2022 General Mathematics Subject Assessment Advice

Overview

Subject assessment advice, based on the 2022 assessment cycle, gives an overview of how students performed in their school and external assessments in relation to the learning requirements, assessment design criteria, and performance standards set out in the relevant subject outline. They provide information and advice regarding the assessment types, the application of the performance standards in school and external assessments, and the quality of student performance.

Teachers should refer to the subject outline for specifications on content and learning requirements, and to the subject operational information for operational matters and key dates.

School Assessment

Teachers can improve the moderation process and the online process by:

* thoroughly checking that all grades entered in school online are correct
* ensuring the uploaded files are a reasonable scan quality, that the work has the correct orientation, and remove blank pages, student notes and formula pages
* ensuring the uploaded responses have pages the same size and in colour so teacher marking and comments are clear
* uploading the SATs as a single scanned fil.
* preferably providing a summary of student results in each of the SATs on the first page of the uploaded SAT’s file
* filling in the variation form if a student did not complete one or more skills and applications tasks
* for SATs and Mathematical Investigations responses, clearly marked answers showing which mathematical calculations are fully or partially correct and which are incorrect is a requirement of moderation. Showing marks and totals for SATs is also helpful.

Assessment Type 1: Skills and Application Tasks

Students undertake five skills and applications tasks, including at least one skills and applications task from each of the non-examined topics. The equivalent of one skills and applications task must be undertaken without the use of either a calculator or notes.

This year teachers were able to reduce one SAT through using the Covid adjustments offered in the subject. It is important to remember that where this has been applied, it should have been the same task for all students in the assessment group. More information can be found at the following link: [Stage 2 General Mathematics – Subject adjustments 2023.](https://www.sace.sa.edu.au/documents/652891/3799563/General+Mathematics+-+subject+adjustments+2023.pdf/616ac13e-dde9-aebe-768c-60a388c53f04?version=1.0)

It is a requirement for moderation that SATs are marked to clearly indicate how much of each mathematical problem a student has been successful in attempting. Marking of all calculations in assessment responses is essential to support the moderation process.

All nine assessment criteria should be assessed at least once in either the skills and applications tasks or in the mathematical investigation. In particular, RC5, ‘forming and testing of predictions’ is easier to assess within Assessment Type 2: Mathematical Investigations. If it is assessed in the skills and applications tasks, then students should have plenty of opportunity to meet the specific feature to an A standard.

Teachers can elicit more successful responses by:

* designing tasks that provide a mix of routine and more complex problems that effectively differentiate student mathematical knowledge and understanding of concepts and relationships across the grade bands. A complexity guide has been provided to support teachers to identify key questions and key concepts that provide the opportunity for complexity in responses. The document ‘Complexity Guide General Mathematics’ is available on the website at the following link: [Complexity Guide General Mathematics](https://www.sace.sa.edu.au/web/general-mathematics/stage-2/support-materials/subject-advice-and-strategies)
* providing multiple opportunities that allow students to demonstrate their interpretation of concepts and results in the context of the problem, including discussion of the assumption and limitations of the of the results in all skills and applications tasks
* using appropriate verbs such as state, explain and interpret to guide students to the form of response required as well as strategically placed ‘show’ questions that allowed students back into a question if they were not able to complete a previous part successfully. An example of a ‘show’ question is providing the answer, or an approximate answer, to an annuity problem so that students who are not able to find the value can use the provided figure to continue on through following parts of the problem. The instruction to ‘show’ ensures that students must provide evidence of the method used to find the value and cannot gain marks for simply writing the value they have been given in the question stem
* where the tasks provided students with the number of marks a question is worth and the appropriate space to allow them to identify the amount of detail required in the answer
* finding a good balance of ‘traditional’ standalone test style assessments focussed on the technical aspects of the subject mixed with innovative approaches that allow students to develop their other skills including video presentations and assessments that built on one another throughout the subject.

The more successful responses commonly:

* were seen when students showed clear working out of all relevant steps, in particular for the ‘show that’ questions (an example of this is when students provide n, i, pv, pmt, fv, p/y, c/y as well as the exact answer in a ‘show that’ finance question).
* were seen when students discussed the assumptions and limitations of the result in the context of the problem.

