action is the 0–1 band.

The rubric below is written against the achievement-standard extracts carried on the two CDs in the authority file (`maths_10.json`), quoted verbatim, so a teacher's judgement maps to the VCAA wording without translation.

> *Students use mathematical modelling to solve problems involving growth and decay in financial and other applied situations, applying linear, quadratic and exponential functions as appropriate, and solve related equations, numerically and graphically.* — VC2M10A15, achievement-standard extract
>
> *They identify the impact of measurement errors on the accuracy of results. Students use mathematical modelling to solve practical problems involving direct and inverse proportion and scaling, evaluating and modifying models, and reporting assumptions, methods and findings.* — VC2M10M04, achievement-standard extract

Criterion A — Formulate — 4 marks

Mark	What you can see the student do	Accept
a (1)	States the situation and the question the model answers, in their own words.	The situation fits the chosen option: growth or decay by a roughly constant percentage per step, or inverse proportion (Option A — `VC2M10A15.E01`, `.E03`); direct or inverse proportion, or scaling (Option B — `VC2M10M04`). "The trade-in value of this van model each year after purchase", "the time for a fixed 240 km trip at different average speeds" and "the scale factor of this model car, checked against measured lengths" all qualify. A situation with no varying quantities, or one the student cannot collect at least four pairs of values for, does not — redirect early.
b (1)	Names both variables, with units.	"t, the number of years since purchase; V, the trade-in value in dollars"; "v in km/h and t in hours"; "x, the length on the plan in cm; y, the actual length in m".
c (1)	States at least one assumption.	"the value falls by the same percentage each year", "the average speed holds for the whole trip", "the photo is enlarged by the same factor in both directions", "every

Mark	What you can see the student do	Accept
		measurement is taken the same way, to the nearest millimetre".
d (1)	Chooses a model type, and writes a rule that fits the data.	The choice is justified by the 3C §2 diagnostic — constant first differences → linear, constant second differences → quadratic, constant ratio → exponential — or by 4C's proportion tests — constant product → inverse proportion, constant quotient → direct proportion. The rule's numbers come from the student's own data: in the exemplar, ratios of 0.85 give $V = 32\,000 \times 0.85^{t}$. For Option B, a scale factor or constant of proportionality found from a measured pair qualifies.

Criterion B — Solve — 4 marks

Mark	What you can see the student do	Accept
a (1)	Sets the evaluate question, and shows the substitution into the rule with full working.	"Value after 5 years: $V = 32\,000 \times 0.85^{5} = 32\,000 \times 0.4437$." Working set out one step per line (R5).
b (1)	The evaluate answer is correct.	Check against the student's own rule; accept stated rounding (to the cent for money, to whole numbers for counts).
c (1)	Sets the solve question, and shows the equation and the working.	"When is the value half the purchase price? $32\,000 \times 0.85^{t} = 16\,000$, so $0.85^{t} = 0.5$; $0.85^{4} \approx 0.522$ and $0.85^{5} \approx 0.444$, so t lies between 4 and 5; refining, $t \approx 4.3$." Trap-and-refine (2E) or a graphical read of the intersection (3B) both qualify — numerically and graphically is exactly what the achievement-standard extract names.
d (1)	The solve answer is correct, with refinement shown where the answer is not a whole number of steps.	The trap between whole steps is shown, then the refinement; accept a correctly read intersection from a hand-drawn or tool-drawn graph. An unreduced claim ("somewhere between 4 and 5") without refinement scores the setup mark (c) only.

Criterion C — Interpret — 4 marks

Mark	What you can see the student do	Accept
a (1)	Reads the evaluate answer back into	"After 5 years the van is worth about

Mark	What you can see the student do	Accept
	the situation, in words.	\$14 200" — not "$V = 14\,198.57$" standing alone.
b (1)	Units and sensible rounding on the evaluate answer.	Dollars and cents, or a stated rounded figure, for money; whole years, metres, minutes, as the situation dictates; the rounding stated.
c (1)	Reads the solve answer back into the situation, in words.	"The value halves in about 4.3 years — during its fifth year"; "a plan length of 3 cm stands for 2 m in the real house".
d (1)	Units and sensible rounding on the solve answer.	$t \approx 4.3$ is read as a time in the situation, not left as a bare number; for Option B, the interpreted value carries the real unit, not the plan unit.

