General Mathematics subject report

2023 cohort

January 2024

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

240029

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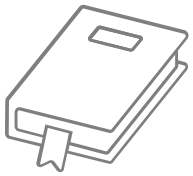
Introduction



Throughout 2023, schools and the Queensland Curriculum and Assessment Authority (QCAA) continued to improve outcomes for students in the Queensland Certificate of Education (QCE) system. These efforts were consolidated by the cumulative experience in teaching, learning and assessment of the current General and General (Extension) senior syllabuses, and school engagement in QCAA endorsement and confirmation processes and external assessment marking. The current evaluation of the QCE system will further enhance understanding of the summative assessment cycle and will inform future QCAA subject reports.

The annual subject reports seek to identify strengths and opportunities for improvement of internal and external assessment processes for all Queensland schools. The 2023 subject report is the culmination of the partnership between schools and the QCAA. It addresses school-based assessment design and judgments, and student responses to external assessment for this subject. In acknowledging effective practices and areas for refinement, it offers schools timely and evidence-based guidance to further develop student learning and assessment experiences for 2024.

The report also includes information about:

- how schools have applied syllabus objectives in the design and marking of internal assessments
- how syllabus objectives have been applied in the marking of external assessments
- patterns of student achievement.

The report promotes continuous improvement by:

- identifying effective practices in the design and marking of valid, accessible and reliable assessments
- recommending where and how to enhance the design and marking of valid, accessible and reliable assessment instruments
- providing examples that demonstrate best practice.

Schools are encouraged to reflect on the effective practices identified for each assessment, consider the recommendations to strengthen assessment design and explore the authentic student work samples provided.

Audience and use

This report should be read by school leaders, subject leaders and teachers to:

- inform teaching and learning and assessment preparation
- assist in assessment design practice
- assist in making assessment decisions
- help prepare students for internal and external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can use it to learn about the assessment practices and outcomes for senior subjects.

Report preparation

The report includes analyses of data and other information from endorsement, confirmation and external assessment processes. It also includes advice from the chief confirmer, chief endorser and chief marker, developed in consultation with and support from QCAA subject matter experts.

Subject highlights

455
schools offered General Mathematics

87.13%
of students completed 4 units

94.66%
of students received a C or higher

Subject data summary

Subject completion

The following data includes students who completed the General subject.

Note: All data is correct as at January 2024. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered General Mathematics: 455.

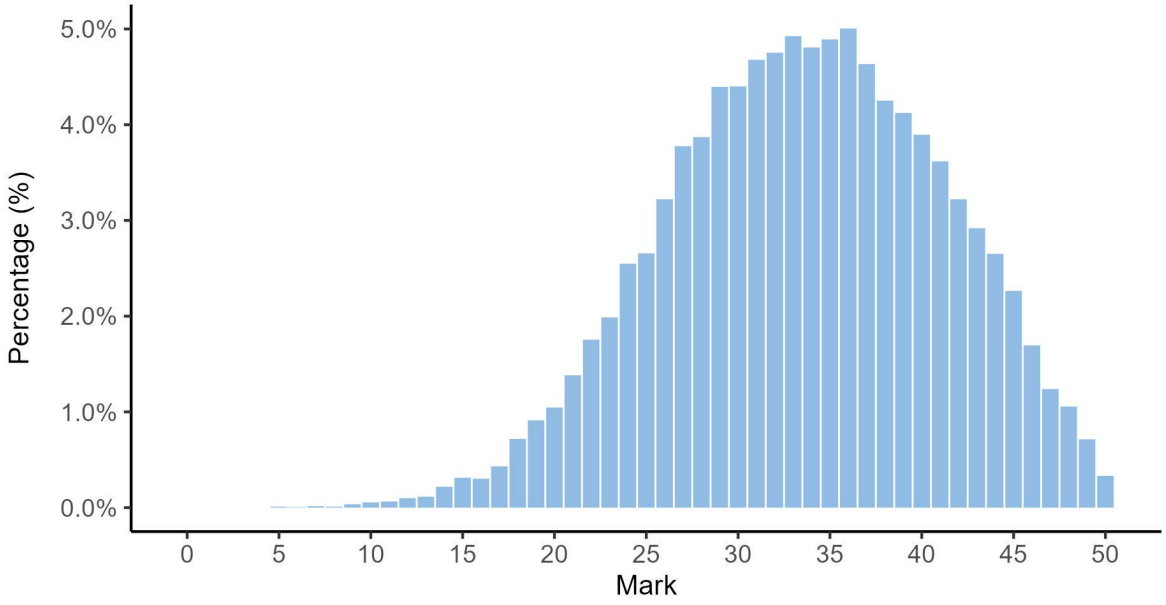
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	22,986	22,015	20,028

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	19,851	3,135
Unit 2	18,891	3,124

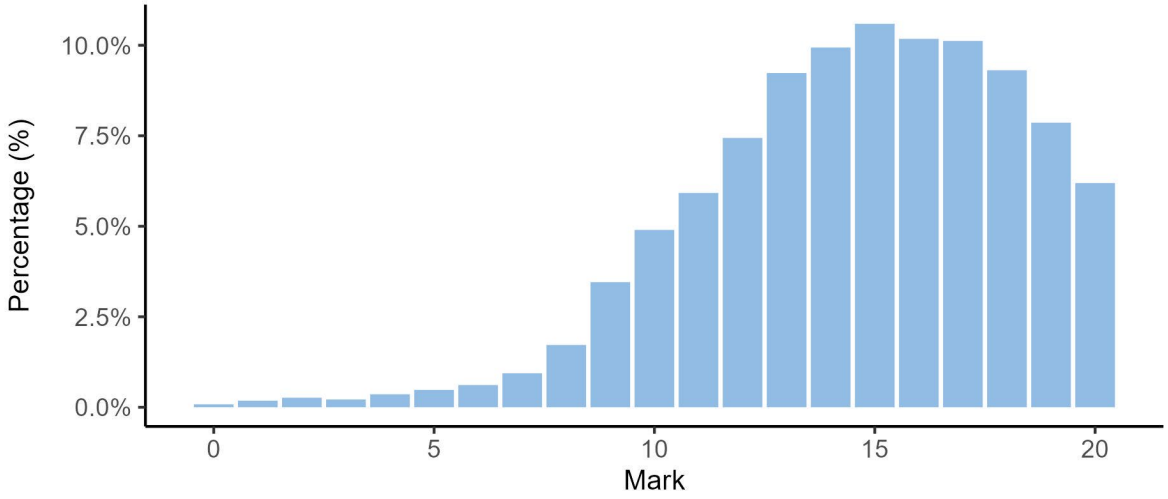
Units 3 and 4 internal assessment (IA) results