The less successful responses commonly:

* were seen in skills and applications tasks that provided limited opportunities for students to respond to questions of a complex nature. Teachers need to ensure that at least 30% of the marks in each task are composed of questions covering complex concepts or requiring complex processes to solve the questions. Please note that where questions requiring complex processes or concepts are heavily scaffolded to support progress through the solution, the complexity is reduced
* were evident when the student was not given opportunity for interpretation of the mathematical results in context of the problem across all five skills and applications tasks
* were evident when students were providing generic responses to assumptions and limitations rather than responses in context as well as responses that did not provide enough detail. An example of this is in finance where a student’s writes ‘interest rate changing’ with no indication of the interest rate is to increase or decrease
* where teachers indicated that they were assessing RC5 (forming and testing of predictions) and CT3 (application of mathematical models), yet the students were not given an opportunity to show these skills at an A level, or at all
* were seen when questions were based on tasks that used questions directly from a textbook or from past exams. Questions from past examinations or exemplar skills and application tasks can be used as the basis for questions in skills and applications tasks, however they should be amended so they are not easily recognisable and do not form the majority of questions assessed in any individual task
* where an open topic was included that did not have enough complexity for students to achieve in the higher-grade bands.

Assessment Type 2: Mathematical Investigations

Students undertake two mathematical investigations with a maximum length of 12 A4 single-sided pages with a minimum of size 10 font. The evidence presented in the two investigations should include key ideas and key concepts from at least two different topics.

Teachers may need to provide support and clear directions for the first investigation. However, the second investigation must be less directed and set within more open-ended contexts.

It is a requirement for moderation that teachers ensure that all mathematical solutions produced by the student in the investigations are marked for accuracy and errors are identified as well as making comments about the written component. This supports both student understanding and the moderation process.

Before uploading teachers should check the file for reasonable scan quality and that the work has the correct orientation. It also assists moderators with the moderation process if both tasks are uploaded in the same file.

Teachers can elicit more successful responses by:

* providing some structure of an initial problem leading to a more open-ended problem to investigate to allow the student to develop the model at the higher-grade bands
* ensuring the task provides multiple opportunities for students to make, test and discuss predictions as well as use these results to make further predictions
* ensuring that the design of the task allows for the discussion of limitations and reasonableness both in the initial problem as well as the open-ended section
* students presenting the response in report format. Communication of mathematical information is best done by using appropriate headings, labelling graphs and tables, referring to them in the main body of the response, and using appendices for repetitive calculations.

The more successful responses commonly:

* were in response to tasks designed with enough scaffolding for students to achieve at the C grade band in the initial parts of the task, but also providing an open-ended section which requires students to extend their investigation in a direction of their own choosing. This allowed them to demonstrate their understanding at the higher-grade bands
* included a detailed development and application of a mathematical model beyond the initial model, with enough complexity. A complexity guide has been provided to support teachers to identify key questions and concepts that provide the opportunity for complexity. The document ‘Complexity Guide General Mathematics’ is available on the website at the following link: [Complexity Guide General Mathematics](https://www.sace.sa.edu.au/web/general-mathematics/stage-2/support-materials/subject-advice-and-strategies)
* were seen where students made appropriate predictions before they begun calculations, as well as using their calculations to refine future predictions and finally discussing the accuracy of their predictions. An example of this is when
* students make a prediction of how much money they may save on a home loan if they
* increase the repayment by $100
* calculations are made to find the savings gained through the $100 increase
* a comparison is made of the calculated value to their prediction
* students use their answer to make a more refined prediction about how much they will save if they were to, for instance, double the payment to $200.
* were seen when students used tables to summarise their results
* were seen when students showed comprehensive interpretation of the results, by interpreting the answers in context, compared the results and discussed the key findings
* occurred when students demonstrated a comprehensive understanding of the assumptions made in their investigations, the reasonableness of their results, and the limitations of the models they had investigated.

