# Government of South Australia LogoSACE Board Logo2024 Specialist Mathematics Subject Assessment Advice

Overview

This subject assessment advice, based on the 2024 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. It provides information and advice regarding the assessment types, the application of the performance standards in school and external assessments, and the quality of student performance.

The Subject Renewal program has introduced changes for many subjects in 2025; these changes are detailed in the change log at the front of each subject outline. When reviewing the 2024 subject assessment advice, it is important to consider any updates to this subject to ensure the feedback in this document remains accurate.

# School Assessment

Overall comments

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

* uploading the SATs as a single scanned file rather than five or six separate files to improve efficiency of the moderation process and likewise for the teacher pack
* thoroughly checking that all grades entered in schools online are correct. Errors in entered grades cannot usually be fixed through the moderation process, particularly if the error means a change in the rank order of results
* ensuring the uploaded tasks are legible, all facing up (and not sideways), and remove blank pages, student notes and formula pages
* ensuring the uploaded tasks also have pages the same size and in colour so teacher marking, and comments are clearly distinguishable from student work
* using the same tasks where possible when combining with another school or schools to ensure standards are equitable. When combining classes across schools, teachers should be involved in moderation activities prior to up-loading materials for the actual moderation to ensure that the rank order of the students within the combined assessment group is appropriate.

SAT comments

* ensuring the uploaded student SATs have been clearly marked showing which mathematical calculations are fully or partially correct and which are incorrect is a *requirement of moderation*. Showing marks and totals is also helpful and appropriate
* preferably providing a summary of student results in each of the SATs at the start of the uploaded SATs file.

Investigation comments

* for investigations, teacher comments and clearly marked mathematical calculations are a *requirement of moderation*
* ensuring uploaded investigations are the final work and not the draft. However, a draft can be assessed and uploaded if a student does not submit a final response.

Assessment Type 1: Skills and Assessment Tasks (50%)

Students complete five or six skills and applications tasks. 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.

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:

* concepts and techniques
* reasoning and communication.

Teachers can elicit more successful responses by:

* ensuring a well-balanced set of SATs which provide opportunities for students to demonstrate learning across the range of grades incorporating both routine and complex questions
* ensuring the SAT is not too short in length or time to allow the student time to consider their responses for more complex questions and allow for enough routine questions so students can demonstrate their knowledge and understanding
* designing some complex questions to allow students to progress one step at a time through a process, using the ‘Show that …’ style of question
* *s*tructuring questions with multiple parts that begin with ‘access’ points to elicit C grade evidence and subsequently increase in complexity, with the potential to elicit A grade evidence
* providing a marks scheme and working space reflective of the cognitive demand of the question and showing the marks attained rather than a system of ticks and crosses which is often not clear to moderators
* providing students with appropriate feedback, including marks, to help them improve their work
* assessing conjecture and proof through this assessment type as they can be difficult to assess within a mathematical investigation
* please ensure that your LAP accurately indicates where RC5 is being assessed
* induction per se is not RC5, completing proofs using Mathematical Induction does not on its own achieve RC5. Students must be given the opportunity to form their OWN conjecture and to then prove it. Teachers may choose to assess this in Induction, for example by including a question of the form:

(a) Given the matrix  find (i)  (ii)  (iii) 

(b) On the basis of your answers to (a) make a conjecture about the matrix 

(c) Prove your conjecture using the principle of mathematical induction for all positive integers 

* referring closely to the key questions and key concepts in the subject outline when designing assessment tasks
* while including material that is outside the subject outline can be considered an extension
(e.g. Inequalities in Induction, Summation and Product notation in Induction, Euler’s form or exponential form of a complex number and more complex integration by substitution), it should not be included to the detriment of including content required to be known, such as polar form for example, in the summative SAT
* setting a variety of SATs that include limited questions drawn directly from past examinations. Schools can use a mid-year examination to provide students with a formative experience of examination style assessment; however, it is recommended that examinations are not included among the Assessment Type 1 SATs
* not marking crossed out work, as work the student has crossed out will not be marked in the final examination
* preferably not awarding half marks as these are not awarded in the final examination and can inflate results and student expectations
* making students fully aware of the capabilities of their graphics calculator so they can make informed choices as to when and where to use it in completing SATs, particularly in graph work
* providing clear and accurate feedback on the appropriate use of mathematical notation, with particular attention needed for questions using vectors and integration which were identified as more common problem areas during moderation and examination marking.