Total marks for IA

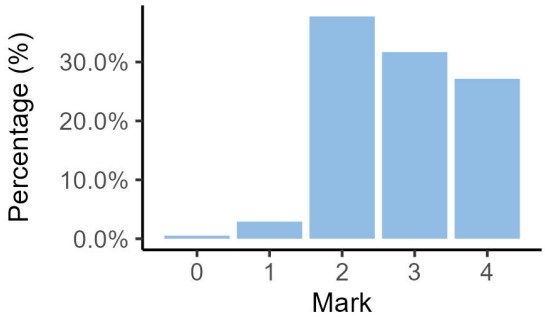


IA1 marks

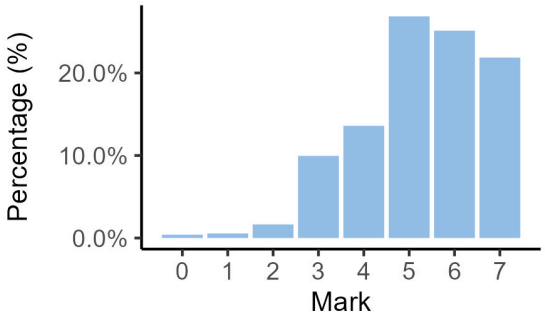
IA1 total



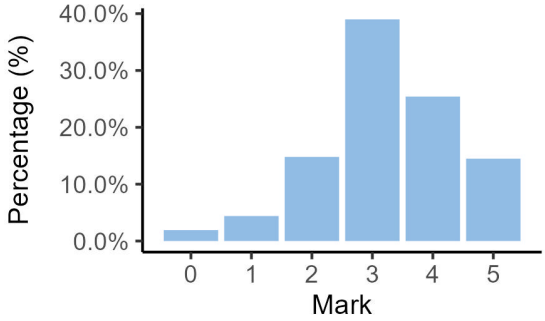
IA1 Criterion: Formulate



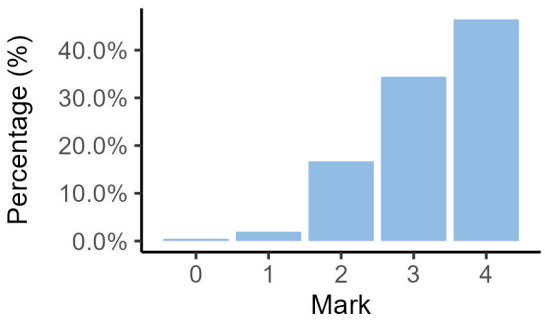
IA1 Criterion: Solve



IA1 Criterion: Evaluate and verify

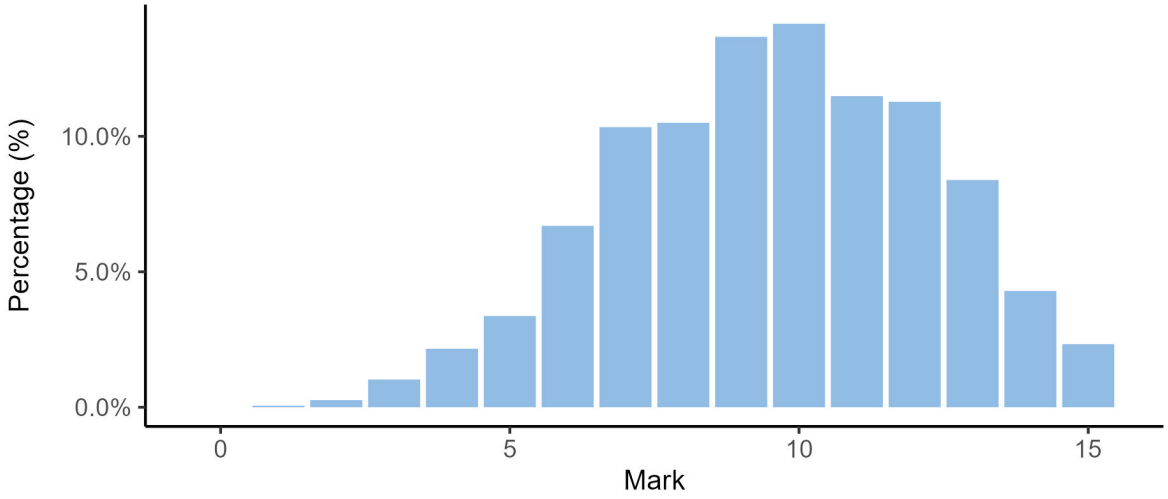


IA1 Criterion: Communicate

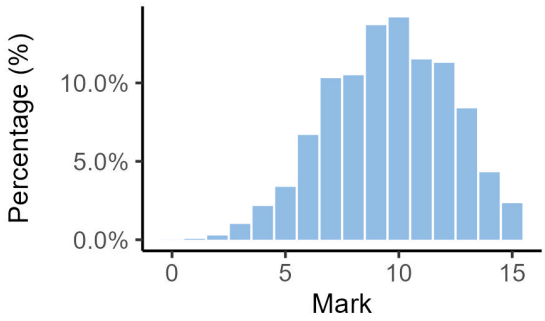


IA2 marks

IA2 total

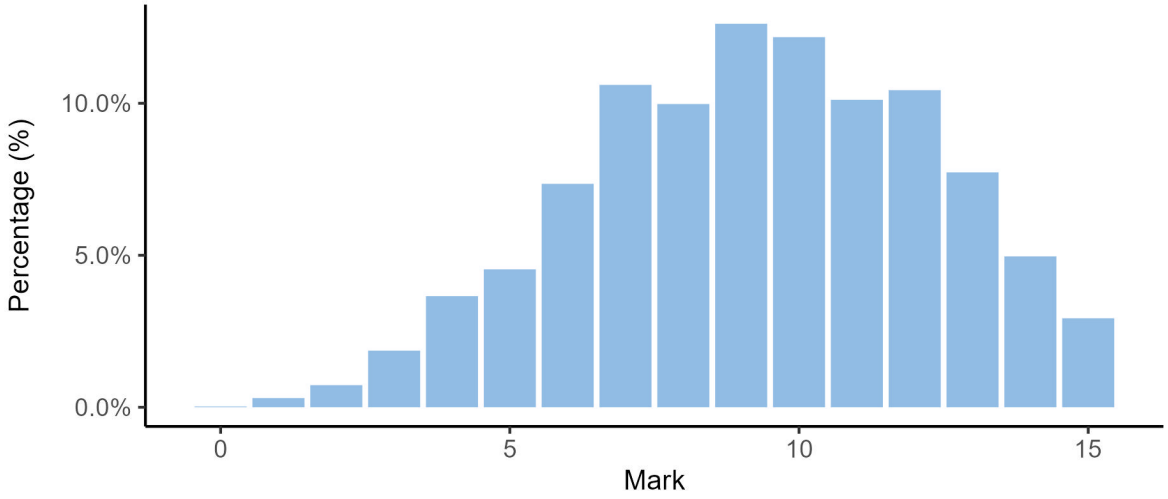


IA2 Criterion: Foundational knowledge and problem-solving

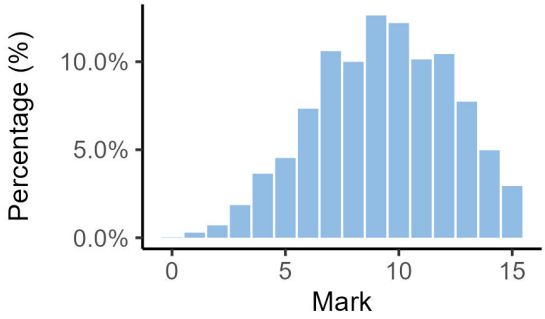


IA3 marks

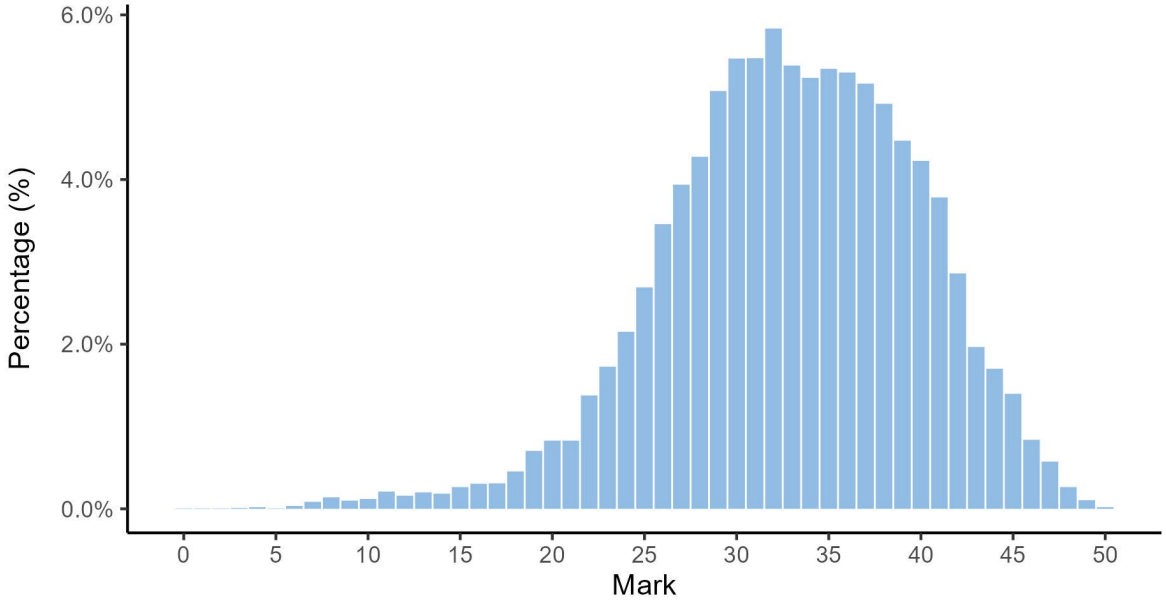
IA3 total



IA3 Criterion: Foundational knowledge and problem-solving

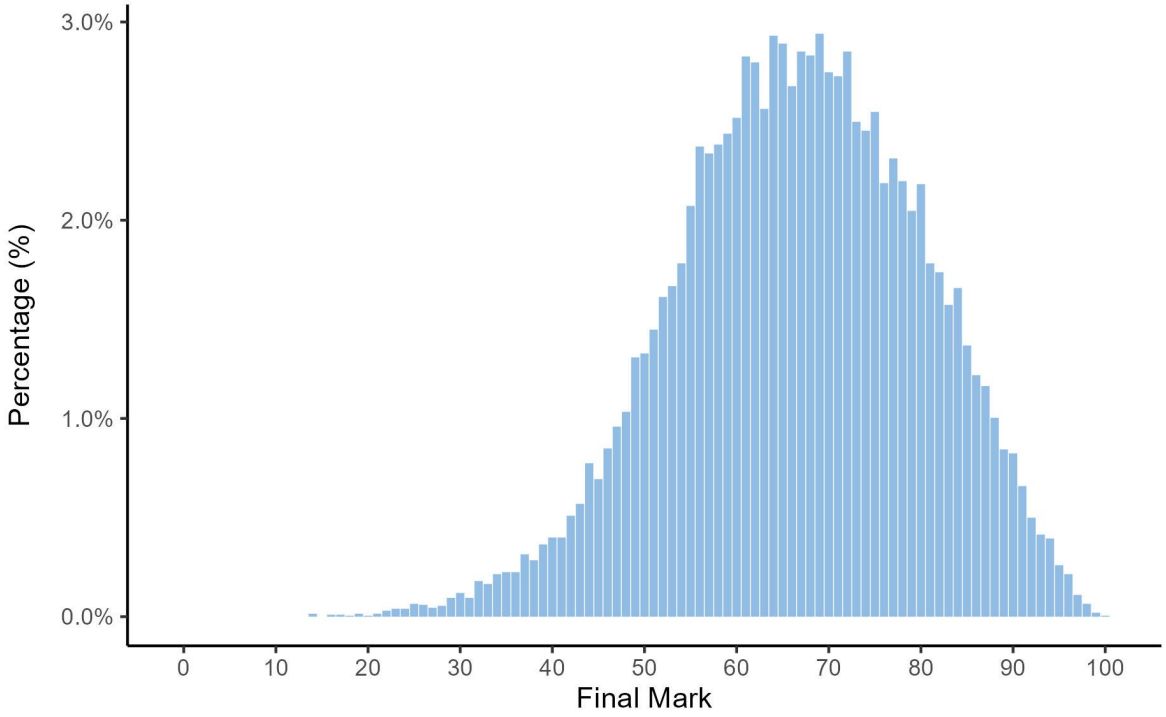


External assessment (EA) marks



Final subject results

Final marks for IA and EA



Grade boundaries

The grade boundaries are determined using a process to compare results on a numeric scale to the reporting standards.

Standard	A	B	C	D	E
Marks achieved	100–83	82–65	64–45	44–22	21–0

Distribution of standards

The number of students who achieved each standard across the state is as follows.

Standard	A	B	C	D	E
Number of students	2,462	8,903	7,593	1,055	15

Internal assessment

The following information and advice relate to the assessment design and assessment decisions for each IA in Units 3 and 4. These instruments have undergone quality assurance processes informed by the attributes of quality assessment (validity, accessibility and reliability).

Endorsement

Endorsement is the quality assurance process based on the attributes of validity and accessibility. These attributes are categorised further as priorities for assessment, and each priority can be further broken down into assessment practices.

Data presented in the Assessment design section identifies the reasons why IA instruments were not endorsed at Application 1, by the priority for assessments. An IA may have been identified more than once for a priority for assessment, e.g. it may have demonstrated a misalignment to both the subject matter and the assessment objective/s.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.6.

Percentage of instruments endorsed in Application 1

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	454	454	452
Percentage endorsed in Application 1	73%	42%	40%

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. The QCAA uses provisional criterion marks determined by teachers to identify the samples of student responses that schools are required to submit for confirmation.

Confirmation samples are representative of the school's decisions about the quality of student work in relation to the instrument-specific marking guide (ISMG), and are used to make decisions about the cohort's results.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.

The following table includes the percentage agreement between the provisional marks and confirmed marks by assessment instrument. The Assessment decisions section of this report for each assessment instrument identifies the agreement trends between provisional and confirmed marks by criterion.

Number of samples reviewed and percentage agreement

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	449	3,960	562	84.19%
2	448	3,066	0	97.1%
3	448	3,016	0	99.33%

Internal assessment 1 (IA1)

Problem-solving and modelling task — extended response (20%)

The problem-solving and modelling task must use subject matter from at least one of the following topics in Unit 3:

- Topic 1: Bivariate data analysis
- Topic 2: Time series analysis
- Topic 3: Growth and decay in sequences.

The task is an assessment instrument developed in response to a mathematical investigative scenario or context. It requires students to respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams.

Students must provide a response to a specific task or issue that is set in a context that highlights a real-life application of mathematics. The task requires students to use relevant stimulus material involving the selected subject matter and must have sufficient scope to allow students to address all the stages of the problem-solving and modelling approach. Technology must be used.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	40
Authentication	24
Authenticity	24
Item construction	13
Scope and scale	31

*Each priority might contain up to four assessment practices.

Total number of submissions: 454.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- posed a specific task or issue that identified the topic/s from which students needed to independently select subject matter to solve the problem (Syllabus section 4.7.1)
- provided students with engaging and realistic contexts that allowed for a real-life application of mathematics, e.g. height of a person versus size of a footprint found at a crime scene, or the amount of screen time per week for a person versus the amount of sleep they have per week

- enabled students to appropriately use technology to analyse data in a written format
- provided stimulus material relevant to the task, such as suitable websites and sample datasets that do not require students to undertake extensive research. The relevant stimulus material should be age-appropriate for language and readability, and align to the context and task descriptions
- were sufficiently different from QCAA sample assessment instruments so as not to compromise the authenticity of student responses.

Practices to strengthen

It is recommended that assessment instruments:

- enable students to address the Formulate criterion and the Evaluate and verify criterion by providing opportunities to
  - identify the mathematical concepts and techniques to use
  - make assumptions and observations relevant to the task
  - explore the strengths and limitations of the solution and/or model
  - evaluate the reasonableness of solutions
- allow students to independently solve the problem by avoiding procedural instructions such as a step-by-step guide to the mathematical techniques to use.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	5
Language	17
Layout	3
Transparency	9

*Each priority might contain up to four assessment practices.

Total number of submissions: 454.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided appropriate stimulus material such as relevant, easy-to-read and accessible websites
- used clear and concise instructions to inform students of what was expected in completing the assessment
- were well presented with appropriate page breaks and other formatting features, e.g. the approach to problem-solving and mathematical modelling flow chart was presented on one page. The formatting can be checked by using the 'Print preview' function within the Endorsement application (app) before submitting the IA1 for endorsement.

Practices to strengthen

It is recommended that assessment instruments:

- only include information required by the students to complete the problem-solving and modelling task, e.g. all attachments should be directly related to the task
- use an appropriate level of literacy so students can engage with the assessment. Appropriate language should be used in the context and task sections and any stimulus material.

Additional advice

- Teachers are encouraged to construct a sample response to the problem-solving and modelling task by applying the expected mathematical techniques and concepts to ensure students will be able to demonstrate all ISMG characteristics. This does not require writing a full report but identifying the mathematics required to solve the problem. This will allow teachers to ensure the assessment instrument is aligned to the chosen syllabus topic/s and has sufficient scope to allow students to address all stages for the problem-solving and modelling approach.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Formulate	90.65%	8.24%	1.11%	0%
2	Solve	91.98%	6.9%	1.11%	0%
3	Evaluate and verify	93.32%	6.01%	0.67%	0%
4	Communicate	97.55%	0.67%	1.78%	0%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- for the Evaluate and verify criterion, judgments matched to the top performance-level characteristics were supported where the student's response
  - evaluated the reasonableness of solutions by considering the
    - results, such as whether the model provided a valid solution to the specific problem identified in the task
    - relevance of the observations, such as the effect of outliers on the reasonableness of predictions from the model
    - implications of the assumptions, such as whether the same solution could have been reached without these

  - documented strengths and limitations using evidence, e.g. how removal of outliers strengthened the linearity of the model, or why gaps in the data limited the model's reliability
  - justified decisions made using mathematical reasoning by describing their mathematical thinking in detail, identifying causes and making relationships evident, constructing mathematical arguments using relevant formulas, and providing reasons for choices made and conclusions reached
- for the Communicate criterion, judgments matched to the top performance-level characteristics were supported where the student's response
  - was coherently organised, e.g. using sections for stages of the problem-solving and modelling approach, and able to be interpreted independently of the task sheet by identifying for the reader the specific task or issue being investigated and any other provided information
  - used appropriate vocabulary that added detail and clarity to the information being communicated
  - presented findings with the correct use of mathematical conventions such as
    - labelling tables, figures, graphs (and their axes)
    - defining variables used in equations
    - using recognised units, symbols and notation, such as for Pearson's correlation coefficient (r) and the coefficient of determination (R^2).

Samples of effective practices

The following excerpts demonstrate documentation of appropriate assumptions and accurate documentation of relevant observations in the Formulate criterion.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

2.1: Assumptions

- The athletes did not use performance-enhancing drugs to set a new world record. These drugs can increase alertness, concentration, metabolic rate, power, strength, and decrease fatigue (Sports Medicine Today, 2015). These factors would affect the prediction and must be removed to ensure accuracy.
- All weather factors are similar and had no effect on the athletes' performance, making the inquiry more reputable. Weather conditions such as temperature, rain, dewpoint, precipitation, and cloud cover may affect the endurance of an athlete (Mantzios, et al., 2021).
- A linear model is appropriate for this research. The linear model will be used in the extrapolation process and therefore, an appropriate model would ensure that the prediction is reputable.
- When extrapolating, the data will follow the same trend as the raw data, which will enhance the accuracy of future predictions.

