# Government of South Australia LogoSACE Board Logo2023 Essential Mathematics Subject Assessment Advice

Overview

Subject assessment advice, based on the 2023 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 are expected to refer to the subject outline for specifications on content and learning requirements, and to the subject operational information for operational matters and key dates.

In 2023 the following subject outline adjustments were available: students provide evidence of their learning through seven to eight assessments, including the external assessment component.

Students undertake:

• four or five skills and applications tasks

• two or three folio tasks

• one examination

It is expected that teachers used their professional judgement in the design of the suite of assessments to suit their cohort, ensuring any specific requirements of the subject outline are met (for example, covering the non-examined topics).

During moderation it was noted that some schools chose to remove *one of the non-examined topics* from the assessment. The subject outline has a specification requiring evidence of learning in both non-examined topics in Assessment Type 1. Most schools completed seven assessment tasks prior to the external component.

Please note that any adjustment to the Learning and Assessment Plan (LAP) must be indicated as an addendum which is submitted for moderation in the teachers’ materials. Any ‘subject adjustment’ amendment that is made to the LAP must apply to all students in the Assessment Group.

*It is a requirement for moderation that student work is marked for both school assessment types*. This means clearly indicating the accuracy of mathematical calculations for SATs and folio tasks. Insightful comments about the written sections for investigations identifying aspects that supported assessment also support the moderation process. Where unmarked samples were identified in moderation samples, schools were contacted and required to upload appropriately marked materials for moderation to proceed.

Before uploading materials, teachers should check the file(s) for reasonable scan quality and that the work has the correct orientation. Scanning all SATs for a student sample as a single PDF file and all Folios for a student sample as a single PDF file is both quicker and easier for the teacher and made the moderation of materials much more efficient.

Some samples did not contain complete sets of materials and did not have any information to explain the variation in the sample. Any samples with missing assessments (i.e. for either Assessment Type) risks disadvantaging the student. Teachers are asked to provide an explanation in a Variations to Moderation Materials (VMM) form, to be uploaded for moderation. These schools were contacted and asked to upload the missing materials or an explanation of the reason for the missing materials (via the electronic VMM form) before moderation could continue. This includes lost tasks and tasks not attempted by students.

# School Assessment

Assessment Type 1: Skills and Applications Tasks

Students complete four or five skills and applications tasks, including at least one skills and applications task from each of the non-examined topics. Skills and applications tasks are completed under the direct supervision of the teacher. The equivalent of one skills and applications task must be undertaken without the use of either a calculator or notes and should be clearly identified on the LAP. In the remaining skills and applications tasks, electronic technology and up to one A4 sheet of handwritten notes (on one side only) may be used at the discretion of the teacher. The school set of assessments, as a whole, should provide students the opportunity to demonstrate evidence for assessment for each of the specific features at least once.

Teachers are strongly encouraged to access the support material document ‘[Complexity Guide Essential Mathematics](https://www.sace.sa.edu.au/web/essential-mathematics/stage-2/support-materials/subject-advice-and-strategies)’ which is available on the website. The complexity guide has been produced to support teachers to identify key questions and key concepts that provide the opportunity for complexity in questions. The Performance Standards rubric indicates the requirement of students to demonstrate success with both routine and complex problems to achieve grades in the A and B bands. A lack of complexity in assessment tasks disadvantages more capable students in preventing them from demonstrating performance standards at the A and B grade bands.

To support student learning, teachers should ensure SATs are marked to clearly indicate how much of each mathematical problem a student has been successful in attempting. Clear marking of mathematics for accuracy supports students in identifying where they have made errors in applying algorithms and manipulating formulae. Students are disadvantaged moving forward when marking does not clearly and accurately identify errors in their mathematics or in the language of their discussions and explanations.

There was little evidence of students not having access to approved graphics calculators. Students are required to show effective use of technology and lack of access to an approved graphics calculator is seen to disadvantage the students.