The more successful responses commonly:

* provided clear and logical reasoning with correct mathematical notation written down the pages and not across
* displayed evidence that aligned with the question requirements (e.g. hence, exact)
* provided solutions that were efficient and demonstrated clear, logical, and comprehensive understanding and interpretation of the question/problem
* used both algebraic and geometric approaches to solve problems in the topic’s Complex numbers and 3D Vectors
* showed all algebraic working by providing all relevant concept steps, particularly for the ‘Show that …’ style of question
* stated any theorems and/or properties that were being applied to support answers
* used mathematically correct notation, particularly in questions using vectors and integration
* used clear labelling with graph work, especially when multiple graphs on same set of axes was required
* labelled axes and scales of graphs correctly
* indicated in Argand diagrams when vectors drawn to represent complex numbers were equal in length or perpendicular or used dotted circles to indicate those equal lengths
* used the graphics calculator efficiently to draw both cartesian and parametric functions by plotting sufficient points, paying attention to correctly labelling and representing asymptotes and correctly showing shape and behaviour of curves near any asymptotes whether or not directed to do so
* paid close attention to all details given in questions and the detail required in answering by showing conceptual thinking in their responses no matter how simple
* included appropriate steps in applying algorithms and did not miss vital concept steps, especially in ‘Show that…” questions where the answer is given in the question
* paid close attention to the accuracy that was at times required e.g. 3 decimal places.

The less successful responses commonly:

* often did not attempt to answer questions, particularly more complex style questions
* displayed incorrect or inconsistent mathematical notation and/or limited communication of reasoning i.e. the solution did not successfully ‘flow’ to a logical end
* graphs not clearly labelled and incorrect scales
* included many arithmetic and algebraic mistakes that complicated the nature of the solutions (e.g. an error causing the student to have polynomials that did not factorise easily)
* do not follow instructions that directed the student to use a particular method such as “implicit differentiation” or to use a previous result, either by instructing students to use specified parts of the question or by using the word hence
* did not read questions carefully and clearly spent too much time on some, leaving no time to complete other questions so time management was generally poor
* lacked the appropriate detail; where several marks have been allocated, all relevant conceptual steps are required
* did not give answers to required level of accuracy e.g. 3 decimal places
* did not communicate a good knowledge of the algorithms covered by the course, often evident through incorrect application of techniques to solve questions or simply being left unanswered
* seemed unfamiliar with the capability of their graphics calculator.

Assessment Type 2: Mathematical Investigation (20%)

Students complete one mathematical investigation.

The subject of the investigation may be derived from one or more subtopics and should have *minimal* teacher direction. The task must afford students the opportunity to extend the investigation in an open-ended context. Students are encouraged to use a variety of mathematical (and other) software to enhance their investigation. It must be completed in a report format and must be no longer than 15 single sided A4 pages with minimum font size 10. Appendices may be used to support the report but are not part of the assessment decision unless they are part of the 15 pages. Teachers should provide feedback where appropriate on the suitability of the direction a student may take with their investigation, especially where the investigation topic was chosen by the student and provide feedback on one draft. In draft feedback the teacher may direct the student’s attention to errors but must not explicitly correct these for the student.

In 2025, the mathematical investigation must be no longer than 12 single-sided A4 pages.

Students provide evidence of their learning in relation to the following assessment design criteria:

* concepts and techniques
* reasoning and communication.

