MATHEMATICS AA / SL / INTERNAL ASSESSMENT

Cooling a drink

An illustrative feedback report

May 2027 | Analytic rubric | Original fictional extracts

15 / 20

ILLUSTRATIVE SCORE PROFILE

Five criterion values demonstrate the report format. They are not a mark awarded to a real submitted draft.

This original teaching example follows a cooling model from an everyday question through an exponential function to a testable prediction. The illustrative profile rewards a clear focus, connected mathematical work and some decision-making, while showing how residual analysis, notation and reflection could become more precise. The 15/20 is a fictional demonstration value, not a mark awarded to a real submitted exploration.

Score overview

Criterion	Illustrative mark	Detail
A Presentation	3 / 4	Page 2
B Mathematical communication	3 / 4	Page 3
C Personal engagement	2 / 3	Page 4
D Reflection	2 / 3	Page 5
E Use of mathematics	5 / 6	Page 6

Read this report as a demonstration

- Illustrative report; not an assessment of a submitted draft.
- All extracts, observations, decisions and scores were created for this demonstration. No student file was reviewed.
- The short extracts are not a complete exploration and cannot establish an IB mark or a final course grade.
- The three checks under each criterion are original diagnostic prompts, not official scored subcriteria or an additive checklist.
- Use the applicable IB guide and school guidance for full descriptors; this report does not reproduce achievement bands.

CRITERION A / DIAGNOSTIC REVIEW

Presentation

Illustrative mark: 3 / 4

The constructed sequence has a focused question, an accessible measurement plan and a conclusion connected to the aim. Its argument is understandable, but the transition from fitting two points to testing later observations needs a clearer place in the main discussion. The demonstration value illustrates a coherent but not yet fully economical presentation.

Three checks, with traceable evidence

Statuses describe a diagnostic observation. They carry no individual marks.

Check / status	Evidence and next action
A1 A specific aim guides the exploration MET	**Evidence: X1 (page 7)** The question identifies the drink, the room conditions and the temperature threshold to be estimated. **Action.** Keep the threshold question visible when introducing each mathematical step.
A2 Results appear in a logical sequence NEEDS WORK	**Evidence: X3, X5 (page 7)** The fit is shown before the prediction, but the later observed values are not yet used in a clearly separated model check. **Action.** Insert a short model-check section between fitting the function and estimating the threshold time.
A3 Tables and visuals earn their place NEEDS WORK	**Evidence: X2, X4 (page 7)** The observation table supports the work; the described graph still needs an explanatory sentence and complete axes. **Action.** Introduce the graph with the comparison it is intended to reveal and remove any duplicate display that adds no insight.

What stronger evidence could look like

Evidence to develop next: a concise route from the aim to the chosen model, its test and the answer, with each table or graph introduced at the point where it advances the reasoning. More pages or decorative sections alone would not demonstrate improvement.

Development guidance, not a promise of a higher mark.

All evidence is original fictional teaching material. See the extract register on page 7.

CRITERION B / DIAGNOSTIC REVIEW

Mathematical communication

Illustrative mark: 3 / 4

The example defines the model and mostly uses consistent symbols. The table and function convey the main quantities, yet the units of the rate constant and the graph's vertical axis are incomplete. The demonstration value shows useful communication that needs a final consistency check.

Three checks, with traceable evidence

Statuses describe a diagnostic observation. They carry no individual marks.

Check / status	Evidence and next action
B1 Variables and units are defined NEEDS WORK	**Evidence: X3, X4 (page 7)** Time is defined in minutes and temperature in degrees Celsius, but k is not labelled as per minute and the graph omits the vertical unit. **Action.** State that k has units min^-1 and label the vertical axis Temperature / degrees Celsius.
B2 The model is communicated symbolically MET	**Evidence: X3 (page 7)** The function relates room temperature, initial excess temperature and elapsed time in one expression. **Action.** Keep the equation beside the explanation of each term and define any new notation before use.
B3 Calculation precision is explained NEEDS WORK	**Evidence: X5, X8 (page 7)** The threshold result is rounded to a tenth of a minute without explaining whether that precision matches the temperature observations. **Action.** Retain full precision internally, then justify the displayed rounding using the resolution and uncertainty of the measurements.

What stronger evidence could look like

Evidence to develop next: precise definitions and units carried through the equation, table, graph and conclusion, with reasoning readable without guessing the meaning of symbols. A notation audit should resolve ambiguity rather than merely add technical vocabulary.

Development guidance, not a promise of a higher mark.