Teachers can elicit more successful responses by:

* including SATs which have an appropriate balance between routine calculations/analysis (approximately 65%), complex calculations (approximately 30%), and complex interpretive questions (approximately 5%)
* including some routine questions that are broken into distinct parts (scaffolded) and at times (but not always) use prompts such as ‘show’ and ‘calculate’ to support students to engage initially with questions. Students can be prompted on the method required for solutions sometimes (e.g. ‘use the Sine rule to’); however, this removes complexity and should not be common in a task (CT2)
* providing students with enough complex problems to enable them to provide evidence of their ability to solve questions of a complex nature. This was particularly evident in Topic 1: Scales, Models and Plans. The Complexity Guide does outline several opportunities for complexity in Topic 1, and teachers should ensure that they have an appropriate range of questions that are considered complex in nature within this SAT. It should also be noted that excessive scaffolding, breaking too many problems down to 1 or 2 mark sections, in any topic, can reduce a complex calculation to one that is more routine in nature
* including questions in the Measurement SAT that required a range of simple, compound, and irregular shapes to be used in solving problems set within appropriate contexts (CT2)
* providing students with the opportunity to answer ‘What if’ and ‘reasonableness’ questions in all SAT assessments. This enables students to demonstrate the development of their skills in analysing their results and to consider assumptions made to find solutions, and how the assumptions impact the reasonableness of the solutions (specific features RC1 and RC2). Such questions are most successful when applied to clear and reasonable contexts
* expanding questions to include the development of an initial scenario, particularly in Loans and Investments. This increases the complexity, particularly where the signs of input values need to be considered (CT2, CT3, and CT4)
* providing diagrams which supported student understanding of contextual information or required students to identify values or add values to the diagram. These supported the students to understand the requirements of the question and/or to identify, and/or interpret all known information. Any diagrams provided should be appropriate to the problem being solved, e.g. if Simpson’s Rule is to be used to estimate the area of an irregular shape, it needs to be divided into an EVEN number of sections
* providing opportunities for students to demonstrate the effective use of technology, particularly in Statistics and Investments and Loans (CT4)
* clearly indicating which assessment(s) provided evidence addressing the specification of at least one SAT without technology and notes
* providing clear feedback about errors in SATs and guidance on what needed improvement in following assessments
* making use of ‘show’ questions that enabled students to progress through subsequent sections of a question even if they were unsuccessful with the initial calculations
* providing opportunities for students to demonstrate the different approaches required for ‘state,’ ‘explain’, and ‘describe’ questions supported by appropriate marking schemes.

Teachers limited opportunities of students by:

* using tasks that cover narrow aspects of topic content, limiting student’s ability to demonstrate comprehensive knowledge and understanding of concepts and relationships (CT1). Alternatively, asking questions about concepts beyond the scope of the subject, e.g. residual plots or non-linear regressions may also disadvantage students
* providing limited opportunities for students to display evidence of good interpretation in the context of the question (RC1)
* providing limited opportunities to effectively communicate mathematical ideas and reasoning to develop logical mathematical arguments (RC4)
* requiring no or limited evidence of calculations. In multiple mark questions where only final solutions are provided and the result is incorrect, marks for appropriate steps cannot be allocated. Teachers should encourage students to show appropriate steps in their mathematical calculations (RC4)
* assessing performance standards within a task that did not provide students with multiple opportunities to provide evidence of that particular feature. Where only one opportunity was provided students were often disadvantaged
* including tests in the set of assessments straight from the SACE website. These provide teachers with exemplars of the standard. However, as they are available in the public domain they should not be directly used as summative assessment. Similarly, questions copied from the textbook, also available to students, do not allow students to demonstrate mathematical techniques in a variety of contexts. (CT2)

The more successful responses commonly:

* displayed clear communication of the steps in solving problems (RC4), with correctly labelled calculations, correct units of measurement, and appropriate rounding (RC3)
* provided detailed, concise calculations when responding to questions (CT2)
* stated any formulas used, identified values that had been given in the question stem or provided in diagrams required for the solution, and provided a clear answer for the variable that was required to be found
* displayed an understanding of the impact of assumptions on the answers they calculate, and the ability to explain these in the context of the problem being solved
* attempted the majority of the questions
* demonstrated discerning and efficient use of technology as required
* presented their solutions in a clear, logical, and legible manner.