Teachers can elicit more successful responses by:

* ensuring that the format of the investigation allows for an open-ended exploration of a problem where the student can show the *development* and not just the *application* of mathematical models through individual choices, refinements/improvements with justification for their rationale
* providing clear annotation on the student work by the teacher to assist the moderator in confirming the school decision
* providing examples in the task sheet of what could be modelled, and structuring the investigation to encourage students to focus on different models, extend their interests and explore more complex models
* ensuring that the investigation is at an appropriate level of complexity, aligns well with the subject outline and does not limit student’s ability to achieve at the highest level
* not using question-and-answer style investigations, which limit student success ensuring the design of the task allows for and explicitly encourages the discussion of limitations and reasonableness of the modelling process
* not using tasks that are designed to look at the generation of curves or shapes by altering values within formulae, as it is not likely to result in individual work that is sufficiently open ended, nor does it allow for deep discussions concerning the reasonableness of solutions or limitations encountered
* not using types of investigations that may limit student success such as Bezier curves with a conjecture and proof that is not unique to the student, graphs of various rational functions, or graphs of other relations that may give altering shapes depending on values chosen. Some Bezier curve investigations may not reach a complex level of modelling and may limit the discussion of reasonableness and limitations
* using the most recently updated wine glass investigation on the SACE website which allows an open-ended approach after initially being directed. Students need to execute a significantly open-ended section to produce an investigation at a complex level. For example, the modelling of pathways with parametric curves provides no direction and allows students to develop their own modelling and as such is an excellent exemplar
* encouraging the correct use of notation and labelling of graphs, axes, scales etc.
* assisting students with unfamiliar software so that they can represent graphs etc. with appropriate information attached and using correct mathematical notation
* providing feedback through drafting and/or discussing the direction taken to ensure that what students plan to do will provide them with the opportunity to achieve at the higher-grade bands and the teacher may direct the student’s attention to errors but must not explicitly correct these for the student
* explaining clearly the page limit and the corresponding appropriate use of appendices. For example, important or initial mathematical calculations should be provided in the main body of the report; however, repetitions of a calculation with variations to the figures can be provided in the appendices with the results clearly provided in the main body of the investigation (within a table or using some other concise manner of presentation)
* not using investigations that have published solutions such as those provided by MASA to ensure that student work is unique and authentic. Examples of several such investigations not to use include the Tennis application, and De Moivre’s Theorem application, both which present as question/answer style.

The more successful responses commonly:

* were student driven and had a good proportion of their report devoted to individual undirected explorations and mathematical modelling based on student’s own choices from a real-world context
* provided detailed information in their introduction about the investigation and the context in the real world and wrote in report style with clearly communicated processes through the report linking their ideas and progress and used the full-page limit allowed
* included both mathematical calculations and the use of technology with a focus on interpretation and evaluation of models that had been developed and applied in the context chosen
* read as a complete report, with sentences of explanation, not a series of dot-point-like ‘answers’ in an ‘assignment’
* included detailed explanations of all algebra, choices of values, and graphical work produced
* included graphical representations appropriately labelled to enhance the discussion within the investigation
* successfully developed a modelling situation with clear explanation of the decisions made throughout the mathematical investigation justified with reference to the real-life context and/or cited research and references as appropriate. This included mathematical calculations for each stage of development of the model that were commensurate with the cognitive demands of Stage 2 Specialist Mathematics
* demonstrated understanding of the reasonableness of the mathematical results and the limitations of the modelling process used, with attempts to improve, expand on, and develop based on these reflections, as appropriate
* used appropriate mathematical software to enhance the quality of the investigation
* used mathematical notation, representations, and terminology appropriately and accurately
* effectively communicated mathematical ideas and reasoning to develop logical arguments
* used sub-headings throughout the investigation which led the assessor through each stage of development and were more comprehensive than a series of paragraphs, calculations, and graphical representations
* formatted their document so the mathematical notation flowed properly, and headings didn’t appear at the bottom of one page and the content at the top of the next page
* used appendices appropriately for repeated algebraic calculations to arrive at results.