The less successful responses commonly:

* were in response to tasks that used the same starting parameters or data reducing the individuality of responses
* had evidence of all students following the same modelling processes (with the same changes implemented to their model), which indicated excessive teacher scaffolding. This particularly impacted the students in the higher-grade bands as scaffolding reduces complex mathematical modelling to a more routine level. An example of this is in the coffee cooling statistics task where all students in the assessment group would do the initial plus the exact same changes to their model for example add milk, change cup
* did not show enough complexity in calculations and model development at the A level even though the task allowed them to. Examples include in:
* Topic 1: Modelling with Linear Relationships, where students did not cover concepts such as wastage, change of constraints, multiple solutions or non-integer solutions
* Topic 3: Statistical Models, where students only looked at residual plots for the exponential model instead of all models or didn’t look at the impact of removing an outlier
* Topic 4: Finance Models where students only changed one variable at a time
* included excessive routine and often repetitive calculations that were prescribed in the task design. This in turn limited the students’ ability to show more complex changes
* occurred when responses lacked depth in the analysis due to the response providing evidence of a recount of what the student did rather than analysis of the outcomes of the mathematical calculations in the context of the problem. Students should be informed that analysis of the mathematical results should provide:
* interpretation of the answers in context
* comparison of results
* discussion of key findings rather than a recount of what they did and how they did it.
* lacked evidence of both drawing conclusions and understanding of assumptions and limitations to address RC2 — most commonly providing minimal evidence of explanation of the assumptions and limitations in context
* were difficult to follow, lacking in explanation of choices made in developing a model
* lacked evidence in either task of predictions being made prior to calculations being completed or a further discussion of the accuracy of the predictions
* when an open topic was covered however the task did not allow the students to show enough complexity to achieve in the higher-grade bands.

Operational Advice

If students present their responses in oral or multimodal form, 6 minutes is the equivalent of 1000 words. Students should not speed-up the recording of their videos excessively in an attempt to condense more content into the maximum time limit.

From 2023, if a video is flagged by moderators as impacted by speed, schools will be requested to provide a transcript and moderators will be advised to moderate based on the evidence in the transcript, only considering evidence up to the maximum word limit.

If the speed of the recording makes the speech incomprehensible, it affects the accuracy of transcriptions and it also impacts the ability of moderators to find evidence of student achievement against the performance standards.

External Assessment

Assessment Type 3: Examination

The evidence in the students’ responses to the 2022 exam showed that the vast majority of well-prepared students were able to complete the paper in the time available. It was also evident that fewer students losing marks unnecessarily by not attempting routine questions.

This year students performed best in the Hungarian Algorithm question, with the Discrete models topic being the best answered of the three topics. The most successful students showed clear process in their calculations, including recording of calculator inputs (especially for the Financial and Statistical models questions) and displaying calculator solutions before appropriately rounding depending on the needs of the question. Where a worded response was required, these students paid attention to what the question asked for, the marks available, giving clear and distinct responses in the context of the question rather than generic responses from their cheat sheet.

The most common concepts students struggled with were; 1(a) the calculation of an effective rate for a flat rate of interest, 2(a) completion of the backward scan, 2(f)(iii) the calculation of latest starting time, 3(d)(iii) comparison of multiple normal distribution curves, 5(d)(ii) calculation of a lump sum, 6(d)(ii) discussion about the reliability of a prediction, 7(b) the explanation of a dummy link, (8e) the calculation of sum of interest and understanding of offset account features, 9(c), (d) the calculation/prediction of an unknown X value from an exponential model.

Examination markers aim to award marks for evidence of student understanding in response to examination questions wherever possible, however students should be advised not to cross out their responses or attempted responses to questions in the examination booklet unless they are confident that no part of what is crossed out should be considered by the marker.

If a student crosses out a response and then decides that it was the correct (or most correct) answer, then the student should indicate clearly to the marker which part of their response should be considered. This could be done by circling or highlighting all or part of the response the student wants to be considered and writing “please mark this work”. Students do not need to rewrite their answers in this case unless the crossing out has rendered the response unreadable.

Question 1: Financial models — savings plans

The calculation of an effective rate for a flat rate is still providing significant numbers of students with issues. As highlighted in the exam feedback last year, this can be completed using the conversion option within the TVM/Financial mode on the graphics calculator, where *n* is the inverse of the number of years . Other issues in this question included students using the number of years multiplied by the C/Y value, instead of just using the C/Y value for account B.

When students are required to show an approximate amount, they must state the value provided by calculation and not simply the value provided in the question.