2.2: Observations

- The data provided for both male and female world records shown in table 2 is accurate and correct because it comes from a reputable source known as the International Association of Athletics Federations (IAAF), and thus the prediction's accuracy would increase.
- The male dataset between 1960 and 2020 had 21 world records, whereas the female dataset between 1981 and 2021 had 11 world records. This is most likely to have an impact on the prediction due to the 10-record difference.
- The male time is faster than the female time. This may result in the prediction of females surpassing men to be far ahead into the future.
- For 15 years, a male athlete, Kenenisa Bekele, held the world record between 2005 and 2020 until Joshua Cheptegei broke it (Wikipedia, 2022). This gap in the data is likely to have an impact on the extrapolation process.
- For 23 years, a female athlete, Sifan Hassan, held the world record between 1993 and 2016 until Letesenbet Gidey broke it (Wikipedia, 2022). This gap in the data is likely to have an impact on the extrapolation process.

Excerpt 2

Assumptions

It was assumed that:

1. To determine a relationship between the ratio of tail to body length, between male and female geckos, all given gecko data had to be the same species; the two location data sets and samples could not be analysed if they did not share some sort of relationship, sexual dimorphic or not.
2. The given location gecko data and three gecko samples represented geckos of the same age. It was assumed the geckos were the same age, so all geckos would have similar body proportions and sit within a range of values. These assumptions were made to identify outliers in the data, where significant differences in either body or tail length would be indicative of anomalies.
3. If sexual dimorphism was present within the species, two different outputs would be produced for male and female when utilising the same input. This was assumed to guarantee the identification of sexual dimorphism in geckos. F1 documentation of appropriate assumptions

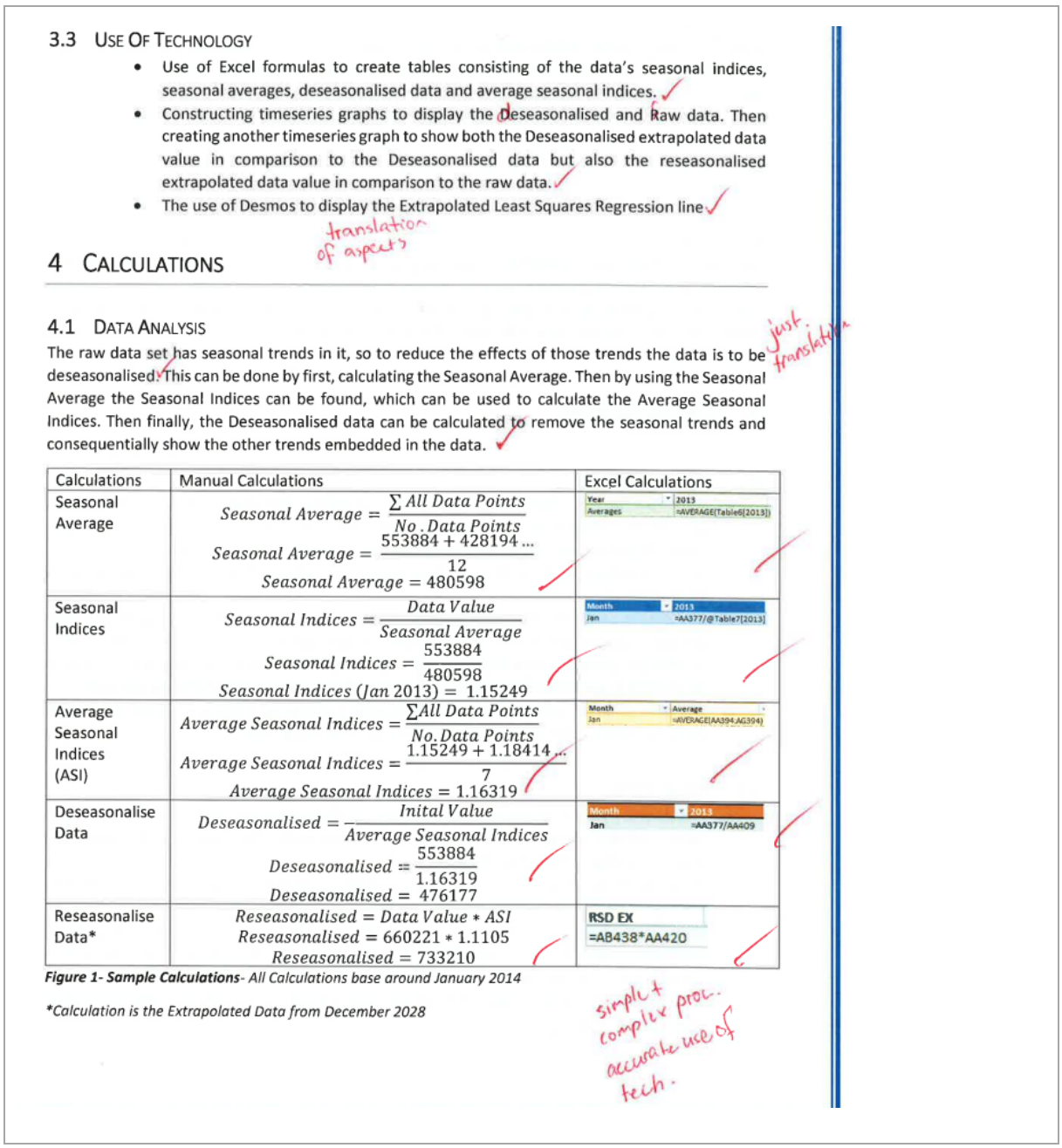
Observations

It was observed that:

1. All male geckos have a shorter body compared to their tail and female geckos have longer body compared to their tail (Johnson, 2007).
2. The tail length for geckos was dependent on the size of their body because the tail stored fat and nutrients that the body could not. (Leopard Gecko Habitat, 2022)
3. Significantly shorter tail lengths in geckos are a result of a detached tail, where the tail grows back over a period of time (Britannica, 2022). These smaller tails would account for anomalies in the data. F2 accurate documentation of relevant observations

The following excerpt demonstrates, addressing the Formulate criterion, the accurate translation of an aspect of the problem by identifying the technology to be used, and addressing the Solve criterion, the inclusion of relevant spreadsheet formulas for data analysis to support the accurate and appropriate use of technology as the appendices are not marked.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



3.3 Use Of Technology

- Use of Excel formulas to create tables consisting of the data's seasonal indices, seasonal averages, deseasonalised data and average seasonal indices.
- Constructing timeseries graphs to display the deseasonalised and raw data. Then creating another timeseries graph to show both the Deseasonalised extrapolated data value in comparison to the Deseasonalised data but also the reseasonalised extrapolated data value in comparison to the raw data.
- The use of Desmos to display the Extrapolated Least Squares Regression line

translation of aspects

4 Calculations

4.1 Data Analysis

The raw data set has seasonal trends in it, so to reduce the effects of those trends the data is to be deseasonalised. This can be done by first, calculating the Seasonal Average. Then by using the Seasonal Average the Seasonal Indices can be found, which can be used to calculate the Average Seasonal Indices. Then finally, the Deseasonalised data can be calculated to remove the seasonal trends and consequentially show the other trends embedded in the data.

just translation

Calculations	Manual Calculations	Excel Calculations
Seasonal Average	$Seasonal\ Average = \frac{\sum All\ Data\ Points}{No.\ Data\ Points}$ $Seasonal\ Average = \frac{553884 + 428194 \ldots}{12}$ $Seasonal\ Average = 480598$	Year 2013 Averages =AVERAGE(Table6[2013])
Seasonal Indices	$Seasonal\ Indices = \frac{Data\ Value}{Seasonal\ Average}$ $Seasonal\ Indices = \frac{553884}{480598}$ $Seasonal\ Indices\ (Jan\ 2013) = 1.15249$	Month 2013 Jan =AA377/@Table7[2013]
Average Seasonal Indices (ASI)	$Average\ Seasonal\ Indices = \frac{\sum All\ Data\ Points}{No.\ Data\ Points}$ $Average\ Seasonal\ Indices = \frac{1.15249 + 1.18414 \ldots}{7}$ $Average\ Seasonal\ Indices = 1.16319$	Month Average Jan =AVERAGE(AA394:AG394)
Deseasonalise Data	$Deseasonalised = \frac{Inital\ Value}{Average\ Seasonal\ Indices}$ $Deseasonalised = \frac{553884}{1.16319}$ $Deseasonalised = 476177$	Month 2013 Jan =AA377/AA409
Reseasonalise Data*	$Reseasonalised = Data\ Value * ASI$ $Reseasonalised = 660221 * 1.1105$ $Reseasonalised = 733210$	RSD EX =AB438*AA420

***Figure 1- Sample Calculations**- All Calculations base around January 2014*

**Calculation is the Extrapolated Data from December 2028*

simple + complex proc.. accurate use of tech.

The following excerpt demonstrates discerning application of relevant mathematical concepts and techniques in the Solve criterion, as the response describes astute choices in the student's approach and insightful knowledge to synthesise and solve the problem.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Two outliers were identified, one in each set of location data, and these outliers were then removed from the data set. An outlier is a data point that significantly differs from other data points. These data points are highlighted in Appendix 1.

This graphical process was repeated for the data without the outliers, shown in figures 1 and 2.

The correlation coefficient for female and male geckos were found to be 0.83 and 0.93, respectively, indicating a strong positive association. As the correlation coefficient was much higher for the data without outliers, this demonstrated that the data without the outliers represented a stronger relationship between tail and body length. The R^2 values were also higher indicating a better fit of the model.

The data without outliers was utilised for further analysis and extrapolation.

Figure 1: The Graph of Female Gecko Tail Length vs Female Gecko Body Length without Outlier

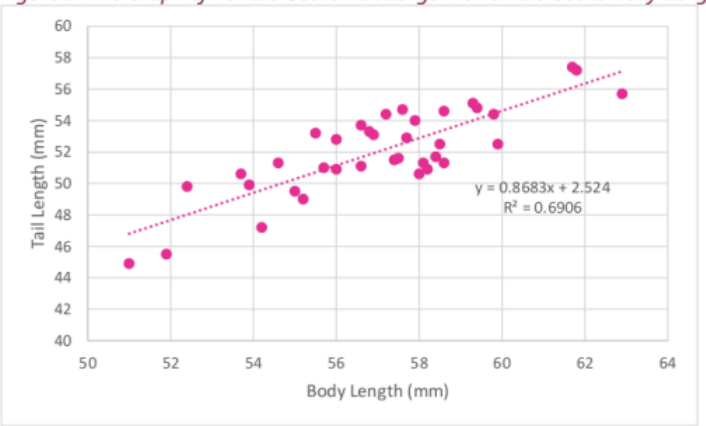
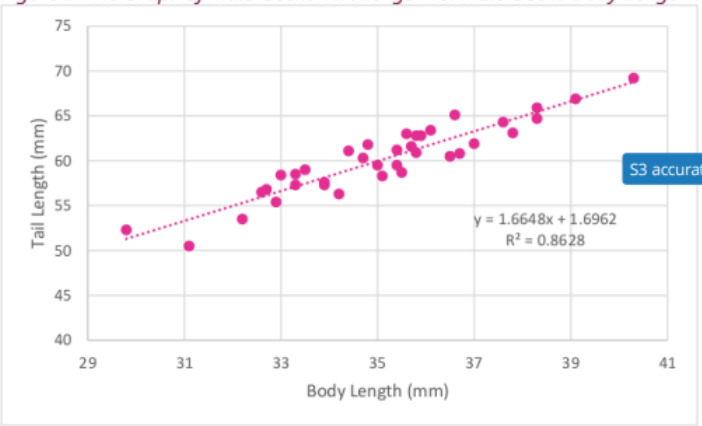


Figure 2: The Graph of Male Gecko Tail Length vs. Male Gecko Body Length without Outlier



S3 accurate and appropriate use of technology

The following excerpt demonstrates, addressing the Evaluate and verify criterion, evaluation of the reasonableness of solutions considering the results, assumptions and observations as well as documentation of relevant strengths of the model and their impact on the solution.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Reasonableness

The residual plots verified the calculated results for samples A, B and C. By demonstrating that the data was randomly scattered around a particular area, it indicated the linearity of the data, hence justifying the use of linear regression to calculate unknowns. Because the correlation coefficient for male data was higher, this indicated that the extrapolated value for sample B was more reasonable than samples A and C, both of which were female. The removal of the outlier data points was justified by the assumption that geckos of the same age would have similar proportions, and the observation that a significantly smaller tail length- an anomaly in the data, would be the result of the loss of the tail. Removing these outliers increased the accuracy of the equations, demonstrated by the increased correlation coefficient strength and R^2 value.

The assumption male and female geckos were the same species, made the solution unreasonable because they were from different locations. As there are 1500 different species the likelihood of the two samples being the same species is extremely unlikely. (Live Science, 2017) Although the dimensions of geckos of different species can be similar, many gecko species do not exhibit sexual dimorphism thus potentially rendering the conclusion that sexual dimorphism existed incorrect (Live Science, 2017).

Therefore, the solution can be considered somewhat reasonable.

