2025 Specialist Mathematics Subject Assessment Advice

Overview

This subject assessment advice, based on the 2025 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.

School Assessment

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

- uploading the SATs as a single scanned file rather than multiple separate files to improve the efficiency of the moderation process; this also applies to 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 where they affect 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 that 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 uploading 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 are clearly marked, showing which mathematical calculations are fully correct, partially correct, or incorrect, as this is a requirement of moderation, preferably showing marks allocated and totals
- preferably providing a summary of student results in each SAT 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. Electronic technology, and up to one A4 sheet of handwritten notes (on one side only) may be used at the discretion of the teacher.

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 that students are no longer required to complete a SAT or part of it without the use of a calculator or notes
- 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
- structuring 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
- encouraging students to show all steps clearly and justifying reasoning, emphasising interpretation of results in context, not just numeric answers
- providing practice on graph sketching, noting key features and labelling of axes and appropriate use of the calculator to support the process
- providing a marks scheme and working space reflective of the cognitive demand of the question, and showing 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 these can be difficult to assess within a mathematical investigation
- ensuring the LAP accurately indicates where RC5 is being assessed
- ensuring that induction per se is not treated as RC5, as completing proofs using Mathematical Induction does not on its own, achieve RC5. Students must be given the opportunity to form their own conjecture and then prove it. Teachers may choose to assess this through induction, for example by including a question of the form:

  (a) given the matrix $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$ find (i) A^2 (ii) A^3 (iii) A^4.

  (b) on the basis of your answers to (a) make a conjecture about the matrix A^n.

  (c) prove your conjecture using the principle of mathematical induction for all positive integers n.
- 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 at the expense of 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 may 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 about when and where to use it in completing SATs, particularly in graph work where setting to y= or parametric mode is important
- providing clear and accurate feedback on the appropriate use of mathematical notation, with particular attention to questions involving 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 page 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 topics 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 the same set of axes were required
- correctly labelled axes and scales of graphs
- 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
- used incomplete or incorrect processes, e.g. Induction, modulus versus Argument, Integration by substitution, and Integration by parts
- displayed incorrect or inconsistent mathematical notation and/or limited communication of reasoning i.e. the solution did not successfully 'flow' to a logical end
- used graphs which were not clearly labelled and had 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)
- did not follow instructions that directed the student to use a particular method such as "implicit differentiation" or "integration by parts" 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 the 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 leaving questions unanswered
- seemed unfamiliar with the capabilities 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. The investigation report, excluding bibliography and appendices if used, must be a maximum of 12 A4 pages if written, or the equivalent in multimodal form. Appendices may be used to support the report but are not part of the assessment decision unless they are part of the 12 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.

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 individual 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 so as the class does not all produce the same results (e.g. as happens in conjecture proof style investigations)
- providing clear annotation on the student work by the teacher indicating whether mathematical calculations are correct in order 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, so that student work is individual, and students are not all getting the same results
- 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, and ensuring the design of the task allows for and explicitly encourages the discussion of limitations and reasonableness of the modelling process, i.e. refer to the three most recently updated exemplars provided on the SACE website
- not using tasks that are designed to look at the generation of curves or shapes by altering values within formulae, as these are not likely to result in individual work that is sufficiently open ended, nor do they allow for deep discussions concerning the reasonableness of solutions or limitations encountered
- not using older 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 that the teacher may direct the student's attention to errors but must not explicitly correct these for the student
- explaining clearly the 12-page (single-sided) 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). If students go over the allowed 12 pages except for appendices, the excessive length often indicates lack of conciseness and can impact clarity. Pages beyond 12 would not have formed part of the investigation for moderation and could negatively impact the final grade
- 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 of which present as question/answer style
- encouraging students who are using AI to reference its use.

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 students' own choices from a real-world context
- successfully developed a modelling situation, stating assumptions made and providing clear mathematical explanations for 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 and evaluations, as appropriate
- 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 12-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
- 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, which were summarised and presented in the main body of the investigation

The less successful responses commonly:

- had poor and unclear structure, often excluding discussions of reasonableness or conclusion and generally disorganised, i.e. not report format
- performed calculations but did not synthesise the results into a meaningful pattern or conclusion, focusing on algebraic calculations rather than using these results to develop and refine their models
- demonstrated 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, and sometimes presented it as a narrative rather than in report format
- had limited supporting evidence of how the models were derived, e.g. trial and error, GeoGebra, researched and adapted without valid reasoning
- 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 had 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, and mostly unconnected mathematical calculations evident in the work
- made poor use of notation and often did not fully identify graphs
- included little or no labelling of diagrams, and these were often not explained in context
- often had no consideration of limitations or assumptions due to real-world constraints, and errors were often ignored
- followed the early direction, if 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 12-page limit, thereby limiting the depth of discussion possible
- appeared to not have submitted their draft to the teacher for feedback, based on the quality of work presented for moderation.