Criterion D — Evaluate and modify — 4 marks

Mark	What you can see the student do	Accept
a (1)	Tests the model or the method against a spare data point — or a fresh measurement — not used to build the rule.	The prediction from the rule and the actual spare value are both shown, and the difference between them is stated. For the exemplar shape: a recorded year-4 value compared with $32\,000 \times 0.85^4$.
b (1)	Says how large the mismatch is; for Option B, includes the size of the measurement errors.	"The model gives $32\,000 \times 0.85^4 = \$16\,704.20$ for year 4 and the recorded spare value is \$16 600 — a difference of about \$104, about 0.6%"; for Option B, a percentage error such as $\frac{0.02}{1.24} \approx 1.6\,\%$ from a measured and a modelled length (4C — the impact of measurement errors on the accuracy of results).
c (1)	Names at least one limitation of the model or of the method.	"A constant 15% fall cannot hold forever — old vans reach a floor value"; "the scale factor assumes the model is an exact enlargement in every direction"; "measurements to the nearest millimetre limit how accurate the scale factor can be"; "four data points is a thin basis for the rule".
d (1)	Modifies the model where the test shows it is needed, or gives a reasoned judgement of the range over which the model is reliable.	Adding a floor value after some years; applying each year's own rate instead of one constant rate (as 3C Q23(d)); re-measuring with a finer instrument; or "the model is reliable only while the percentage fall

Mark	What you can see the student do	Accept
		holds". "The model is good" with no test or range does not score.

Criterion E — Report — 4 marks

Mark	What you can see the student do	Accept
a (1)	The report is one page or one slide deck, for a stated reader.	The reader is named — the class, the teacher, a school committee — and the length is respected.
b (1)	The report carries the assumptions and the method.	Where the data came from, the rule and how it was found, and how each question was solved.
c (1)	The report carries the findings.	Both interpreted answers and the evaluate-and-modify conclusion, not raw numbers alone.
d (1)	Every sourced value carries its source line, and any value presented as current carries its *as at* date.	R1 format — *Source: <publisher>, <title>, <year>. Retrieved <DD Month YYYY>.* — and an *as at* stamp for a current rate, price or population (R3). For student-generated data: who measured, where, and when.

How the marks map to the curriculum

Curriculum words	Marks
Formulate problems, choosing to apply linear, quadratic or exponential models (VC2M10A15); formulate problems (VC2M10M04)	A a, A b, A c, A d
Solve related equations, numerically and graphically (VC2M10A15 achievement-standard extract)	B a, B b, B c, B d
Interpret solutions in terms of the situation (VC2M10A15; VC2M10M04)	C a, C b, C c, C d
Evaluate and modify models as necessary (VC2M10A15); evaluating and modifying models (VC2M10M04)	D a, D c, D d
The impact of measurement errors on the accuracy of results (VC2M10M04)	D b
Report assumptions, methods and findings (VC2M10A15; VC2M10M04)	E a, E b, E c
The data source named and dated (R1, R3; §6)	E d

Teacher recording sheet

Part	Criterion	Marks	Action notes
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	

Part	Criterion	Marks	Action notes
4	Evaluate — model tested, limitations named, model modified	/4	
5	Report — methods and findings communicated to the stated audience	/4	
		/20	

What the marks say

The marks use the words VCAA carries on the two CDs: *formulate … interpret solutions in terms of the situation; evaluate and modify models as necessary and report assumptions, methods and findings*. A student who scores across all five criteria has run the whole modelling cycle of 3C and 4C on data of their own — and has done the things a timed written item cannot show: choosing the model from real data, testing it against a point it was not built on, and reporting the assumptions honestly. A mark not scored here is a gap to teach next; the full cycle of `VC2M10A15` and `VC2M10M04` is assessed only by this task (T2 and T3 score the skills but not the cycle; §7.3), so an absent student completes it at a makeup session.

Record the total: □ out of 20

Task

Mathematics 10 · Extended tasks · Task X2 — Bivariate / time-series statistical investigation (Level 10)

Task	X2 — Bivariate / time-series statistical investigation
Host	Chapter 6 Statistics · Subtopic 6E
Content description	VC2M10ST05
Draws on	6A (VC2M10ST01), 6B (VC2M10ST02), 6C (VC2M10ST03), 6D (VC2M10ST04)
Marks	20 — five criteria at 4 marks each, against the Marking guide
Mode	Teacher-marked; not a timed paper

> **Content description (verbatim):** *plan and conduct statistical investigations of situations that involve bivariate data, including where the independent variable is time; evaluate and report findings with consideration of limitations of any inferences*
>
> **Achievement standard (extract):** *They plan and conduct statistical investigations involving bivariate data, including where the independent variable is time.*
>
> This is a school-designed paper. It is not a VCAA instrument. Achievement in the Victorian Curriculum is reported against the Level 10 achievement standard, not against a mark on this paper.