E1 evaluation of the reasonableness of solutions by considering the results, assumptions and observations

Strengths

The use of bivariate data analysis strengthened the solution, helping to explore how dependent the response variable was on the explanatory value, exploring the association between two variables. Through bivariate analysis, a variable could be predicted from the given data based on a determined equation. Assuming the location data and samples were the same species strengthened the calculated solution- sexual dimorphism was present. Because certain species do not exhibit sexual dimorphism (Live Science, 2017), it would be difficult to ascertain a specific relationship if the given data were all different species. The removal of the outlier data increased the linearity of the model, increasing the R-value from a moderate to strong association. This indicated the strength of the applied linear equation and hence the resultant solutions for the samples.

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- teachers annotate the ISMG for each sample by shading/ticking/circling which characteristics in the performance-level descriptors are demonstrated
- for the Formulate criterion, judgments about
  - documentation of assumptions and observations require reasoning in the student's response for the relevance and appropriateness of the assumptions and observations about the specific task or issue, such as including references for data sources, evidence for known information, and explanations for why factors other than the data used are assumed to be present or absent
  - accurate translation of all aspects of the problem require the student's response to identify all mathematical concepts and techniques applicable to the context of the task, e.g. identifying variables, constructing scatterplots and their associated residual plots, fitting a least-squares line to the data, and calculating and interpreting the correlation coefficient

- for the Solve criterion, judgments about
  - discerning application of relevant mathematical concepts and techniques require the response to demonstrate astute choices in the student's approach and insightful knowledge to synthesise and solve the problem
  - accurate and appropriate use of technology require evidence in the body of the report of the use of spreadsheet formulas as the appendices are not marked.

Additional advice

- School-based assessment policies and procedures for managing response length must be applied clearly and consistently when making judgments about student responses to assessment (*QCE and QCIA policy and procedures handbook v5.0,* Section 8.2.6). Schools must identify how they applied their school assessment policy to responses exceeding the maximum of 2000 words or the maximum of 10 pages. Communication with the QCAA is recommended if further advice is required about managing responses that exceed the allowable length. Schools are responsible for ensuring that students are aware of the school-based assessment policy and procedures, particularly regarding the management of response length.
- The ISMG from the current syllabus must be used to award a mark for each criterion and it must not be altered, added to, or reformatted in any way (*QCE and QCIA policy and procedures handbook v5.0,* Section 7.3.3). Each summative internal assessment instrument should be printed directly from the Endorsement app for use with students to ensure the correct instrument and ISMG are used (*QCE and QCIA policy and procedures handbook v5.0,* Section 8.3*)*.
- Schools must apply the best-fit approach to using the ISMG to determine a mark for each criterion after matching assessment evidence to performance-level descriptors (*QCE and QCIA policy and procedures handbook v5.0,* Section 9.7.1). It is recommended that teachers and schools refer to the Resources *Module 3 — Making reliable judgments* in the Assessment Literacy app on the QCAA Portal and the *Making judgments* webinar in the Syllabuses app.
- Schools are responsible for ensuring that student results are accurately recorded in Student Management (*QCE and QCIA policy and procedures handbook v5.0,* Section 9.7.1 and Section 11.1.2). Schools should check their data entry for confirmation to ensure the marks entered in the Student Management app for each student are the same as the marks determined by the best-fit approach in each criterion.

Internal assessment 2 (IA2)

Examination — short response (15%)

This examination assesses the application of a range of cognitions to a number of items, drawn from all Unit 3 topics. Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	214
Authentication	0
Authenticity	11
Item construction	12
Scope and scale	41

*Each priority might contain up to four assessment practices.

Total number of submissions: 454.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- assessed a representative sample of subject matter from all Unit 3 topics using an appropriate number of questions for the time conditions, matched to the syllabus degree-of-difficulty descriptors (Syllabus section 4.7.2)
- used questions relevant to the student and school context that were sufficiently different from textbook questions and QCAA sample questions to ensure responses were the student's own and were not rehearsed.

Practices to strengthen

It is recommended that assessment instruments:

- align to subject matter from Unit 3 only, e.g. students are not required to calculate the coefficient of determination, but only use it to assess the strength of a linear association in terms of the explained variation
- provide opportunities in the questions for students to demonstrate all syllabus objectives, in particular Objective 4: evaluate the reasonableness of solutions, and ensure the mark allocation in the marking scheme reflects the assessment of this objective, e.g. allocating a mark for evaluating the appropriateness of a developed linear model

- correctly align complex familiar questions to the degree-of-difficulty specification (Syllabus section 4.7.2), so relationships and interactions have a number of elements, such that connections are made with subject matter within and/or across the domains of mathematics, and all of the information to solve the problem is identifiable. For instance, using algebraic techniques linked to geometric or arithmetic sequences or requiring connections between the time difference and the distance between two locations
- correctly align complex unfamiliar questions to the degree-of-difficulty specification (Syllabus section 4.7.2), so relationships and interactions have a number of elements, and all the information to solve the problem is not immediately identifiable. That is, questions should not have a series of parts that step students through the problem, provide cues that indicate the procedure to use, or include diagrams or graphs that simplify the nature of the problem. Complex unfamiliar questions should be in a context in which students have had limited prior experience.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	23
Language	61
Layout	16
Transparency	31

*Each priority might contain up to four assessment practices.

Total number of submissions: 454.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- avoided bias in questions by using appropriate contexts, language, visual prompts, diagrams and tables
- had clear guidelines in the instructions for students on how to respond to questions, where appropriate, e.g. questions
  - worth more than one mark required mathematical reasoning and/or working to be shown to support answers
  - asked students to use recursion to generate the next three terms of the sequence
  - required students to construct a scatterplot with labelled axes on the grid provided and use their calculator to determine the equation of the least-squares line
  - asked students to calculate the distance to the nearest kilometre
- provided adequate space, where relevant, for students to respond to all questions, which may have included adding extra working space, graphs or diagrams at the end of the instrument for students to use. Prior to submission for endorsement, it is advised to complete handwritten responses on a printed version of the IA2 instrument to check the suitability of the provided response space and whether the examination can be completed within the syllabus conditions.

Practices to strengthen

It is recommended that assessment instruments:

- contain accessible language without jargon and provide clear and legible tables, images and graphs of a suitable size that are relevant to the question.

Additional advice

- Supportive features of the Endorsement app are useful for constructing instruments, e.g. the use of the 'Print preview' function and the inclusion of marks for individual questions in the 'question block'. These features can be used to check that the layout within questions and across the instrument is not distracting, e.g. text or numerical values are not split across lines, and tables, diagrams and graphs appear in their entirety on a page.
- It is advised that schools with a non-endorsed assessment instrument from Application 1 consult with the Lead endorser before submitting Application 2. These consultations are supportive and provide feedback to school communities to strengthen the endorsement process.
- For assessment instruments requiring modifications for subsequent applications during the endorsement event, the marking scheme should be updated to match the revised instrument.
- It is recommended that teachers watch the Maths moments videos (accessible via the Resources tab in the Syllabuses app on the QCAA Portal), which provide teacher training for writing examinations, including advice on subject matter, syllabus objectives, degree of difficulty, comparable assessment, amending an endorsed instrument and using previously endorsed instruments.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Foundational knowledge and problem-solving	97.1%	2.01%	0.67%	0.22%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- the school's marking scheme provided at confirmation matched the endorsed instrument, was accurate, and indicated where each mark was allocated within the sample solutions. When appropriate, the marking scheme provided at endorsement was updated, e.g. inclusion of common alternative accurate ways of working, allowance for follow-through marks
- the student response was annotated to clearly indicate where marks matching the school's marking scheme were awarded.

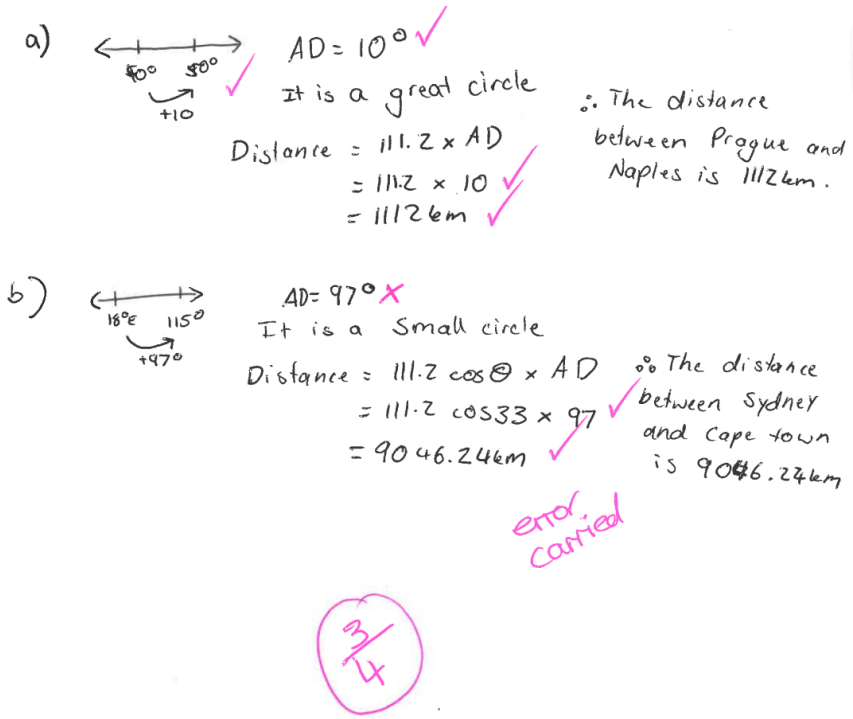
Samples of effective practices

The following excerpts illustrate the use of ticks and teacher annotations to indicate:

- which parts of the response were awarded part marks, including where follow-through marks were awarded due to a prior transcription error from the question
- the number of marks awarded for each question
- the awarding of marks where responses demonstrated understanding of Objective 4: evaluate the reasonableness of solutions.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1



Excerpt 2

$t_1 = 5$ ✓

d = 2nd − 1st term

$= 8.5 - 5 = 3.5$ ✓

$15.5 - 12 = 3.5$

$19 - 15.5 = 3.5$

$\therefore d = 3.5$

Rule:

$t_n = 5 + (n-1)\,3.5$ ✓

To find 18 months, sub in $n = 18$

$t_n = 5 + (n-1)3.5$ ✓

$t_{18} = 5 + (18-1)\,3.5$

$t_{18} = 5 + (17)3.5$

$t_{18} = 5 + 59.5$

$t_{18} = 64.5$ cm ✓

$\therefore$ The tree will be 64.5 cm at 18 months.

3/3

Reasonableness

To check reasonableness, d was added onto the data above

$t_5 = 19$ +3.5
$t_6 = 22.5$ +
$t_7 = 26$ +
$t_8 = 29.5$ +
$t_9 = 33$ +
$t_{10} = 36.5$ +
$t_{11} = 40$ +
$t_{12} = 43.5$ +
$t_{13} = 47$

$t_{14} = 50.5$ +
$t_{15} = 54$ +
$t_{16} = 57.5$ +
$t_{17} = 61$ +
$t_{18} = 64.5$ ✓

As the same result was achieved it means calculations and results are accurate and reasonable ✓

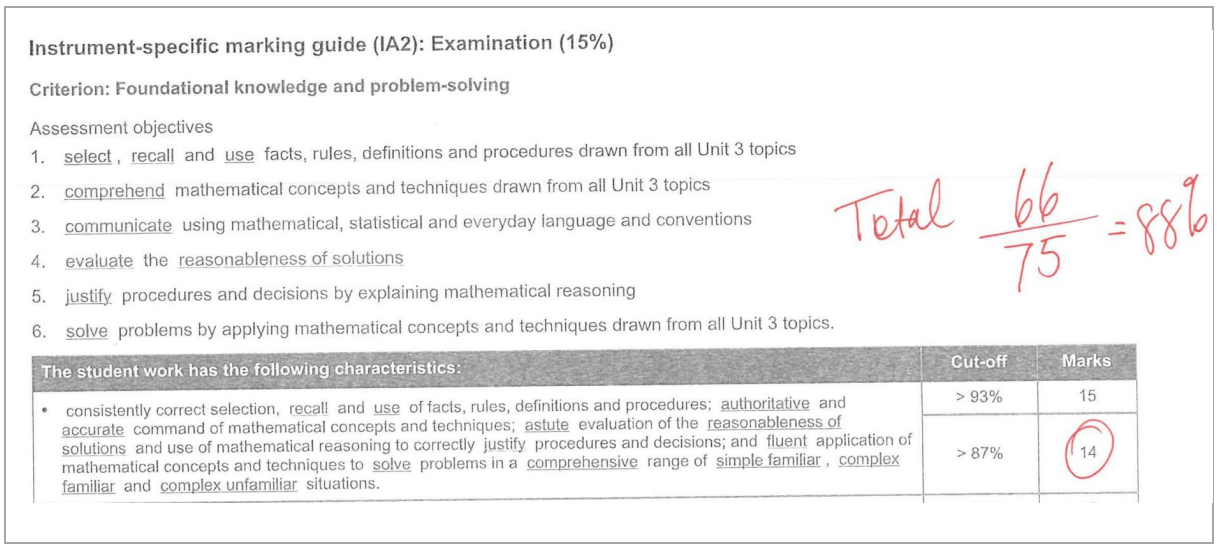
General Mathematics — IA2 Page 7

Excerpt 3

This comment is mostly reasonable because by extrapolating the point moving megan shows a strong increase to around 92000 in 2025. ✓ This is also likely due to the previous years having steady increases ✓

The following excerpt illustrates teacher annotations on the syllabus ISMG to indicate the total awarded marks out of available marks and the precise, non-rounded achievement percentage, which is aligned to the correct ISMG mark out of 15 by applying the appropriate 'greater than' percentage cut-off.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



Instrument-specific marking guide (IA2): Examination (15%)

Criterion: Foundational knowledge and problem-solving

Assessment objectives

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 3 topics
2. comprehend mathematical concepts and techniques drawn from all Unit 3 topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 3 topics.