The less successful responses commonly:

* demonstrate a poor understanding of the context of the modelling being investigated
* had a limited introduction to the investigation, giving the reader little insight into the nature of the problem and the investigation to be undertaken
* had limited supporting evidence of how the models were derived e.g. trial and error, Geogebra, researched and adapted
* provided little evidence of effective use of technology; the investigation is an ideal assessment to implement a range of technologies to represent and solve problems leading to the development of the model
* read like a series of dot-point-answers as if the student just listed responses to an assignment or worksheet
* did not provide explanations or reasoning for the decisions made throughout the investigation with little discussion around the reasonableness of results and limitations
* made poor use of notation and often did not fully identify graphs
* included little or no labelling of diagrams
* followed the early direction given, but did not achieve much more, often failing to attempt the open-ended part of the investigation or sometimes spending too much time on the directed part and too little on the open-ended part, so the end result was often incomplete
* often presented well under the page limit allowed, thereby limiting the depth of discussion possible
* appeared to not have submitted their draft to the teacher for feedback.

# External Assessment

Assessment Type 3: Examination (30%)

General

The examination consists of two booklets. Book one is worth 55 marks and Book two has longer questions with a total of 45 marks. As in past years the cohort who undertook the examination was made up of those students who knew their work and produced good to very good results, but there were a proportion of students who struggled to respond successfully.

Students often find Book one questions more accessible and many successfully displayed their knowledge well. Questions within Book two are sometimes found to be more difficult, but there were still many students with excellent work in both booklets.

General comments and advice worth stressing for students to be more successful:

* The ‘Show that …’ style of question requires students to show appropriate working, displaying all steps of logic, for maximum marks. The style of solution here should be approaching one side of the given information and working towards developing the other side. The two sides should not be used together.
* An ‘exact answer’ means the answer should be in rational or irrational form without approximations to decimal values.
* Students need to be reminded that if the answer is stated in the question, marks are awarded for providing the working steps needed to reach this answer.
* Knowledge of, and the use of, a graphics calculator is assumed. Rounding of values when required is to three significant figures unless stated otherwise in a question.
* Students should use correct notation throughout their working. Examples of common misuse are within questions involving vector notation and integration notation.
* Students should also be mindful of using the variables used in the question. For instance, if a function of  is stated then student responses should be in terms of  not  for example.
* Students should recognise that earlier parts of a question are often relevant to the later parts of a longer question. Some questions for instance may state ‘hence’ or ‘using part (a)(i)’ instructing students to follow on from previous work.
* Students should be aware of algebraic language. Some students do not use the brackets required to show a logical flow of their algebraic reasoning. This leads to errors in their mathematics.
* Students must set out mathematical induction proof appropriately to gain full marks.
* Students should ensure they answer a question on extra pages in the correct booklet. It is advisable that students indicate in the space for an answer if they are also using the extra page for more working. For example, “see page x”. The work on the extra pages must be labelled clearly.

Examination markers aim to award marks for evidence of student understanding in responding 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 their response should be considered by the marker.

If a student crosses out a response and then decides that it was the correct (or the 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 that the student wants to be considered and write, for example, “please mark this work”. Students do not need to rewrite their answers in this case unless the crossing out has rendered the response unreadable.

Specific comments for the questions within Booklets 1 and 2 follow:

Booklet 1

Question 1

Many students excelled in this question due to their thorough understanding of it:

1. Well done by many provided the knowledge of using conjugate pairs of roots was recognised and used to produce a quadratic factor. Some wrote the quadratic factor incorrectly as $z^{2}+6z+10$. Students are reminded to use the correct notation set up in the question and use the variable *z,* not *x*.
2. (i) and (ii) These parts are ‘show that’ style questions so appropriate working is required to gain the marks. Many students answered this part well.
3. Good knowledge of the graphics calculator was displayed in this question by many students.
4. This part allowed students to take different approaches to arrive at the factored form of the polynomial. Some less successful students chose to incorrectly use (z+1) from part (b)(ii) as a factor.