All evidence is original fictional teaching material. See the extract register on page 7.

CRITERION C / DIAGNOSTIC REVIEW

Personal engagement

Illustrative mark: 2 / 3

The invented author makes a purposeful choice of temperature threshold and selects a tractable model to answer a practical question. Some ownership is visible in the plan to compare models. The next step is to document how an actual result changes a mathematical decision, rather than relying on a personal introduction alone.

Three checks, with traceable evidence

Statuses describe a diagnostic observation. They carry no individual marks.

Check / status	Evidence and next action
C1 A personal purpose leads to a mathematical choice MET	**Evidence: X1 (page 7)** The chosen threshold is connected to the author's intended use, and the question calls for a time estimate. **Action.** Explain how the threshold and observation interval shaped the method.
C2 The author considers an alternative approach MET	**Evidence: X7 (page 7)** A straight-line comparison is proposed as a check on whether the exponential model adds value. **Action.** Carry out the proposed comparison and show what was learned from it.
C3 Findings change a decision NEEDS WORK	**Evidence: X6, X7 (page 7)** The extracts notice later disagreement but do not yet document a revised fitting or measurement decision. **Action.** Choose one response to the mismatch, explain why it is justified and show its effect on the prediction.

What stronger evidence could look like

Evidence to develop next: a traceable sequence of independent decisions, such as testing an alternative model, noticing a mismatch and revising the method with a mathematical reason. This is about intellectual ownership shown in the work, not a claim of enthusiasm.

Development guidance, not a promise of a higher mark.

All evidence is original fictional teaching material. See the extract register on page 7.

CRITERION D / DIAGNOSTIC REVIEW

Reflection

Illustrative mark: 2 / 3

The demonstration acknowledges that constant room temperature is an assumption and notices that later observations exceed the model. Those comments are relevant, but their effects on the answer are not yet quantified or used to judge the model's domain. This fictional score illustrates partial reflection rather than a verified level of attainment.

Three checks, with traceable evidence

Statuses describe a diagnostic observation. They carry no individual marks.

Check / status	Evidence and next action
D1 The conclusion answers the stated question MET	**Evidence: X1, X5 (page 7)** The model gives an approximate time for the chosen threshold under the stated room-temperature assumption. **Action.** Restate the result as a conditional estimate and distinguish model time from an observed threshold crossing.
D2 Discrepancies are interpreted NEEDS WORK	**Evidence: X2, X6 (page 7)** The model is about three degrees below the invented observation at twenty minutes; the draft calls this small without a comparison standard. **Action.** Calculate residuals at every recorded time and discuss their size and pattern relative to measurement resolution.
D3 Assumptions are tested for their effect NEEDS WORK	**Evidence: X6, X8 (page 7)** Possible room-temperature drift and probe uncertainty are named but not connected to a changed prediction. **Action.** Recalculate under a justified alternative room temperature or fitting window and compare the threshold estimate.

What stronger evidence could look like

Evidence to develop next: reflection that changes the interpretation of the result. Calculate and interpret discrepancies, test a reasonable alternative assumption and explain when the threshold estimate is useful or unreliable. A longer limitations list alone is insufficient.

Development guidance, not a promise of a higher mark.

All evidence is original fictional teaching material. See the extract register on page 7.

CRITERION E / DIAGNOSTIC REVIEW

Use of mathematics

Illustrative mark: 5 / 6

The original example uses an exponential function, logarithms and algebra to estimate a rate and solve a threshold equation. The displayed steps are connected to the research question and can be checked. The model choice and error treatment would need fuller mathematical support before a stronger achievement claim could be made.

Three checks, with traceable evidence

Statuses describe a diagnostic observation. They carry no individual marks.

Check / status	Evidence and next action
E1 The chosen model has a stated rationale MET	**Evidence: X3 (page 7)** Cooling is represented as a rate proportional to the temperature difference from the room, leading to an exponential form. **Action.** Explain the physical scope of that assumption and why it is a useful approximation here.
E2 The main algebra is visible and checkable MET	**Evidence: X3, X5 (page 7)** The rate estimate uses the ten-minute observation and the threshold calculation uses logarithms rather than a black-box output. **Action.** Show units beside the rate and verify the final time by substituting it into the model.
E3 Fit quality supports the prediction NEEDS WORK	**Evidence: X2, X6, X7 (page 7)** Only the initial and ten-minute readings determine the function; the remaining observations are available but not yet used systematically. **Action.** Compare predictions with all observations and use that comparison to justify retaining or changing the model.