Brief. Conduct **one** statistical investigation of a situation involving **bivariate data** — two variables measured on the same people, objects or occasions — and run the full investigation cycle of 6E §1: question, plan, collect, organise and display, analyse, interpret, report. Every inference you draw — each conclusion the data is used to support — must be reported **with its limitations**. The data must be **generated or sourced by you**: by observation, experiment or measurement, or from a legitimate public source you name. Collect at least eight pairs of values (at least twelve if you want to claim a seasonal pattern), record how they were obtained, and report your findings in one page or one slide deck for a stated audience. Submit your planning frame, your raw data and your report together. This task is teacher-marked against the Marking guide below and is not counted in the test totals. The data set of the exemplar at the end of this booklet is practice material: it may not be used as your task data.

Option A — bivariate investigation, neither variable time. Choose two variables that may be related — the kind of question 6B's scatterplot answers. Pose the question, collect or source at least eight pairs, draw the scatterplot, describe the association in words, place a line of good fit by eye if the pattern is roughly straight, use it for one interpolation (a reading taken inside the range of the data), and report with limitations. Remember from 6B: association is not cause and effect.

Option B — time-series investigation, the independent variable is time. Choose a quantity that changes through time — something you can measure yourself weekly, or a published series (the Australian Bureau of Statistics and the Bureau of Meteorology both publish series the public can read). Collect or source at least eight equally spaced values (twelve or more if you claim a seasonal pattern). Draw the time-series graph, describe its trend (a long-term rise or fall) and any seasonal variation (a pattern that repeats each year), place a line of good fit if the trend is roughly straight and read its gradient as a rate of change, make one interpolation and one careful extrapolation (a reading taken outside the range of the data), and report with limitations — including why the extrapolation may fail.

Planning frame. Complete the frame before any data is collected, and submit it with your report.

Stage	Record
Question	The question, in one sentence, answerable with bivariate data
Plan	The two variables and their units; which is independent; where the data comes from; how much; ethics, if people are involved
Collect	The method, or the source with its date (*as at* month and year)

Stage	Record
Organise and display	The table, and the display that fits the data, with axes labelled
Analyse	The features described; the line of good fit, its gradient and its meaning, if one fits
Interpret	Each result read back into the situation, with units
Evaluate	The limitations of every inference made — range of the data, length of the window, the assumption that the pattern continues, association against cause and effect
Report	One page or deck for the stated audience, carrying question, method, findings and limitations

Data-quality checklist. Before analysing, check: at least eight values (twelve for a seasonal claim); units recorded with every value; the same measuring method throughout, or one named source; the source dated; a spread wide enough to show the pattern; outliers (values that sit well away from the rest) recorded and explained, not silently deleted; and, if people are involved, consent and privacy sorted before any data is collected.

Timing and administration. This task is not a timed paper and has no Part A / Part B split: it is completed over the lessons your teacher nominates and marked against the Marking guide. A scientific calculator is allowed throughout. Where you use a digital tool, it is a spreadsheet or a graphing tool as nominated by your teacher; **no CAS**. Every display may be drawn by hand on grid paper, and no mark in the guide requires a digital tool.

Equipment

Student:

- scientific calculator;
- pencil, ruler and eraser; grid paper for any display drawn by hand;
- the planning frame and report sheet, issued by the teacher.

School-issued, as each approved plan requires:

- measuring devices matched to the plan — for example a tape measure, a stopwatch, a thermometer or a kitchen scale;
- a spreadsheet or a graphing tool where the teacher nominates digital tools; **no CAS**;
- printed tables, or supervised access to public data sources, where the data is sourced rather than collected.

Safety

Controls at the point of use. The teacher checks the plan against these before any data is collected.

1. **Approved plan.** No data is collected until the teacher has approved the question, the method and the location.
2. **People.** If the investigation measures people: each person gives informed consent — permission given after they understand what is recorded; measurements are simple and harmless, such as height, arm span or reaction time; results are recorded without names and stay within the class.
3. **Health data.** The class does not collect medical or health information. A health question — for example, about vaccines and immunity — is answered with published data from an approved health body, never collected by students.
4. **Location.** Measurements are taken on school grounds or at a teacher-approved location. No measuring or counting beside traffic or in car parks. Outdoor collection follows the school's sun-protection and wet-weather rules.
5. **Food.** No data collection involving food or tasting without teacher approval under the school's allergy rules.
6. **Online sources.** Teacher-approved public sources only; personal information is never uploaded.