Question 2

Quite a few students found the final part of this question challenging but managed the initial parts well.

1. Showing the planes are not parallel requires considering the normal vectors to each plane and showing they are not a scalar multiple of each other or showing the cross product of the normals is not zero. Many students considered the actual planes not being a multiple of each other which is meaningless.
2. Students were required to show the row operation(s) to reduce this matrix, and many did that well, but clear working is necessary to establish the resulting parametric solution given.
3. The most successful students in this question showed clearly that the value of t = 2 in the line resulted in all the coordinates of the given point A.
4. Some students found this part challenging. The most successful students found the vector $\vec{AQ}$ and used this with the direction of the line to find the normal to the plane via a cross product. The subsequent equation of the plane required was then found. Some students tried to find the equation of the plane in vector form and were unsuccessful. It should be noted that finding the equation of a plane in vector form is not in the subject outline for this subject.

Question 3

Overall, this question was quite well done.

1. The most successful students knew the process of matrix multiplication. The second mark was not achieved by some students due to lack of detail in their working toward establishing the elements of the final matrix given.
2. The process of mathematical induction must follow a logically fluent set up. The proposition must be stated as P(n) for instance, then the first term must be trialled and shown true. Successful students used P(1) for their trial, but some inappropriately used P(3) from (a). Assuming P(k) and then testing P(k+1) are necessary steps along with the working displaying the use of the inductive step to achieve the (k+1)th term. Some students are omitting steps of logic in their working and are not awarded the inductive step mark. The final statement for an induction proof is used in conjunction with the statement of the proposition as well as correct mathematics.
3. Many students followed the direction of a “hence” statement and successfully used part (a) and the result of part (b). Less successful students made algebraic mistakes when collecting the terms to find -3a – (-2027a) = 2024a.

Question 4

Many students found this question challenging. Poor vector notation and lack of appropriate steps of logic cost some students marks.

1. (i) Poorly done overall due to many students not indicating that $\vec{ON}=\frac{1}{2} \vec{OB}$ to support their working in a ‘show that’ style question.

(ii) Many candidates were successful here.

1. The most successful students used correct vector notation and vector properties correctly. Some notation was very poor. Correct notation must be used. For instance, $a∙b$for the dot product(rather than, incorrectly, ***ab***) and $a∙a=\left|a\right|^{2}$ (rather than incorrectly $a^{2}$).
2. Correct notation in this question is also required for correct working within the question and for the ‘show that’ result to be found. The most successful students used correct notation and knew how to use cosine rule with vector lengths.
3. Many students were more successful in this question.

Question 5

Many students achieved well in this question.

1. Drawing a curve from the graphics calculator onto the page requires some care. Students who gained the 2 marks started the curve in an appropriate position and displayed the slow increase of the curve.
2. (i) Was well done by most students who understood the process of algebraically finding the inverse.

(ii) Finding the exact domain was sometimes challenging for students. Students needed to take note of the requirement for an exact value and for finding the x values (not the y values).

(iii) There were mixed responses in this question. Some students did not take heed of the domain and incorrectly included sections of the graph where $x<ln2$.

1. (i) This question was poorly done overall. The most successful students referred to the symmetry via reflection in the y = x line.

(ii) Many students successfully found the volume of the solid but need to be mindful of the requirement for the accuracy to 3 significant figures.

Question 6

Students who had a good grasp of complex numbers were able to gain success in this question.

1. (i) Most students were able to find the six solutions required although some incorrectly gave a negative value for the modulus.

(ii) Students could have approached this question in different ways. Any method chosen must clearly display the logical reasoning to result in the given statement. Some students did not explain choices made which led to poorly set out working.

1. (i) Again, it is required to show working and state reasoning rather than assuming values. For instance, there is a requirement to show reasoning for any angle used in the development of the area of the given triangle.

(ii) Very well-done question, using the fact that there are 6 triangles each with the area given in part (b)(i).