Generally the calculations on inflation were completed well and students were able to calculate the extra required in the account successfully in the majority of cases.

In the final part of this question students really needed to pay specific attention to the wording of the question. In order to gain full credit here, students needed to state a factor which was not linked to inflation and then explain how this factor would impact the savings plan. The key wording being ‘in the context of the question’. This has been something that has been highlighted in several questions over the past few years and students need to be aware of its importance.

Question 2: Discrete models — critical path analysis

This question was split into two main sections and containing two simple networks. The first section (parts (a)–(e) contained sections which would be very familiar from questions in previous examinations.

The forward scan was completed well, with most errors occurring in the backward scan (usually around the dummy link). Students need to have awareness of the number of marks on offer when asked for the critical path(s). In this case two marks were on offer, so markers were expecting two solutions or two clearly identified critical paths. If students highlight paths on the network diagram, they should use different coloured highlighters/pens, in order to clearly distinguish between the two paths. This year more students were successful in the calculation of slack time.

The second part of this question (f)–(g) was not completed as well as the first section. In general, (f)(i) and (f)(ii) were successfully answered by most students, however the latest starting time for task S was poorly attempted with the most common errors being 14 or 18 weeks. In this case, a calculation was required to establish 15 weeks as the correct solution.

The only possible solution for (g)(i) was to reduce task R by 3 weeks. While this was given by a good number of students, the vast majority were not able to justify why this was the case. Here students really needed to think about the network in three sections (i.e. section 1 from the start to the double 10, section 2 from double 10 to double 14 and section 3 from double 14 to the finish). When considering this, section 2 would be the only section that would allow a 3 week reduction as the critical path would change if changes were made in either section 1 or 3.

Question 3: Statistical models — normal distribution

Parts (a) and (b) contained routine elements seen in previous examinations. These sections were generally successfully attempted by the vast majority of students who were able to apply Ncd and InvN operations successfully.

Rounding incorrectly was an issue in several sections within this question.

1. Students need to be mindful that discrete variables (number of candles) will require an integer solution.
2. The continuous variable of time was used throughout the question. Here it would be better for students not to round to the nearest minute, but to leave a couple of decimal places. This was an issue specifically in part (b).
3. In part (c), when calculating a probability, it is not acceptable to provide a solution of 8.2 E-3 straight from the calculator. In this case students needed to understand that this was scientific notation and convert to either 0.0082, 8.20 x 10-3 or alternatively 0.82%.

The labelling of the graph in part (d) was very well attempted, with the majority of students able to identify the distribution curves correctly. In part (d)(ii) most students were able to explain that it was the standard deviation which caused the distribution cures to be higher or lower, however very few students talked about the fact that all three curves had the same area (1 or 100% of all probabilities). This is something that has been highlighted in previous years, where students were required to sketch an additional curve.

Question 4: Discrete models – Hungarian algorithm

This question was the best attempted by students completing the examination this year, with approximately 77% of students gaining at least 12 out of the 14 marks available. It is pleasing to see that the Hungarian algorithm is so well understood by our students.

The completion of the algorithm within part (d)(i) was strong, although we are still seeing some processing errors. The main issue tends to be in the final stages where students need to do the addition/subtraction of the smallest value.

A useful way of indicating lines without obscuring numbers is to show the lines using a highlighter. For students who use this method, it makes their subsequent working easier for both themselves and the marker to follow.

In part (f)(ii) most students were able to successfully reason and explain limitations of using the Hungarian algorithm in this context. Unsuccessful responses included reference to the dummy column causing a member to miss out. This is not acceptable as it has already been stated in the question.

Question 5: Financial Models – home loans

Students largely coped well with part (a)(i), with the majority of students able to find the pmt value provided. Again it was important that students stated the calculated pmt value and do not simply restate the amount given in the question. Part (a)(ii) offered students the opportunity to utilise the amortization function on the Graphics calculator to find the  where PM1 was 1 and PM2 was 240. It is important to note that in some questions, using the amortization function can save students significant working and time.

Common problems in part (b)(i) were where students failed to reduce Pv to $520 700 or where this value was instead used as Fv. Again, this question relied on students reading the information carefully and finding the additional time required to repay the loan. In this case it was important for students to state the time period (months). Students generally found Part (b)(ii) more challenging with many not understanding that a calculation was first required to find Pv, before finding the difference with the $520 700.