Total $\frac{66}{75} = 88\%$

The student work has the following characteristics:	Cut-off	Marks
• consistently correct selection, recall and use of facts, rules, definitions and procedures; authoritative and accurate command of mathematical concepts and techniques; astute evaluation of the reasonableness of solutions and use of mathematical reasoning to correctly justify procedures and decisions; and fluent application of mathematical concepts and techniques to solve problems in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations.	> 93%	15
	> 87%	14

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- the marking scheme is applied consistently across the cohort and marking decisions are checked during internal quality assurance processes to ensure that equivalent responses matching the marking scheme are awarded the same number of marks
- the total awarded marks and calculated percentage are checked for accuracy
- the syllabus ISMG is annotated by teachers with the precise, non-rounded percentage. This is then aligned to the correct ISMG mark out of 15 by applying the appropriate 'greater than' percentage cut-off. It is useful also to record the total awarded marks out of available marks. (See *Advice to schools: How to correctly apply a percentage cut-off ISMG*, available from the Internal Assessment and Certification resources for schools tile in the Noticeboard app.)

Additional advice

- If a comparable assessment instrument is administered to a sampled student, then the school must indicate this in Student Management on the individual student's learning account and in the Confirmation app. Comparable assessments should be developed in the Endorsement app to ensure the correct examination and its matching marking scheme are available for the confirmation review (*QCE and QCIA policy and procedures handbook v5.0*, Section 7.4). For further information see the quick-step guide *Upload samples* in the Help section of the Confirmation app on the QCAA Portal.
- It is recommended that teachers clearly identify on the student's response the number of marks awarded for each question. Further, when applying marking schemes that allocate both full and part marks, schools are advised to use a consistent method (e.g. ticks or ½ mark notations) to clearly show what marks are awarded.

- Schools must administer the endorsed assessment instrument with students and cannot change or modify an ISMG (*QCE and QCIA policy and procedures handbook v5.0*, Section 7.3.3 and Section 8.3).
- Schools are required to submit samples of student assessment responses for review during confirmation. Submissions should align to the relevant *Confirmation submission information* (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.3). The *Confirmation submission information* for General Mathematics is available via Resources in the Syllabuses app. Before submitting responses for confirmation, schools are advised to check that all scanning of student work has been completed without error. This includes ensuring that
  - no pages are missing from the response
  - all pages are visible and easy to read
  - the submitted response matches the student selected.

Internal assessment 3 (IA3)

Examination — short response (15%)

This examination assesses the application of a range of cognitions to a number of items, drawn from all Unit 4 topics. Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	180
Authentication	0
Authenticity	5
Item construction	6
Scope and scale	140

*Each priority might contain up to four assessment practices.

Total number of submissions: 452.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- assessed a representative sample of subject matter from all Unit 4 topics using an appropriate number of questions for the time conditions, matched to the syllabus degree-of-difficulty descriptors (Syllabus section 5.6.1)
- used realistic contexts and stimulus material related to Unit 4 subject matter so that students could provide authentic responses to situations presented in questions, particularly those involving critical paths, minimum spanning trees and flow networks.

Practices to strengthen

It is recommended that assessment instruments:

- assess subject matter within the scope of the syllabus, e.g. the syllabus requires students to
  - use a recurrence relation to only model and investigate an annuity, reducing balance loan, and compound interest loan or investment, rather than any other application
  - use the Hungarian algorithm only up to a 3 x 3 matrix, and not larger matrices
  - construct an adjacency matrix from a given graph or digraph, and not to construct a given graph or digraph from an adjacency matrix

- provide opportunities in the questions for students to demonstrate all syllabus objectives, in particular Objective 4: evaluate the reasonableness of solutions, and ensure the mark allocation in the marking scheme reflects the assessment of this objective, e.g. allocating a mark for evaluating whether a loan could be paid off within a specified time
- correctly align complex familiar questions to the degree-of-difficulty specification (Syllabus section 5.6.1), so relationships and interactions have a number of elements, such that connections are made with subject matter within and/or across the domains of mathematics, and all of the information to solve the problem is identifiable, e.g. incorporating speed or time taken to travel between various locations involving a minimum spanning tree, or applying an hourly cost to activities on the critical path to determine the overall completion time for a project
- correctly align complex unfamiliar questions to the degree-of-difficulty specification (Syllabus section 5.6.1), so relationships and interactions have a number of elements, and all the information to solve the problem is not immediately identifiable, i.e. questions
  - should not identify a procedure to use, e.g. statements such as ‘determine the minimum completion time by constructing a network diagram’ could be written as ‘determine how soon after the start time the project can be completed’
  - are in a context in which students have had limited prior experience, e.g. not providing networks or activity tables that are familiar to students.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	4
Language	38
Layout	3
Transparency	30

*Each priority might contain up to four assessment practices.

Total number of submissions: 452.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear and well-presented tables, images and graphs that were relevant to the questions, so students could access the necessary information, e.g. network diagrams that were presented with vertices and edges well drawn and clearly labelled
- had clear guidelines in the instructions for students on how to respond to questions, where appropriate, e.g. questions
  - worth more than one mark required mathematical reasoning and/or working to be shown to support answers
  - required students to calculate the effective annual rate of interest for each option and compare these to determine the best loan

  - asked students to apply Euler's formula to determine the number of faces for a planar graph with 5 vertices and 10 edges
- provided adequate response space for each question, including those that required students to construct an adjacency matrix or project network diagram, or develop a solution involving complex annuity calculations
- included duplicate copies of diagrams or tables at the end of the assessment instrument to assist students who may make an error during the examination.

Practices to strengthen

It is recommended that assessment instruments:

- contain accessible language without jargon so students know what they are expected to do, e.g. using syllabus terms such as 'maximum flow', providing clear instructions such as 'conduct a forward and backward scan to identify the critical path', and using correct mathematical notation such as A_{n+1}.

Additional advice

- Supportive features of the Endorsement app are useful for constructing instruments, e.g. the use of the 'Print preview' function and the inclusion of marks for individual questions in the 'question block'. These features can be used to check that the layout within questions and across the instrument is not distracting, e.g. text or numerical values are not split across lines, and tables, diagrams and graphs appear in their entirety on a page.
- It is advised that schools with a non-endorsed assessment instrument from Application 1 consult with the Lead endorser before submitting Application 2. These consultations are supportive and provide feedback to school communities to strengthen the endorsement process.
- For assessment instruments requiring modifications for subsequent applications during the endorsement event, the marking scheme should be updated to match the revised instrument.
- It is recommended that teachers watch the Maths moments videos, accessible via Resources in the Syllabuses app on the QCAA Portal. These videos provide teacher training for writing examinations, including advice on subject matter, syllabus objectives, degree of difficulty, comparable assessment, amending an endorsed instrument and using previously endorsed instruments.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Foundational knowledge and problem-solving	99.33%	0.45%	0.22%	0%

Effective practices

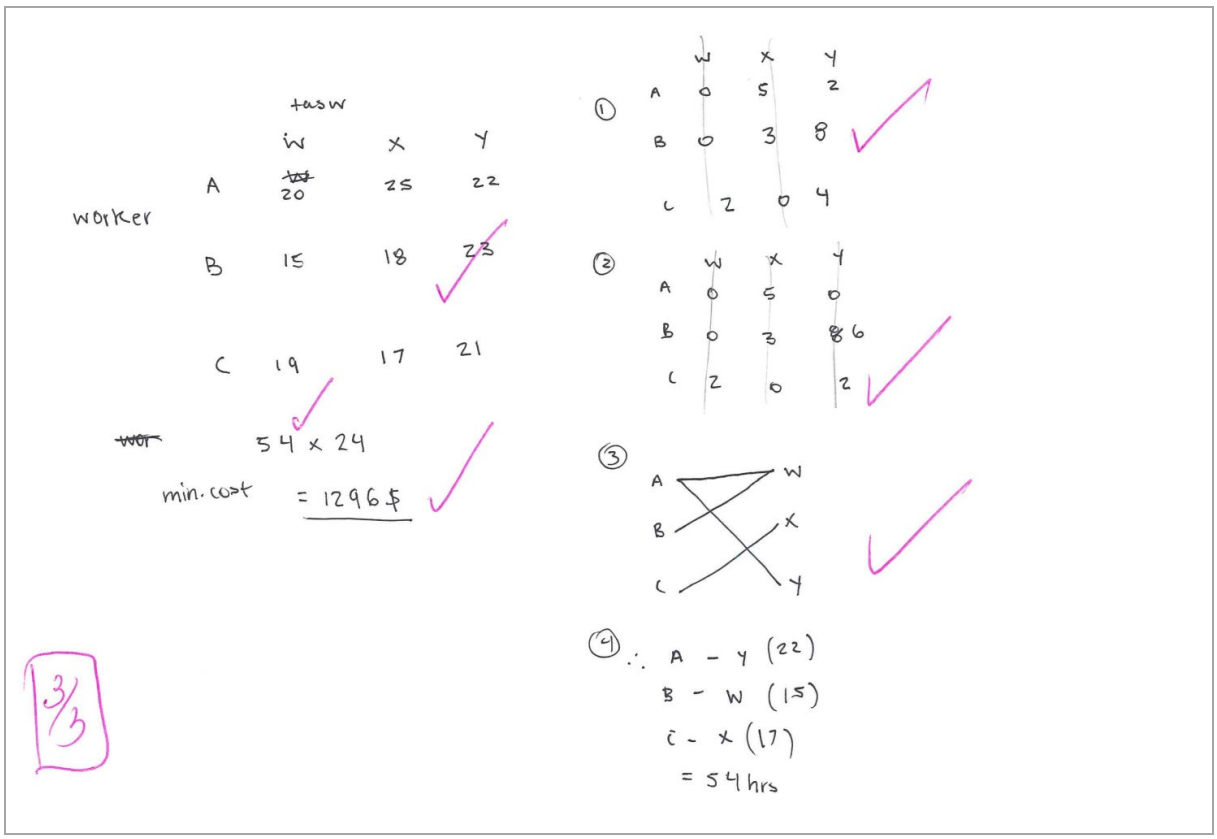
Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- the school's marking scheme provided at confirmation matched the endorsed instrument, was accurate, and indicated where each mark was allocated within the sample solutions. When appropriate, the marking scheme provided at endorsement was updated, e.g. inclusion of common alternative accurate ways of working, allowance for follow-through marks
- the student response was annotated to clearly indicate where marks matching the school's marking scheme were awarded.

Samples of effective practices

The following excerpt illustrates the use of ticks to indicate where each half mark was awarded in the response to obtain the identified number of marks for the question.