1. Many students were not successful in finding the value of k to be 216 or -216.

Question 7

1. The integration by parts was undertaken well by most students. The most successful students took care to show steps of working towards achieving the given expression on the right-hand side.
2. The calculation of the definite integral was very well done by many students who saw the connection to part (a).
3. The most successful students clearly labelled both branches of the new curve. The right-hand branch was sometimes not drawn by students or labelled. It is permitted to use colour if students wish to make their curves more obvious.
4. This question was difficult for many students. The requirement to double the area found in part (b) but also to use the negative of the integral was often missed by students. Many gave the answer as *ln*2 -1, instead of the correct answer of 1 - *ln*2.

Many students who gained success in the first booklet displayed the points stated in the general comments at the beginning of this report. They also had a sound grasp of the coursework and were able to communicate their thinking and knowledge of the concepts well.

Booklet 2

Question 8

1. Many students were able to sketch the parametric curve, but care must be taken to clearly show the start and end, and shape of the curve.
2. (i) and (ii) Some students mixed up responses to parts (i) and (ii). The first part was more easily approached using implicit differentiation, ensuring the derivative of the constant is zero. The second part was approached with more success although some students wrote the derivative incorrectly in the form of $\frac{dy}{dx}=\frac{x'(t)}{y'(t)}$ .
3. Mixed responses were seen here but the most successful students did show that the tangent to both curves is zero at the point P by considering the derivatives found in part (b).
4. The most common errors in student responses were the incorrect statement for the triangle inequality, or not using this rule in their answer, as well as some not showing the circumference is 2$π$ because the radius is 1 unit.
5. (i) Many students managed to progress through the mathematics to the step where, within the integral, the expression $\sqrt{2-2cost}$ resulted, but the final step of producing $\sqrt{4sin^{2}(\frac{t}{2})}$ illuded some to achieve the final “show that”. It was disappointing to see many students omitting the ‘dt’ in their integral notation.

(ii) Many students answered this question successfully, with most using their calculators.

Question 9

1. (i) The most successful students recognised the need for separation of variables to proceed through this question.

(ii) Many students found the required c value to be 0.3 but continuing on to find that $y\rightarrow \frac{10}{3}$ proved difficult for some.

1. Mixed responses were seen in this question with some students recognising part (a)(ii) to assist them in their drawing of a slope field. Care must be taken to follow slope field lines without crossing them.
2. Some excellent answers were seen in this question. The less successful students did not differentiate $y^{2}$ correctly with respect to t and omitted the $\frac{dy}{dt}$ term. This meant the required result was not possible.
3. Many students achieved the first mark awarded by finding $\frac{1}{2}+\frac{1}{5}e^{-0.5t}y=1$, but the rest of the algebra required to find $t=2ln2$ was difficult for many.

Question 10

1. (i) and (ii) Many students were successful in finding the $z\_{2}=0.6cis(\frac{ϑ}{2})$ but care must be taken when drawing this solution on the Argand plane with good indication of angle and length.
2. (i) Well done by many but indicating correct shading and position of the circle describing the set of complex numbers is important.

(ii) Similarly, the correct shading and drawing of a solid line for the set T is important.

1. (i)The most successful students used technology to find the integer value of n = 10. Reading the question carefully is important as some gave decimal approximations or did not consider the inequality sign.

(ii) It is important to read the “Hence” statement here and use the value for n found in part (c)(i).

(iii) (1) The most successful students recognised that “cartesian form” required the answer to be written as $w=0.901+0.0567i$ . It was also necessary to round the components to three significant figures (as all decimal approximations throughout the examination should be, unless specified otherwise).

 (2) Many students justified their answer in this question by considering the real part of *w* found in part (c)(iii) (1).

 (3) This last question was not as successfully completed as the previous question, with many students not considering the modulus of the complex number. That is, it was necessary to consider if $|w-1|$ is greater than 0.1 (the radius of the set S).

Overall students displayed good work in the second booklet, clearly gaining marks by knowing the content well and being able to apply it in the context of some complex sections of work.