7. **Equipment.** Use equipment as intended; do not stand on furniture to reach a measurement; report breakages to the teacher.

Marking guide

20 marks — five criteria (marking standards) at 4 marks each. The criteria are written in the language of the achievement-standard extract and the content description carried for `VC2M10ST05`, so teacher judgement maps to VCAA wording without translation:

Criterion	Wording followed (verbatim, `VC2M10ST05`)
Formulate · Solve	*plan and conduct statistical investigations involving bivariate data, including where the independent variable is time* (achievement-standard extract)
Interpret · Evaluate · Report	*evaluate and report findings with consideration of limitations of any inferences* (content description)

Marks are awarded from the evidence in the submitted planning frame, raw data and report — a behaviour counts wherever it appears. Award the band whose descriptors best match the evidence.

Criterion	4 marks	3 marks	2 marks	1 mark	0 marks
Formulate	The plan states all of: a one-sentence question the data can answer; both variables with their units; which variable is independent; the source or collection method; the assumptions (what is held constant or taken as true)	The question, both variables with units, the independent variable and the source or method are stated; assumptions are missing or vague	A question and the variables are stated; units are missing or the independent variable is not identified	A question is written; no workable variables are stated	No workable question
Solve	The data table is complete with units; the correct display for the data (scatterplot or time-series graph) is drawn with axes labelled with variable names and units and points plotted accurately; the features are described in words (association for a scatterplot; trend and any seasonal variation for a time series); where a line of	The display and the description of features are correct; one arithmetic slip or one gap in the working	A display is attempted but is the wrong type, has unlabelled axes or inaccurate points, or the arithmetic has major errors	The data table is present; no display is attempted	Mathematics not correct or not shown

Criterion	4 marks	3 marks	2 marks	1 mark	0 marks
	good fit belongs it is placed with the points roughly balanced on each side; the working the option calls for — gradient as rise ÷ run, interpolation, extrapolation — is correct and shown one step per line				
Interpret	Every result is read back into the situation with units and sensible rounding — the gradient stated as a rate of change in the situation, and each estimate said in terms of the situation	Most results are read back into the situation; units or rounding occasionally missing	Results are restated but not read back into the situation	Results are given as bare numbers	No interpretation
Evaluate	Limitations are named for every inference made and linked to it — the range of the data (interpolation against extrapolation), the amount of data or the length of the time window, the assumption that a pattern continues, and, where two variables move together, that association is not cause and effect; the method is tested where possible (for example, a reading checked against the data)	Limitations are named but not linked to the particular inferences made	One limitation is named, or the limitations are general	An evaluation is stated with no reason given	No evaluation

Criterion	4 marks	3 marks	2 marks	1 mark	0 marks
Report	One page or one slide deck for a stated audience; the question, the method, the findings and the limitations are all present; the display is included and referred to; the findings answer the question in one or two sentences in context	The report carries the question, findings and limitations; the audience is not stated or the method is only partly shown	Findings are given; the method is only partly shown and no limitations are given	Only parts of the report are present	Not communicated

Applying the guide.

- A line of good fit is placed by judgement; a digital tool may draw the line once the student has judged where it belongs. A line computed by formula, and any single number used to score the strength of a relationship, are not part of Level 10 and earn no credit.
- Hand-drawn displays can earn full marks; no criterion requires a digital tool.
- A response that misses exactly one element of the 4-mark column for a criterion is awarded 3 marks for that criterion.

Recording the mark.

Criterion	Mark
Formulate	/ 4
Solve	/ 4
Interpret	/ 4
Evaluate	/ 4
Report	/ 4
Total	**/ 20**

The 20 rubric marks are not counted in the topic-test totals or the end-of-book review (§7.3).

Exemplar

EXEMPLAR — practice, not the task. The supplied data set below is practice material: it may not be submitted as task data. The exemplar is worked against the five criteria so the Marking guide can be read in use.

Supplied data: `SCENARIO` a household's monthly electricity bills for one year, in dollars:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bill (dollars)	212	196	158	138	149	183	224	231	172	141	152	189

Question used by the exemplar. How does the household's electricity bill change through the year?

Formulate. The two variables are the month (the independent variable, time) and the bill in dollars. Twelve equally spaced monthly values are enough to look for a seasonal pattern. The data comes from the household's bills, so every value is in the same units and measured the same way. Assumption: the household's circumstances — who lives there, and how the house is heated and cooled — stayed the same through the year.