The less successful responses commonly:

* often did not attempt to answer questions, particularly more complex style questions
* included many arithmetic and algebraic mistakes
* didn’t use the prompts given in ‘show’ questions to identify when they have made an error or use that value in following calculations to allow them to continue on through the question successfully
* used incorrect notation and did not communicate a good knowledge of the mathematical techniques and algorithms covered in the course
* attempted to use the compound interest formula in place of the graphics calculator making Financial Models calculations much more difficult, and in some cases, impossible
* stated rather than explained or discussed assumptions, limitation, and reasonableness
* did not demonstrate the rearrangement of equations to resolve an independent variable sought
* applied given formulae incorrectly
* gave general statements rather than interpretations in context with the question
* did not round appropriately
* supplied an answer only, with no evidence of working or steps taken in the calculation.

Assessment Type 2: Folio

Students complete two or three folio tasks, where they investigate a mathematical problem based in an everyday or workplace context. Where the option of four SATs for the school assessment is used, the topic not assessed in skills and applications should be assessed within a folio task. The subject of the mathematical problem may be derived from one or more topics. Each folio task, excluding cover page, bibliography and appendices if used, must be a maximum of 8 A4 pages (or 12 A4 pages for two folio tasks) if written (minimum font size 10), or the equivalent in multimodal form. The folio tasks should provide ample evidence of specific feature CT3.

Again, teachers are encouraged to access the support material document ‘[Complexity Guide Essential Mathematics](https://www.sace.sa.edu.au/web/essential-mathematics/stage-2/support-materials/subject-advice-and-strategies)’ which is available on the website. Teachers need to ensure each folio task provides an opportunity for students to clearly demonstrate complexity in their mathematical calculations.

Teachers are required to ensure that all mathematical solutions produced by the student in the investigations are marked for accuracy and errors are identified. This supports both students’ understanding and the moderation process. Where samples were provided for moderation without a clear indication of the level of correctness of the mathematical calculations, schools were required to upload appropriately marked materials before the moderation process could commence.

Teachers can elicit more successful responses by:

* providing students with 12 A4 pages as their maximum page count for each task when the option of two investigations is adopted
* referring explicitly to the Complexity Guide when providing feedback and guidance to students
* providing students with clear opportunities to format predictions. Predictions should not be arbitrary, but rather students should be encouraged to communicate their reasoning behind their predictions (RC4) and to go on to test those predictions mathematically and interpret the results of their testing in context of the predictions made (RC1 and RC5)
* supporting students to understand where complexity can be found in the mathematical investigations that are undertaken (CT1, 2, and 4) and how they can develop mathematical models to explore and interpret changes to the initial models (CT3 and RC1, 2, and 5). Opportunities for the development of mathematical models exist in all topics, e.g. (but not limited to):
	+ Scales, Plans, and Models: development of bearings problems from unstructured information where changes to an initial scenario are posed and the impact of these changes examined and interpreted
	+ Measurement: improving the estimate of the area of irregular shapes by refining and improving initial models
	+ Business Applications: both mathematically and graphically exploring and interpreting the effect of multiple and combined changes to an initial Break Even scenario
	+ Statistics: the recalculation of correlation statistics after appropriate outliers are removed and using the equation of the line of best fit to examine the effect of their removal on the appropriateness of the model to predict within and beyond the given set of data
	+ Investments and Loans: the creation and analysis of real-life timelines to reflect combinations of changes to loan conditions or superannuation funds over extended periods of time.
* providing students with open-ended tasks that allow students to choose the path of their model development in their investigation and select their own ideas/figures/contexts to follow. This ensures individuality in responses and supports differentiation in assessment of the responses seen (CT3)
* not expecting students to complete mathematics beyond the scope of the course
* not scaffolding excessively, e.g. providing fully structured excel sheets that limit students to the appropriate application of technology and prevents them from being able to demonstrate effective use of technology. (CT4)

The more successful responses commonly:

* demonstrated a high level of accuracy in their calculations
* provided clear and reasoned predictions, followed by mathematical testing where results were compared to the initial prediction and interpreted within the context of the study (RC5 and 1)
* had clear communication of the steps undertaken in the investigation — providing connections between the mathematical investigations which were easy to follow and clearly identifiable (specific feature RC4). Included clear and accurate units and notation (RC3)
* developed a model that addressed “What if…” scenarios/opportunities that were of a complex nature (addressing multiple, simultaneous/sequential changes) (CT3)
* made links between the results of different “What if…” scenarios and were able to interpret differences within the context of each scenario and the mathematics used (RC1)
* provided in-depth discussion of reasonableness and limitations that clearly linked to the context of the investigations, not just stating generic reasons (RC2). The student discussions provided clear explanation of the likely effects of the assumptions/limitations on the model/answers
* showed intuitive modelling and did not repetitively change variables unless it made sense to investigate that particular part of the problem further
* included repetitive calculations in the appendices, with an initial calculation providing evidence of the skill in the main body. The results of the additional calculations that were placed in the appendices were included in a table (or other concise manner of presenting multiple results) in the main body for comparison and discussion (RC4)
* provided clearly labelled and accurate diagrams and graphs as required (RC3)
* demonstrated discerning and highly effective use of technology. (CT4)

Teachers limited opportunities of students by:

* providing minimal, no, or incorrect feedback to the students, therefore, not assisting them to identify areas that they needed to develop further (e.g. communication of the mathematics, including interpretation and analysis), or supporting students to identify which areas of the mathematical calculations had errors. Note: In this instance, teachers should provide students with the drafting feedback to check calculations on page ‘X’, not specifically highlight all calculations with errors
* designing assessment tasks that were too short by providing maximum page limits less than the subject outline allowed for the number of assessments undertaken in this assessment type. Providing students with a page maximum less than the subject outline specifies limits the student’s ability to demonstrate comprehensive knowledge and understanding of concepts and relationships (CT1)
* limiting opportunities to provide alternative investigations or changes to scenarios by providing tasks that had obvious scaffolding throughout all parts of the task. This limited the complexity of the overall set of tasks and impeded the student’s ability to show that they could ‘develop’ a model (CT3)
* designing tasks with very limited scope for further investigation or included mathematical content that did not get beyond basic or routine levels. This was often evident in Topic 2: Measurement folio tasks where only basic shapes were often seen
* providing tasks that did not encourage students to develop their initial models. (CT3)

The less successful responses commonly:

* provided no or limited introduction or summary
* provided limited evidence of mathematical calculations
* provided brief discussions with little or no reference to calculations (RC4) or provided a description of the mathematical process used rather than a discussion of the assumptions of the mathematical model and its impact on the reasonableness of solutions (RC2)
* often only addressed the initial routine scenario set up by the task and did not go on to develop “What if…” questions in any depth
* did not provide evidence of using technology when it was identified for assessment in the task. Using technology does not include typing up the folio task response or continually using an ‘online calculator’ or using a calculator for basic arithmetic, often seen in Break Even or Measurement tasks (CT4). Use of technology is demonstrated through excel spreadsheeting (provided students can demonstrate their involvement in its construction, not just its application) and through the use of the graphics calculator, particularly in graphing, statistical analysis, and financial applications
* provided evidence of students creating and using unreliable models, particularly in Statistics where correlation investigations with a very weak relationship between the variables were used to make predictions. As a guide, an r 2<0.7 is not sufficiently large to proceed with. Where students have not got the time to investigate new variables, they need to show a very clear understanding of the limitations of using a least squares regression line to make predictions when the relationship is so weak
* reworded statements from the task sheet slightly rather than discussing findings in their own words with links to their calculations and specifically in the context of their own investigation
* would state an arbitrary prediction, without justification
* testing predictions using incorrect mathematical processes or not at all
* provided limited, if any, interpretation of differences between predicted values and mathematically calculated solutions
* missed the opportunity of exploring the effect of rounding choices
* missed the opportunity to discuss the reasonableness of results or to improve the reasonableness, e.g. removal of outliers in correlation or improved techniques in estimation of irregular or compound areas.
* missed the opportunity of developing and interpreting the impact of meaningful and reasonable changes to an initial scenario, e.g. the impact of making the same lump sum payment at alternative times during the term of a loan, or recognising the relationship between different interest minimisation strategies, e.g. a first home buyer’s grant as a lump sum payment made at the start of a loan term is effectively reducing the amount borrowed and not a complex calculation
* were careless with notation, rounding and labelling and oblivious to unreasonable results
* had not appeared to have taken advantage or acted upon drafting opportunities given.