What stronger evidence could look like

Evidence to develop next: a complete and convincing explanation of why the mathematical method is suitable, with checked calculations, consistent units and a justified test of fit or sensitivity. More sophisticated mathematics is not automatically better if it is unexplained or unnecessary.

Development guidance, not a promise of a higher mark.

All evidence is original fictional teaching material. See the extract register on page 7.

EVIDENCE REGISTER

Original illustrative extracts

These are the complete short excerpts used by this demonstration. They are not quotations from a student, experiment or Clastify report. IDs replace invented page references.

X1 / Illustrative extract · question and purpose

I want to estimate when a drink first cools from 80 degrees Celsius to 45 degrees Celsius in a room near 20 degrees Celsius. I will observe the drink over twenty minutes and use a model to estimate the threshold time. The threshold is my chosen comparison point, not a claim about a safe drinking temperature.

X2 / Illustrative extract · invented observations

For this teaching example, the invented observations are: time t in minutes = 0, 5, 10, 15, 20; temperature T in degrees Celsius = 80, 69, 61, 55, 51. These values are constructed to support discussion of modelling; they were not collected in an experiment.

X3 / Illustrative extract · model and rate estimate

Assume that the rate of cooling is proportional to the difference between the drink and a room at 20 degrees Celsius. With t in minutes, use T(t) = 20 + 60 exp(-kt). At t = 10, T = 61, so exp(-10k) = 41/60 and k = -ln(41/60)/10, approximately 0.0381. I have not yet written the unit of k.

X4 / Illustrative extract · proposed graph

The planned graph places the observed temperatures and the exponential model on common axes. Its horizontal label is Time / min, while its vertical label is only Temperature. The caption currently says Cooling graph, without explaining what the comparison shows.

X5 / Illustrative extract · threshold calculation

To estimate when T = 45, solve 25 = 60 exp(-kt). Thus t = -ln(25/60)/k, approximately 23.0 minutes using the unrounded value of k. This is a model prediction beyond the final twenty-minute observation, not an observed crossing.

X6 / Illustrative extract · incomplete interpretation

At twenty minutes the model predicts about 48.0 degrees Celsius, compared with the invented value of 51. The difference seems small. The room may not remain exactly at 20 degrees, and later cooling might behave differently, but I have not tested the effect on my answer.

X7 / Illustrative extract · proposed alternative

A straight line through the readings at zero and ten minutes would be easier to use. I want to compare its later predictions with the exponential model before choosing which one better supports the threshold estimate. That comparison has not yet been completed.

X8 / Illustrative extract · uncertainty to investigate

If this were a real investigation, I would record the temperature probe's stated resolution and check whether room temperature changed. I would then repeat the calculation with justified alternative inputs. The present constructed table supplies no measured uncertainty, so I cannot claim an experimental error bound.

REVISION ROADMAP

Priorities and completion checks

P1 Test the model before relying on the threshold time

Criteria: D, E | Evidence: X2, X6

Create a compact comparison of model predictions and observations at all five times. Calculate observed-minus-predicted residuals, then explain their pattern and what it implies for extrapolation to the threshold.

Done when. Every observation has a checked prediction and residual; a short interpretation states whether the model tends to over- or under-predict and why the threshold remains conditional.

P2 Turn an alternative idea into a documented decision

Criteria: C, D, E | Evidence: X7, X8

Complete the proposed straight-line comparison or one justified sensitivity test. Explain the mathematical reason for retaining, modifying or rejecting the chosen model.

Done when. The alternative is calculated using a stated method, the effect on the result is visible, and the author explains a decision supported by that comparison.

P3 Make the mathematical communication consistent

Criteria: A, B | Evidence: X3, X4, X5

Add the unit of k, complete both graph axes, replace the generic caption with the purpose of the comparison and justify the precision of the final time.

Done when. A reader can identify every symbol and unit, understand why each display appears and reproduce the threshold calculation without guessing.

Method and scope

Checks are diagnostic, not individual scored subcriteria. Their statuses are not converted into points or averaged. Only the five analytic criterion marks are added for this Mathematics AA SL IA demonstration. A not-assessed criterion remains null and makes the overall score null; missing evidence is never silently scored as zero. TOK holistic assessment requires a separate contract and must not use this analytic sum.

Official reference sources

IB Mathematics: analysis and approaches guide, first assessment 2021 (official source for criterion names and maxima)

IB Mathematics curriculum page (official course context)

Criterion labels and maxima follow official reference material; all feedback wording and extracts are original. Reference review: 2026-09-24.