Question 6: Statistical models — linear regression

Most students were able to successfully input the information provided into their graphics calculator and answer all or part of sections (a) and (b). Common errors were where students incorrectly identified the variables D and S, or did not use them at all. In part (b), the negative sign was important as it indicated the decreasing trend being observed. In questions where *r* or *r*2 are asked for, it is recommended that students provided at least three decimal places in their solution.

The residual plot section was reasonably attempted by the majority of students, although some students did miss that they were required to plot point A on the diagram provided. Several methods were acceptable for the residual calculation and students should be reminded that they do not need to only rely on their graphics calculator for this. Residual = actual y value − predicted *y* value, can also be used.

Most students were then able to apply one of several methods in order to predict the year when the Area of Arctic sea ice will be 1 million km2. This is another instance where an integer solution would be required as it would not be appropriate to state a decimal value for a specific year. Students were then generally able to discuss that this solution was an extrapolation, but in most cases they struggled to further discuss the reliability of the calculated solution. In this case it is important that students understand that two clear reasons are needed as stated in the question. Once again, the marks allocation of two should indicate to students that a fuller response is required in order to gain full credit here.

Question 7: Discrete models — precedence tables and networks

This question was relatively short and generally very well attempted by the vast majority of students. Most students were able to correctly interpret the information from the precedence table in order to correctly identify the positioning of the missing tasks D and E.

Part (b) was not completed as well, with many students not fully explaining the reasoning for dummy link X. In this case, it was important that students mentioned tasks A, B, C, D and E within their response and clearly explain the role that the dummy link plays within this part of the network.

Parts (c) and (d) were generally well answered by most students. Again, in part (d), it is important for students to realise that a question worth two marks would require two responses. Students who ticked additional boxes would also not able to gain full credit here.

Question 8: Financial models – loans

Part (a) included a comparison rate calculation, which was generally completed well by most students. We are still seeing some schools use the old Maths Apps method of pre-loading all fees to the start of the loan. Please note that this method is considered incorrect and will not gain students full credit.

The two most common errors within part (c) were students not subtracting the $50 000 deposit from the principal and not showing the calculator solution for the new interest rate. As highlighted in previous questions, students must always show their calculator solution in any “show that” question.

In part (d) less successful responses came from students who did not have the correct combination of positive and negative inputs for Pv, Fv and pmt. In this case pmt and Fv needed to be the same sign.

Part (e) introduced the two options for students to consider for refinance. Students who attempted this question generally completed (e)(i) more successfully than (e)(ii). Within (e)(ii) a new calculation of pmt was required, before a  calculation. The most common error here came from students using the pmt value from part (c) to find 

Part (e)(iii) then assessed students knowledge of the features of offset accounts within the context of this scenario. Most students who attempted this question were generally able to gain one mark, however two independent reasons were required to gain full credit here and we found that students were not going into sufficient detail to gain the second mark. There also still seems to be a common misconception amongst students that offset accounts earn interest.

Question 9: Statistical models — exponential regression

The start of question 9 contained a lot of information which the students were required to review prior to explaining why a linear model would not be appropriate. In this question students needed to be clear whether they are were referring to the residual plot provided or a scatter plot which they had created. Please note that ‘clear pattern in residual plot’ and ‘no random scatter in residual plot’ are essentially the same answer so would not gain both marks.

Within part (b), the most common error was selection of 89% decrease. Students also found it challenging to explain why the model was an underestimate of the original data. Here students could either compare the ‘a’ value from the model with the original recorded data or complete a residual calculation. This concept was previously examined within the ‘Tower of Hanoi’ question and again not well attempted.

Parts (c)(i) was completed well, however part (c)(ii) and (d)(i) was less well attempted with many students unable to perform the XCalc calculation from graphing mode on their graphics calculator. An alternative would be using a Solver function. A common error in both was for students to treat these calculations a linear and not exponential.

The final question required students to explain why one model would reach a certain level prior to the other. Here students needed to analyse the difference in the b values of each model and interpret what that would mean within the context of the question. The most common errors here were students comparing the *a* value with no interpretation of the *b* values.