# External Assessment

Assessment Type 3: Examination

Generally, the students who were successful provided logical and clear solutions. 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.

Questions with multiple parts often have a ‘show’ opportunity provided to ensure students can continue with a question despite not achieving an answer or having an incorrect answer in the problems leading to the ‘show’ opportunity. Some students try to incorporate the ‘show’ answer in their solution suggesting they do not understand or are unfamiliar with this type of question. Teachers should consider incorporating the ‘show’ style parts of a question into their SATs so they become familiar with them prior to the examination. Students should be assured that they should respond to a ‘show’ question in the same way they would answer any question, and to use the ‘show’ as a check or to continue with if their answer is not similar.

**Measurement topic**

**Question 1**

Most students showed they understood Simpson’s Rule but made errors when applying the formula to the question. Some common errors made included not calculating the width by failing to divide the length by the number of regions the block was split into and omitting the step of width being divided by 3 in the formula.

Most students were able to apply the trapezium formula, but some successfully obtained the answer by splitting the trapezium into a rectangle and a triangle and calculating it as a compound shape.

Students were challenged by the question part requiring an explanation of whether the trapezium represented an appropriate approximation. Some students did not show understanding that the two methods of calculating the area were comparable. While many recognised the trapezium was an appropriate shape and/or too large, to obtain full marks for this question students needed to discuss the lack of balance of the areas inside and outside of the trapezium to support their answer. Some students made contradictory statements in their explanations which meant they could not be awarded full marks for the question part.

**Question 2**

Many students forgot to apply the square root when rearranging the Cosine Rule or Pythagoras’ Theorem. In general, the student cohort were more successful in solving this problem through applying the Sine Rule.

Some students continued to apply right-angled triangle trigonometry to questions with non-right-angled triangles.

The majority of students were successful in determining whether the kitchen met one or both of the design rules when given three options to select the correct answer from. In Q2(c), students were less successful in responding to the question about the design of the kitchen and its ability to meet the design rules where options for the answer did not include the same level of structured support. This differentiation allowed higher achieving students to demonstrate their higher level of understanding and capability.

**Question 3**

Common errors made by students when calculating the volume of the recycling bin included:

* squaring rather than cubing the side dimension of the cubic part of the bin
* not halving the volume of the sphere calculated to get the correct volume of the hemi-sphere section of the bin.

When students were required to explain the reasonableness of the number of cans that would fit in the bin, they were able to describe real scenarios that could allow the number of cans to fit. However, they did not adequately answer the question using sound mathematical thinking to explain why their answer was or was not reasonable. Again, some students answered with contradictory statements.

Rearranging the formula for a cylinder to calculate the height of the crushed can was generally not attempted by students. When this question was attempted, it was answered correctly. This question allowed higher achieving students to demonstrate their higher level of understanding and capability. Some students found a solution applying trial and error and when done successfully achieved full marks.

Most students attempted to determine the number of bins that could be purchased in one year even if other parts of the question were not attempted or completed unsuccessfully. Marks were awarded for the correct steps of the calculation that were carried out in this instance.

**Statistics topic**

**Question 4**

Students found it difficult to come up with two reasons why a sample may be used. Students regularly recognised time, often with a statement, such as “quick” and “easy”, as a factor but did not recognise the increased expense that would also occur due to other factors, such as human resources and administrative materials.

When discussing the reliability of the results of the sample, many students incorrectly indicated that the sample was fair because each school system had the same representation. Students failed to show understanding that the proportions of the school systems should be represented in the sample.

The stratified sample calculation was generally completed successfully, and students regularly answered appropriately with a rounded whole number.

**Question 5**

Standard deviation was the only statistical value often not correctly recorded in the table. Students may not have recognised the symbol representing the standard deviation on their graphic calculator as other statistical values were correct.

The most common error on the box and whisker plot was incorrect or missing whiskers. When included by students they often did not represent the minimum and maximum data values. All other aspects of the box and whisker plots were generally completed successfully, and labelling conventions were applied successfully.