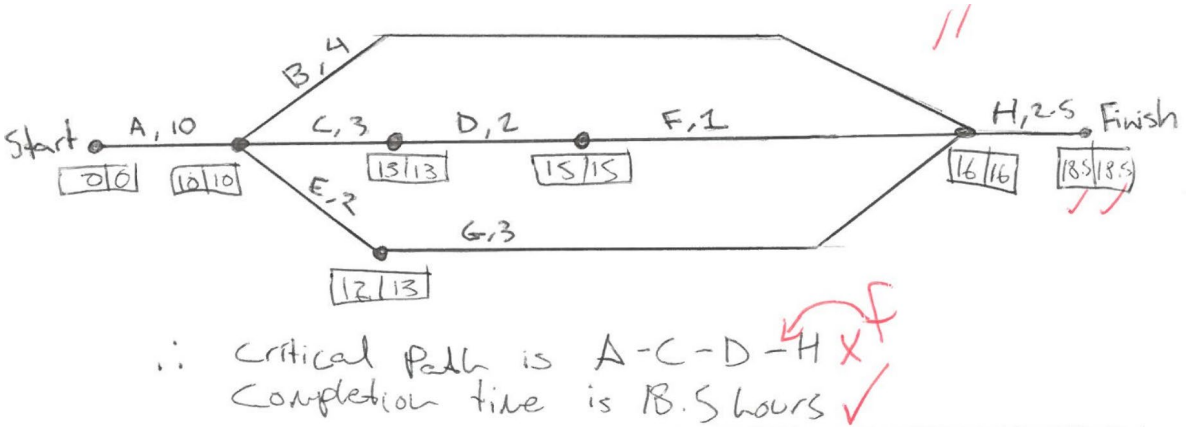
Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.


tasw
W X Y
A ~~20~~ 25 22
worker
B 15 18 23
C 19 17 21
~~wor~~ 54 × 24
min. cost = 1296 $
3/3
① W X Y
A 0 5 2
B 0 3 8
C 2 0 4
② W X Y
A 0 5 0
B 0 3 6
C 2 0 2
③ A W
B X
C Y
④ ∴ A - Y (22)
B - W (15)
C - X (17)
= 54 hrs

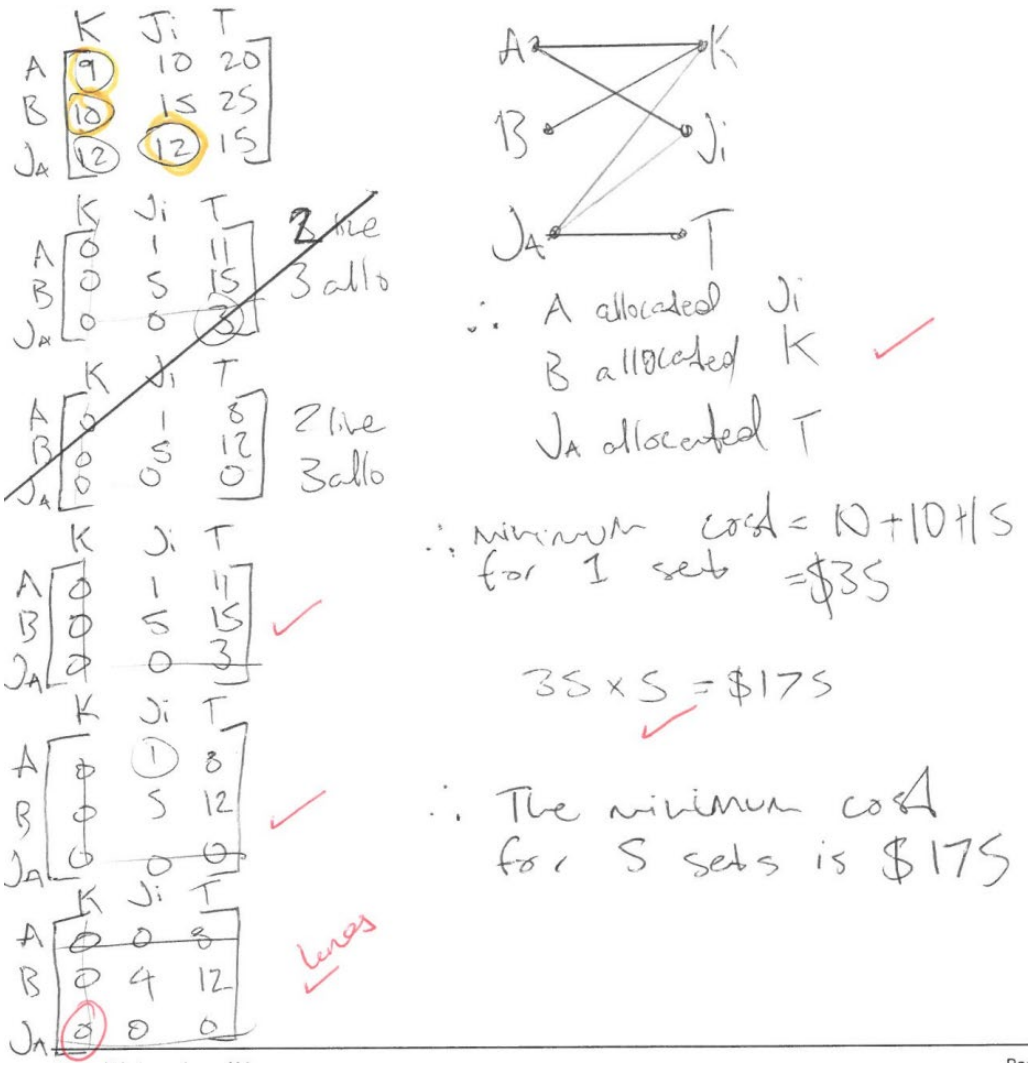
The following excerpts illustrate the use of ticks and teacher annotations to indicate where each whole mark was awarded in the response as well as where and why marks were not awarded.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1



Excerpt 2



The following excerpt illustrates teacher annotations on the syllabus ISMG to indicate the total awarded marks out of available marks and the precise, non-rounded achievement percentage, which is aligned to the correct ISMG mark out of 15 by applying the appropriate 'greater than' percentage cut-off.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Instrument-specific marking guide (IA3): Examination (15%) 57 / 60 = 95%

Criterion: Foundational knowledge and problem-solving

Assessment objectives

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 4 topics
2. comprehend mathematical concepts and techniques drawn from all Unit 4 topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 4 topics.

The student work has the following characteristics:	Cut-off	Marks
• consistently correct selection, recall and use of facts, rules, definitions and procedures; authoritative and accurate command of mathematical concepts and techniques; astute evaluation of the reasonableness of solutions and use of mathematical reasoning to correctly justify procedures and decisions; and fluent application of mathematical concepts and techniques to solve problems in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations.	> 93%	15
	> 87%	14

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- the marking scheme is applied consistently across the cohort and marking decisions are checked during internal quality assurance processes to ensure that equivalent responses matching the marking scheme are awarded the same number of marks
- the total awarded marks and calculated percentage are checked for accuracy
- the syllabus ISMG is annotated by teachers with the precise, non-rounded achievement percentage (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.1). This is then aligned to the correct ISMG mark out of 15 by applying the appropriate 'greater than' percentage cut-off. It is useful to also record the total awarded marks out of available marks. (See *Advice to schools: How to correctly apply a percentage cut-off ISMG*, available from the Internal Assessment and Certification resources for schools tile in the Noticeboard app on the QCAA Portal.)

Additional advice

- If a comparable assessment instrument is administered to a sampled student, then the school must indicate this in Student Management on the individual student's learning account and in the Confirmation app. Comparable assessments should be developed in the Endorsement app to ensure the correct examination and its matching marking scheme are available for the confirmation review (*QCE and QCIA policy and procedures handbook v5.0*, Section 7.4).

For further information see the quick-step guide *Upload Samples* in the Help section of the Confirmation app.

- It is recommended that teachers clearly identify on the student's response the number of marks awarded for each question. Further, when applying marking schemes that allocate both full and part marks, schools are advised to use a consistent method (e.g. ticks or ½ mark notations) to clearly show what marks are awarded.
- Schools must administer the endorsed instrument with students and cannot change or modify an ISMG (*QCE and QCIA policy and procedures handbook v5.0*, Section 7.3.3 and Section 8.3).
- Schools are required to submit samples of student assessment responses for review during confirmation. Submissions should align to the relevant *Confirmation submission information* (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.3). The *Confirmation submission information* for General Mathematics is available under Resources in the Syllabuses app on the QCAA Portal. Before submitting responses for confirmation, schools are advised to check that all scanning of student work has been completed without error. This includes ensuring that
  - no pages are missing from the response
  - all pages are visible and easy to read
  - the submitted response matches the student selected.

External assessment

External assessment (EA) is developed and marked by the QCAA. The external assessment for a subject is common to all schools and administered under the same conditions, at the same time, on the same day.

Examination — short response (50%)

Assessment design

The assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the syllabus.
The examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (15 marks)
- Paper 1, Section 2 consisted of short response questions (42 marks)
- Paper 2, Section 1 consisted of short response questions (38 marks).

The examination assessed subject matter from Units 3 and 4.

The assessment required students to respond to multiple choice and short response questions.

Assessment decisions

Assessment decisions are made by markers by matching student responses to the external assessment marking guide (EAMG). The external assessment papers and the EAMG are published in the year after they are administered.

Multiple choice question responses

There were 15 multiple choice questions in Paper 1.

Percentage of student responses to each option

Note:

- The correct answer is **bold** and in a blue shaded table cell.
- Some students may not have responded to every question.

Question	A	B	C	D
1	**83.99**	7.27	4.87	3.25
2	7.44	7.34	**82.15**	2.45
3	5.06	**79.86**	6.12	8.28
4	2.55	8.62	**71.64**	16.6
5	7.62	**68.33**	14.44	8.98
6	41.41	**36.24**	16.31	5.27
7	7.39	4.19	5.26	**82.52**
8	**49.05**	27.28	7.39	15.26

Question	A	B	C	D
9	5.05	**75.39**	3.83	15.13
10	21.27	2.49	**72.37**	2.64
11	10.85	17.96	**55.56**	14.47
12	6.33	14.34	17.27	**60.67**
13	0.66	3.28	**94.12**	1.31
14	20.21	**51.94**	6.19	20.39
15	11.73	**41.38**	26.89	18.91

Overall, students responded well to:

- questions related to angles of latitude and longitude, time zones, angular distance and distance between two places on Earth
- problems requiring a comparison of investment options using the effective annual rate of interest, compound interest and perpetuity formulas
- items requiring construction of an adjacency matrix and project network, as well as application of the Hungarian algorithm and Euler's formula
- questions requiring the communication of syllabus terminology to
  - identify a feature, e.g. direction of an association, degree of a vertex, minimum completion time or explanatory variable for the stronger linear association
  - provide a description or explanation, e.g. describe what feature in a drawing should be changed to represent a graph as planar or explain which two sites are in the same standard time zone.

Samples of effective practices

Short response

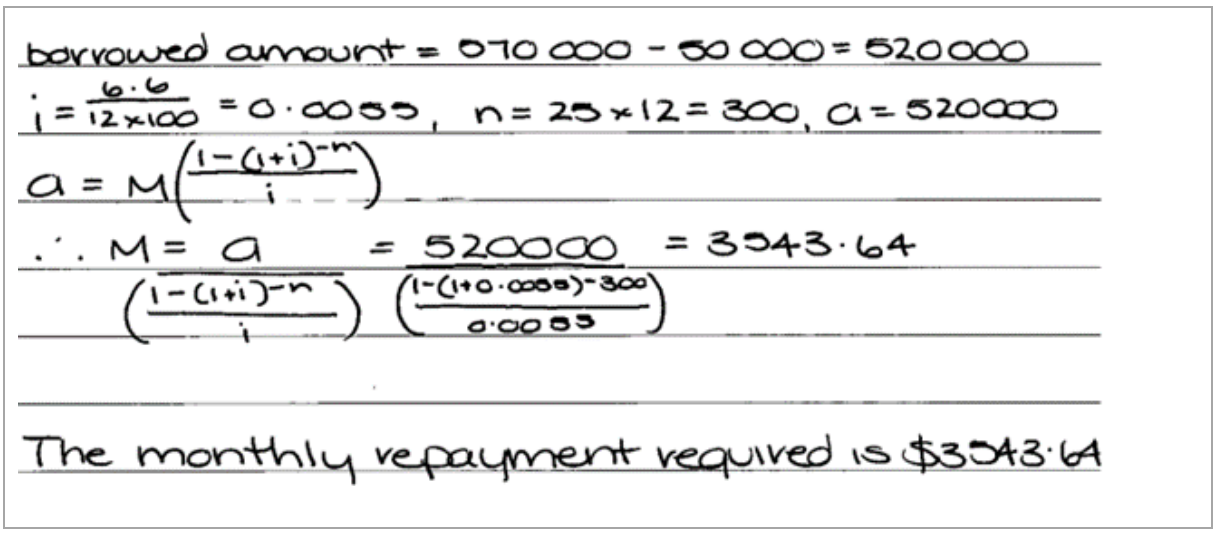
The following excerpt is from Question 17 in Paper 1. It required students to determine the monthly payment needed to pay off a reducing balance loan over 25 years using given information for the value of a house, deposit paid and compounding interest rate.

Effective student responses:

- correctly determined the amount borrowed
- correctly determined the *i* and *n* values
- substituted into appropriate annuity formula
- determined the monthly repayment.

This excerpt has been included:

- to demonstrate correctly determined and clearly labelled values for the amount borrowed, *i* and *n*, which are then substituted into the correct annuity formula for a reducing balance loan selected from the General Mathematics formula book
- to show mathematical reasoning and/or working to support the answer for the monthly repayment amount, which has been appropriately rounded up to two decimal places.



The following excerpts are from Question 18c) in Paper 1. It required students to use a given map of Australia and location coordinates for three sites to determine and explain which two sites are in the same standard time zone.

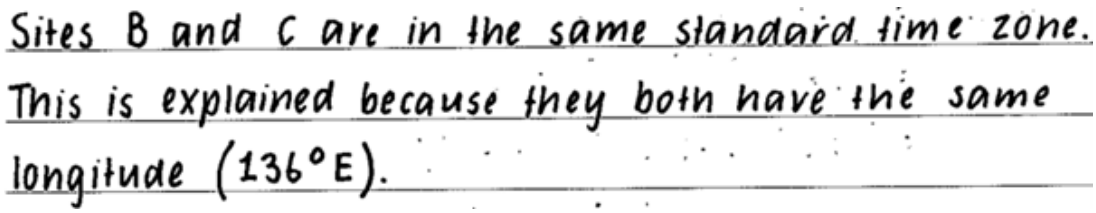
Effective student responses:

- correctly determined sites B and C are in the same standard time zone
- correctly explained using longitude.