Solve. The display is a time-series graph, drawn from the table (Figure 6E.10). The series shows no straight trend to fit a line to — it rises and falls through the year. The bills are high in winter (June $\$183$, July $\$224$, August $\$231$) and low in autumn and spring (April $\$138$ is the trough; October $\$141$ the next lowest). The total for the year:

$$212 + 196 + 158 + 138 + 149 + 183 + 224 + 231 + 172 + 141 + 152 + 189 = 2145$$

$\therefore$ the mean monthly bill is $2145 \div 12 = \$178.75$.

The peak is August at $\$231$, which is

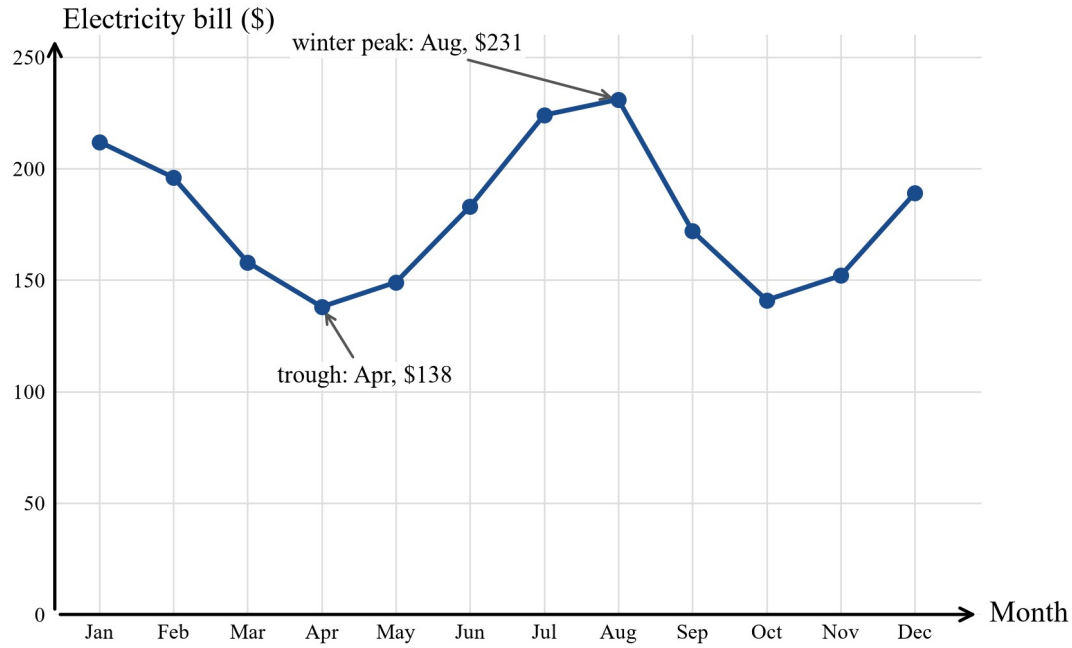
$$231 - 138 = 93$$

dollars above the April trough.

Interpret. The household's bill follows the seasons: it peaks in winter, when heating runs, and sits lowest in the mild months. Over the year the household paid $\$2145$, averaging about $\$179$ a month.

Evaluate. Only one year is recorded, so the pattern may not repeat — a colder or hotter year would change it. The bill mixes price and usage: if the electricity price rose during the year, part of the winter peak is price, not usage, and this data cannot separate the two. No extrapolation is made: with one seasonal year, predicting next year's bills would assume the pattern repeats, and that assumption is exactly what the data cannot yet check.

Report. "The household's electricity bill is seasonal: it peaks in winter — August was the highest at $\$231$ — and is lowest in the mild months, with April the trough at $\$138$. The year's total was $\$2145$, about $\$179$ a month on average. One year of bills cannot show whether the pattern will repeat, and price changes during the year may be part of the winter peak."



A time-series graph of monthly electricity bills in dollars for one year, January to December. Bills peak at 231 dollars in August and fall to a trough of 138 dollars in April, with both points labelled.

The exemplar against the Marking guide. Formulate 4 — question, variables with units, independent variable, source and assumptions all stated. Solve 4 — correct display drawn from the table, features described in words, all arithmetic correct and shown (no line of good fit is claimed, because the pattern is not roughly straight). Interpret 4 — every result read back into the household's situation with units. Evaluate 4 — the limitations are named and linked to

what the one year of data can and cannot support. Report 4 — a short finding, in context, for a stated reader, carrying the limitations. Total: $4 + 4 + 4 + 4 + 4 = 20$.