Students generally referred correctly to the range, interquartile range, or standard deviation to support answers related to variability of amounts spent and referred to the mean or median when discussing the average amounts spent.

Students needed to be more specific with their statements about aspects that affect the amounts spent by customers. Some responses focussed on the orientation of the store which was identified in the question stem to not be considered in the response. A successful response needed to relate specifically to the amount spent, such as the number of people the shopping represented, the number of days being shopped for, frequency of items purchased, etc.

**Question 6**

Some students did not plot the missing data value on the scatter plot. A number of students identified the direction of the trend even though it was not specifically asked for in the question but in doing so identified the direction incorrectly. This was irrelevant to the marks allocated for this examination.

An ability to calculate the coefficient of determination and strength of the correlation was well done by the majority of students.

Students who recorded the equation of the least squares regression line wrote it correctly and made predictions successfully, but many did not complete this question at all. Some students used the graph successfully to make predictions when they were unable to determine the equation which was appropriate to do.

Calculating whether the battery would last all day was a differentiating question that allowed the more able students to demonstrate their higher level of understanding and capability.

**Investments and Loans topic**

**Questions 7, 8, and 9**

This topic continues to be the topic that appears to provide the most challenge for students.

Throughout the topic many students were challenged by the necessary placement of negative values to ensure they obtain correct answers from their graphics calculators.

Students were successful with questions that required them to ‘show’ or the question included an approximate answer. This also provides the opportunity for students to re-enter questions when they may have been challenged by one part. Students have shown an ability to persist when they are given these re-entry opportunities.

Students appropriately recorded graphics calculator entries which allows for maximum marks to be achieved. Some students chose to write their answers only. It is important for students to understand that if that answer is incorrect no marks can be achieved but marks will be allocated for correct entries when shown.

Some students incorrectly applied compound interest to solve the simple interest question.

Some students incorrectly subtracted the interest from the principal when finding the total amount for simple interest.

Some students did not calculate the interest as required when calculating the final value for compound interest.

Calculations determining the interest paid and interest saved were generally not completed successfully.

**Question 9**

Students demonstrated a good understanding of superannuation. This was the best completed question of the Investment and Loans section.

Students were generally able to successfully state one assumption regarding superannuation; however, students found it challenging to explain the impact. Successful answers should specifically state a change, an increase or decrease, and then explain the potential impact of that specific change. The students who answered this successfully often described both the positive and negative impacts even though only one was required. The impact discussed must relate to the assumption stated. Stating multiple assumptions does not address the question appropriately and will not achieve additional marks.

Some students did not calculate the reduction of the contribution (‘how much less’) as required in the superannuation question.

Students who calculated the indexed value of his retirement withdrawal using the compound interest formula were more often correct than those who used their graphics calculator despite both methods being appropriate methods for a solution. The common error for those students who used their graphics calculator for inflation was not recognising that it compounded annually.

General Comments

Students appeared to relate well with the contexts of the topic.

Most students made a reasonable attempt at all questions, even if there were parts of questions that they did not attempt. The lead-in first parts of questions were generally attempted.

There was evidence that students were confidently using answers given in ‘show’ questions to re-enter a question where they had been unsuccessful in the parts leading up to the ‘show’ prompt. It is important to understand that when marking questions of this nature, students are able to continue with the answer they have obtained (given that it is similar) or the answer given in the question. Markers will follow through with either solution. When solutions are significantly different from the answer given, students should be encouraged to use the given answer for the subsequent parts of the question. Also, in ‘show’ questions some students work backwards using the answer as a starting point. Markers will also follow through these solutions and students will achieve full marks with correct mathematical thinking and calculations.

Questions requiring students to answer worded questions, describing unfamiliar situations, were most challenging for students. Students’ answers suggested they were unsure about what they were being asked to describe. Questions where students were asked to ‘explain’ their answer were often not well done and their answers did not specifically address the context of the question.

If any questions were not attempted, it was often the Investment and Loans questions. Students must continue to be encouraged to complete the examination in an order that allows them to maximise the marks achieved.

Students should be encouraged to carefully consider comments to ensure contradictions are not made in their explanations.