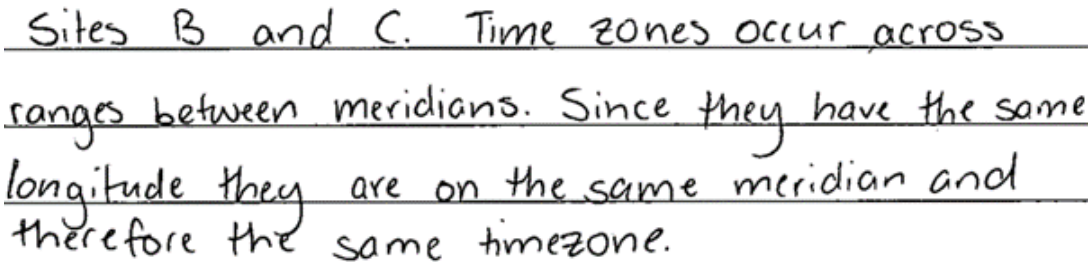
These excerpts have been included:

- to demonstrate statements that effectively communicate, using syllabus terminology, both requirements of the question, i.e. identification of which two sites are in the same standard time zone and an explanation for why.

Excerpt 1



Excerpt 2



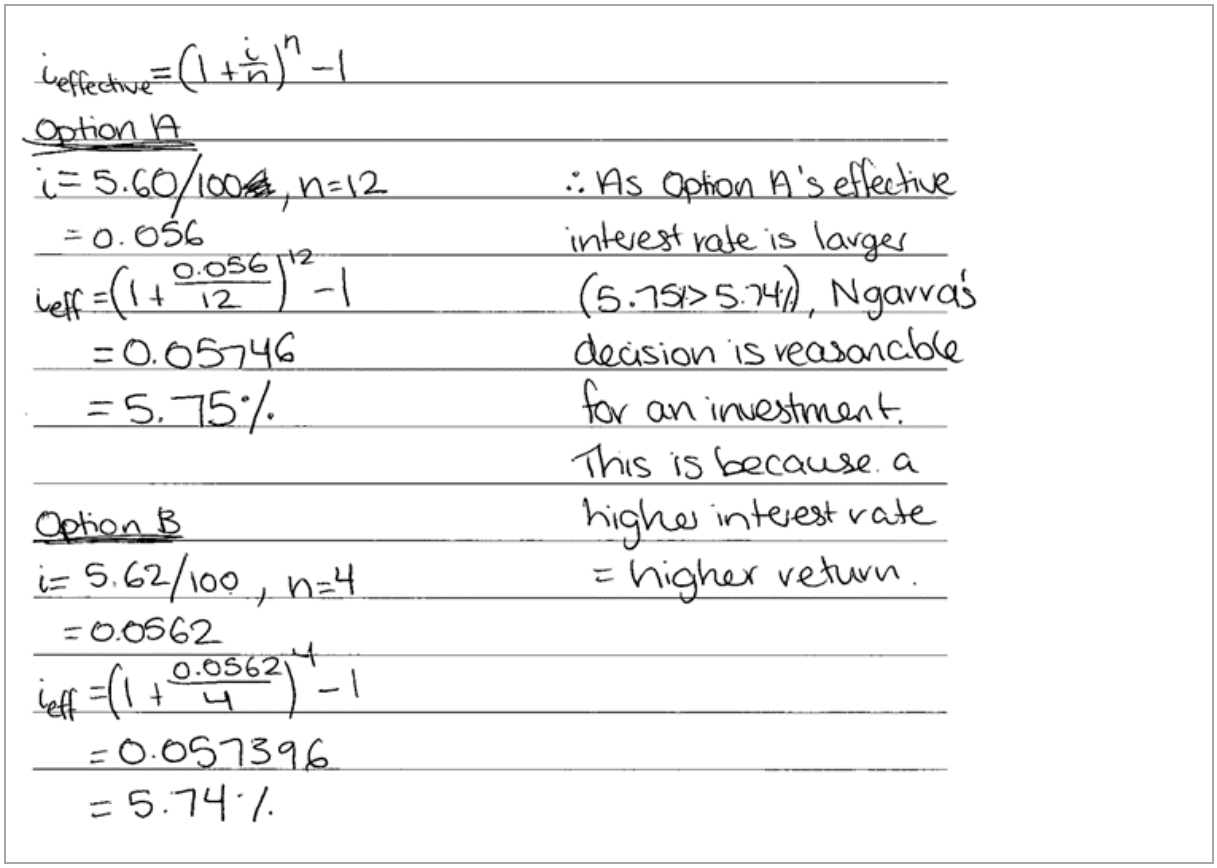
The following excerpt is from Question 19 in Paper 1. This question provided compounding interest rate information for two investment options. It required students to use the effective rate of interest formula to evaluate the reasonableness of a person's decision that option A will provide the better return.

Effective student responses:

- correctly substituted into the appropriate rule for either option
- calculated effective interest rate for option A
- calculated effective interest rate for option B
- provided a statement of reasonableness linked to effective interest rate.

This excerpt has been included:

- to demonstrate correct use of the effective rate of interest formula for both options followed by an appropriate statement of reasonableness, as it includes a comparison of the two calculated effective interest rates to identify the higher rate.



The following excerpts are from Question 20b) in Paper 1. It required students to describe what feature in a provided drawing should be changed to represent a graph as planar.

Effective student responses:

- correctly identified the feature to be changed.

These excerpts have been included:

- to demonstrate statements that effectively describe that, to represent the graph as planar, its drawing should be changed so that no two edges cross.

Excerpt 1

One of the intersecting edges should be drawn around graph

Excerpt 2

redraw one of the edges to stop them intersecting through the middle of the graph

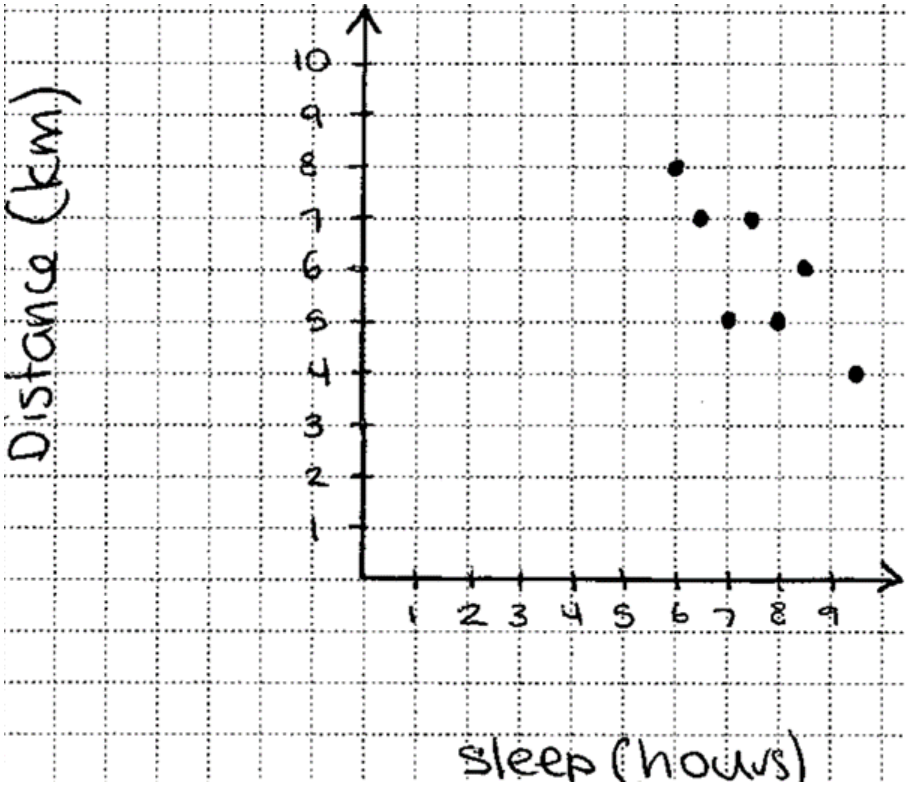
The following excerpt is from Question 22a) from Paper 1. It required students to use distance as the response variable to display provided data for a person's hours of sleep and the distance they travelled each day.

Effective student responses:

- correctly identified the axis for the response variable
- formatted scatterplot with appropriate scaling and labelling for both axes
- accurately plotted all points.

This excerpt has been included:

- to demonstrate a correctly formatted scatterplot with the vertical axis used for the response variable (distance), appropriate labelling and scaling values written at equally spaced increments on each axis, and all points plotted accurately.



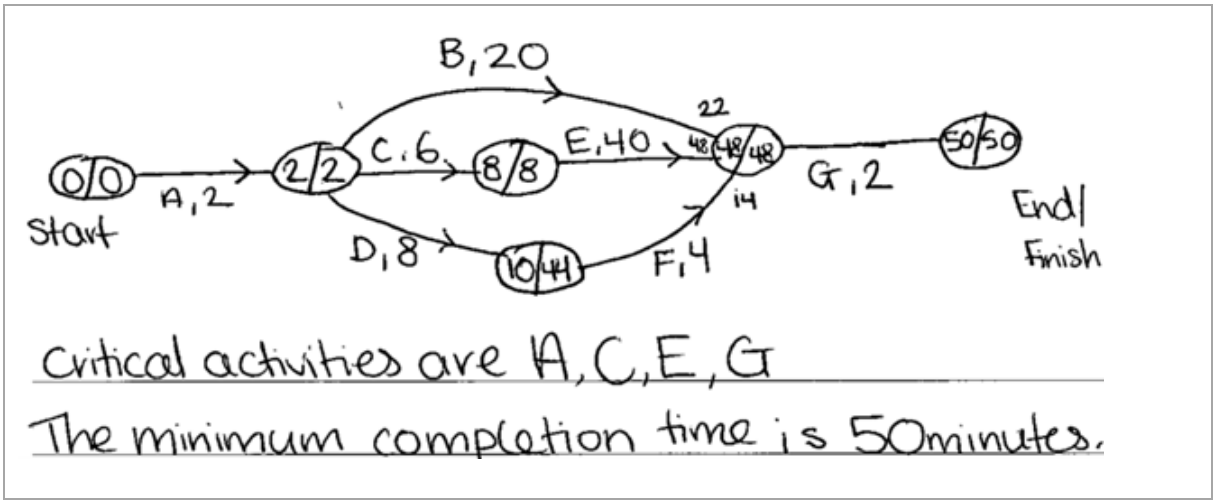
The following excerpt is from Question 24 in Paper 1. This question provided a table showing the durations and interdependencies of seven tasks (A–G) that must be completed during a project. It required students to construct a network diagram, use forward and backward scanning to determine the earliest and latest starting times for all tasks, and to determine the critical activities and minimum completion time for the project.

Effective student responses:

- correctly constructed a network diagram showing the appropriate sequence for all tasks
- labelled all tasks and durations on the network diagram
- showed earliest and latest starting times for all tasks
- determined critical activities
- determined minimum completion time, including units.

This excerpt has been included:

- to demonstrate a correctly constructed network diagram that shows all tasks and durations appropriately sequenced and labelled as well as earliest and latest starting times for all tasks
- to show clear communication of the critical activities by writing a vertex sequence and the minimum completion time including minutes as the unit.



The following excerpt is from Question 1 in Paper 2. This question provided a matrix showing the average number of minutes for three athletes to complete each section of a triathlon relay. It required students to use the Hungarian algorithm to predict the minimum total relay time if assigning each athlete to completing one section.

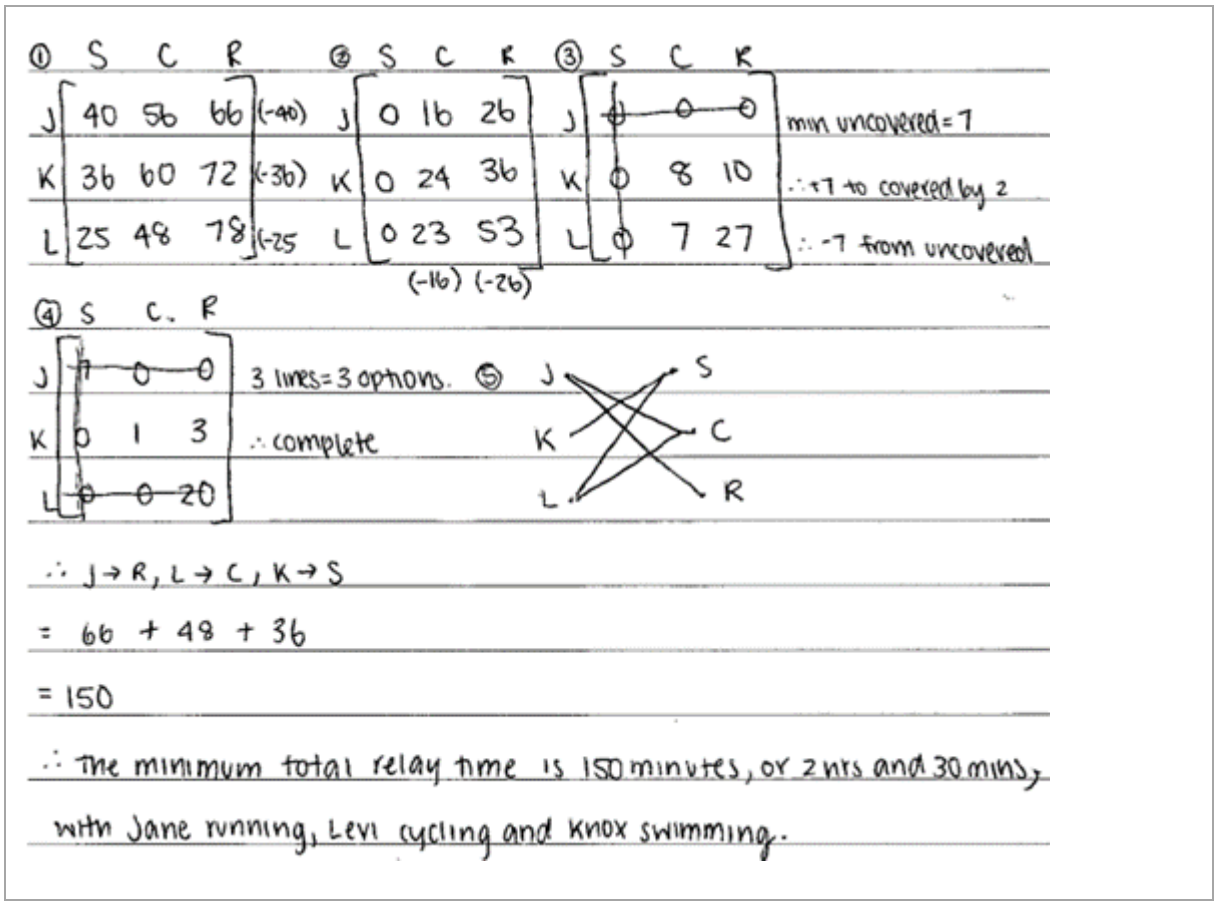
Effective student responses:

- correctly reduced each column and reduced each row (in either order)
- continued algorithm steps until number of lines to cover all zeroes equalled number of tasks
- assigned each athlete to complete one section
- predicted minimum total relay time, including units.

This excerpt has been included:

- to demonstrate correct application of the Hungarian algorithm with separate matrices drawn to show the outcome for each step, e.g. row reduction, column reduction, continuing the algorithm until the minimum number of lines to cover all zeroes is equal to the number of assignments

- to show clear communication of the optimum assignments for the athletes and the predicted minimum total relay time, including appropriate units.



The following excerpts are from Question 2 in Paper 2. It required students to deseasonalise time series data related to cattle that was provided in a table showing the average number each season for two years.

Effective student responses:

- correctly determined the yearly averages
- determined number/yearly average values
- determined seasonal indices
- determined deseasonalised numbers.

These excerpts have been included:

- to demonstrate succinct setting out of working with steps completed in the correct order to calculate the seasonal indices across the two years. Each response calculates the average of the data values for each year before each data value is expressed as a ratio of the average for its year. The ratios for the corresponding seasons for different years are then averaged to determine the seasonal indices, which are used to determine the deseasonalised numbers.

Excerpt 1

2021 $\bar{x}$ = 242 ; 2022 $\bar{x}$ = 215

2021 AUTUMN SI = $^{285}/_{242}$ = 1.178

2021 WINTER SI = $^{28}/_{242}$ = 0.116

2021 SPRING SI = $^{195}/_{242}$ = 0.806

2021 SUMMER SI = $^{460}/_{242}$ = 1.901

2022 AUTUMN SI = $^{276}/_{215}$ = 1.284

2022 WINTER SI = $^{22}/_{215}$ = 0.102

2022 SPRING SI = $^{170}/_{215}$ = 0.791

2022 SUMMER SI = $^{392}/_{215}$ = 1.823

$\bar{x}$ AUT. SI = $\frac{1.178 + 1.284}{2}$ = 1.231 ; $\bar{x}$ WIN. SI = $\frac{0.116 + 0.102}{2}$ = 0.109

$\bar{x}$ SPR. SI = $\frac{0.806 + 0.791}{2}$ = 0.7985 ; $\bar{x}$ SUM. SI = $\frac{1.901 + 1.823}{2}$ = 1.862

	AUTUMN	WINTER	SPRING	SUMMER
2021	285 ÷ 1.231 = 232	28 ÷ 0.109 = 257	195 ÷ 0.7985 = 244	460 ÷ 1.862 = 247
2022	276 ÷ 1.231 = 224	22 ÷ 0.109 = 202	170 ÷ 0.7985 213	392 ÷ 1.862 = 211

Excerpt 2

Find yearly average:

2021 = $\frac{285+28+195+460}{4}$ = 242 2022: $\frac{276+22+170+392}{4}$ = 215

Divide each value by yearly average:

$\frac{285}{242}$ = 1.1777 $\frac{28}{242}$ = 0.1157 $\frac{195}{242}$ = 0.8058 $\frac{460}{242}$ = 1.9008

$\frac{276}{215}$ = 1.2837 $\frac{22}{215}$ = 0.1023 $\frac{170}{215}$ = 0.7907 $\frac{392}{215}$ = 1.8233

Calculate seasonal indices

$\frac{1.1777+1.2837}{2}$	$\frac{0.1157+0.1023}{2}$	$\frac{0.8058+0.7907}{2}$	$\frac{1.9008+1.8233}{2}$
= 1.2307 autumn	= 0.1090 winter	= 0.79825 spring	= 1.86205 summer

Divide each value by seasonal indices:

$\frac{285}{1.2307}$ = 231.58 $\frac{28}{0.1090}$ = 256.88 $\frac{195}{0.79825}$ = 244.28 $\frac{460}{1.86205}$ = 247.04

$\frac{276}{1.2307}$ = 224.26 $\frac{22}{0.1090}$ = 201.83 $\frac{170}{0.79825}$ = 212.97 $\frac{392}{1.86205}$ = 210.52

Deseasonalised Data:

	Autumn	Winter	Spring	Summer
2021	231.58	256.88	244.28	247.04
2022	224.26	201.83	212.97	210.52

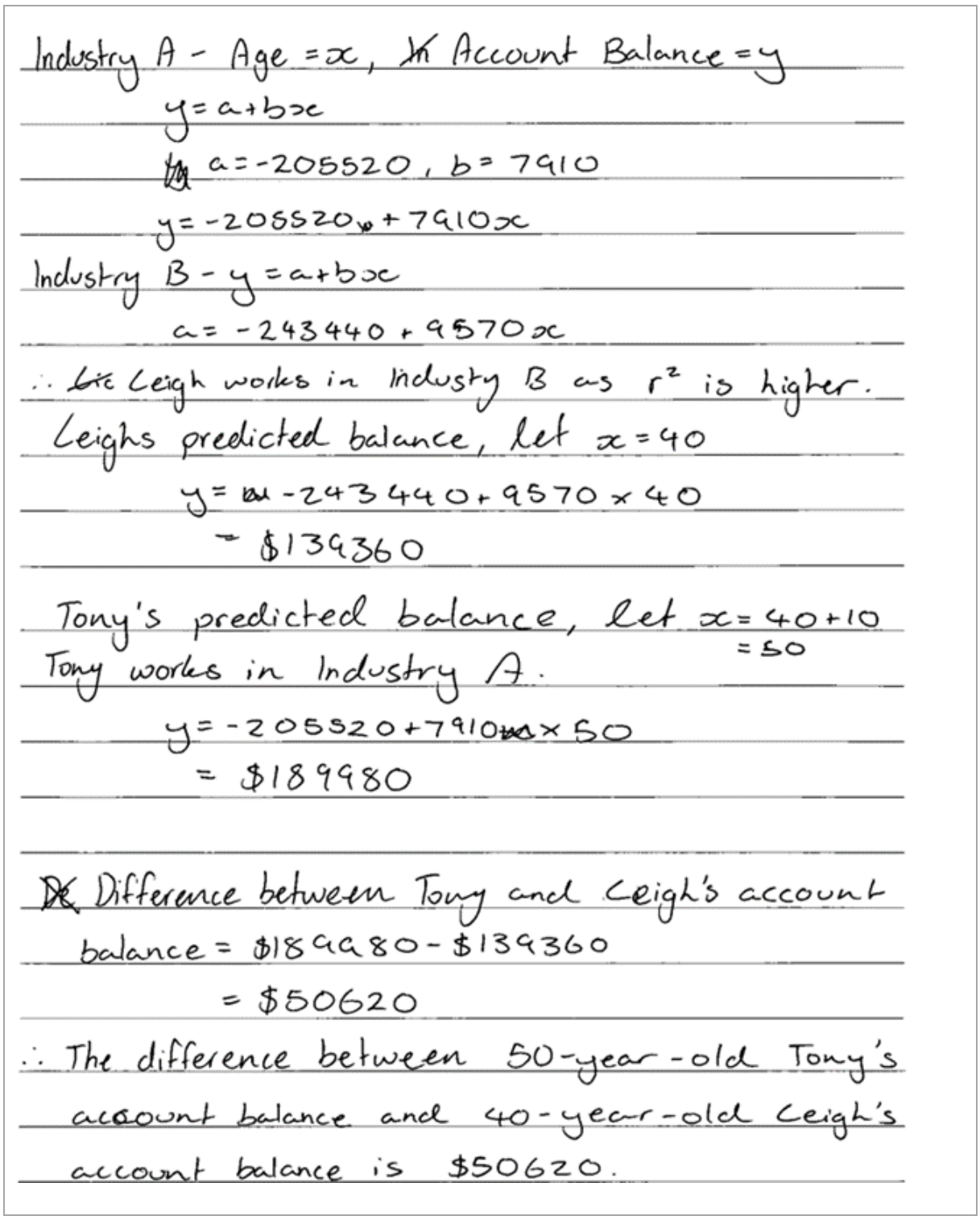
The following excerpt is from Question 6 in Paper 2. This question provided a table showing the average superannuation account balance for workers of various ages in two different industries (A and B), the coefficient of determination for the data for each industry, and information about the age and industry worked for two people (Leigh and Tony).

Effective student responses:

- correctly identified the dataset for which age explained a higher percentage of the account balance variation
- correctly determined the linear model for age versus account balance for industry A data
- correctly determined the linear model for age versus account balance for industry B data
- substituted $x = 40$ into appropriate equation and calculated Leigh's current account balance
- substituted $x = 50$ into appropriate equation and calculated Tony's current account balance
- calculated the difference in current account balances for Leigh and Tony
- showed logical organisation communicating key steps.

This excerpt has been included:

- to demonstrate succinct setting out of working for the two developed linear models such that each equation is firstly stated in terms of the two variables, which the student has defined, before the relevant age value is substituted into each appropriate equation to make predictions
- to show logical organisation and communication of key steps.



When preparing students for external assessment, it is recommended that teachers:

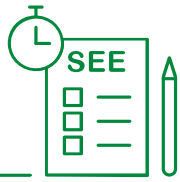
- support students to identify cues in questions that would enable them to select the appropriate rule from the General Mathematics formula book, such as for annuity calculations and determining the distance between two places on Earth
- instruct students that, when developing linear models, to first state the equation in terms of the two variables (using the given symbols if variables are defined in the question or by defining the variables themselves) before substituting values into the equation to make predictions

- support students to practise constructing scatterplots by using given data to write scaling values at equally spaced increments on each axis so that points can be plotted accurately
- model use of provided network diagrams for how to clearly identify the edges and vertices in a minimum spanning tree and shortest path, such as by using a squiggly line or, where appropriate, writing the vertex sequence in the response space
- instruct students that when applying the Hungarian algorithm they should write separate matrices to show the outcome for each step, e.g. row reduction, column reduction, continuing the algorithm until the minimum number of lines to cover all zeroes is equal to the number of assignments
- support students to complete steps in the correct order when calculating seasonal indices across multiple years, e.g. the average percentage method (Syllabus section 4.4 and section 6) requires the average of the data values for each year to be calculated before each data value is expressed as a percentage (or ratio) of the average for its year. Then the percentages (or ratios) for the corresponding seasons for different years are averaged to arrive at each seasonal index.

Additional advice

- Students should be aware that the number of available marks for each question is commensurate to the amount of knowledge and understanding of subject matter that needs to be demonstrated to be awarded the marks described in the mark allocation statements in the EAMG. Section 1 of the question and response book provides students with the instruction that ‘Questions worth more than one mark require mathematical reasoning and/or working to be shown to support answers’, e.g. a response awarded five marks provides evidence for five mark allocation statements in the marking guide and a response awarded two marks provides evidence for two mark allocation statements in the marking guide.
- If additional pages are required to complete a response, students should continue their solution on the additional pages at the back of the response book. On the additional pages, they should clearly indicate the question they are responding to. If a new response is provided, students must rule a single diagonal line through any work to be cancelled, otherwise the original response will be marked.
- Students should be advised to use part of their perusal time to identify the total number of questions in the examination and where the ‘END OF PAPER’ message is located.

Senior External Examination



The General Mathematics Senior External Examination (SEE) is a standalone examination offered to eligible Year 12 students and adult learners. It contributes 100% to a student's final subject result.

Assessment design

The assessment was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the General Mathematics Senior External Examination syllabus.

The SEE consisted of two assessments:

- SEE 1 contributed 50% of the marks
- SEE 2 contributed 50% of the marks.

Note: The SEE information should be read in conjunction with the rest of the subject report.

Number of students who completed the General Mathematics Senior External Examination: 7.

There were insufficient student enrolments in this subject to provide useful analytics.