External Assessment

Assessment Type 3: Examination

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 also a proportion of students who were unable+ to respond successfully.

Students often find book one questions more accessible and many successfully demonstrated 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 to approach one side of the given information and work 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.
- When undertaking problems involving integration by parts students should employ appropriate techniques using the approach outlined by the formula on the formula sheet.
- Students should also be mindful of using the variables used in the question. For instance, if a function of t is stated, then student responses should be in terms of t not x 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 proofs 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 writing, 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 achieved a good result for this question overall.

(a) Students had the opportunity to use technology for this question, and many did so correctly.

(b) This is a 'Show that' style question, so students were required to show their working clearly. Some undertook the chain rule appropriately. Some found $\frac{dV}{dh}$ and then used the property that

$$\frac{dV}{dt} = \frac{dV}{dh} \times \frac{dh}{dt}$$

(c) Most students were successful here if they followed instructions to answer to three significant figures and if they used the correct value: $\frac{dV}{dt} = 2$.

Question 2

This question was quite well done by many students. It must be noted that some students do not use appropriate integration notation. That is, omitting the 'dx' is not logically correct. It is also important to note that the question required integration by parts which must be approached correctly as shown by the formula on the formula sheet (in terms of f(x) and g(x) or in terms of u and v for example).

(a) Some students worked through this problem well, using the supplied information to assist them with an easier approach. Those who did not use this assistance sometimes found their work did not result in the required result. Most often this was due to the lack of brackets in their working.

(b) This question had mixed responses from students. Some did not use the correct formula (provided on the formula sheet), some had the bounds of the integral in the incorrect order, and some made substitution errors. It is pleasing to note that many recognised the requirement for an exact answer.

Question 3

Some students struggled with this routine question.

(a)(i) The most successful students used De Moivre's theorem to show that $\left(2cis\left(\frac{3\pi}{5}\right)\right)^5 = 2^5 cis(3\pi) = -32$.

This was the simplest approach.

(a)(ii) Successful attempts at this question displayed good knowledge of polar form, De Moivre's theorem and, since the results were given, appropriate setting out. The less successful students did not use brackets around the argument of the polar form, and some did not clearly identify how the given results were generated.

(b)(i) A variety of methods were on offer to the students: synthetic division, long division, or polynomial expansion. For one mark synthetic division or polynomial expansion was the most efficient and successful approach.

(b)(ii) Many students successfully employed the "hence" instruction and listed the correct solutions.

(c)(i) The most successful responses showed the angle required to be $\frac{2\pi}{5}$ and used the area of a triangle formula: $A = \frac{1}{2}ab\ sinC$.

(c)(ii) Not many students were successful with this last part of the question. Some students did not make the connection between the symmetry of solutions from (a)(ii) and the use of the double angle formula for sine.

Question 4

Many students made a good start with this question, although poor setting out of a proof and poor knowledge of notation was evident.

(a) Many students achieved well displaying good knowledge of the product rule of differentiation.

(b) Issues were evident in students' work for mathematical induction proofs:

a. The proposition P(n) or Pn should be rewritten if P(1), P(k) and P(k+1) notation is used further into the proof.

b. Stating "P(1) is true" needed justification along with the recognition of the resulting work in part (a).

c. The notation for P(k+1) was not often recognised as $\frac{d^{k+1}y}{dx^{k+1}} = \frac{d}{dx}\left(\frac{d^k y}{dx^k}\right)$. The inductive step may therefore follow from here.

d. The final statement is awarded only if the initial P(n) is stated as well as the algebraic process of the P(k+1) consideration is correctly using the assumed P(k) in the inductive step.

Question 5

The more successful students used correct vector notation and provided convincing evidence for 'show that' style responses.

(a) Notation issues were common here. The lack of recognition that the vector (cross) product of vectors is written as $\underset{\sim}{a} \times \underset{\sim}{a}$ and not $\underset{\sim}{a} \times \underset{\sim}{a}$ as $\underset{\sim}{a}^2$ was evident in many papers seen. Similarly with any other vector cross products (e.g. $\underset{\sim}{x} \times \underset{\sim}{y}$ as $\underset{\sim}{x}\underset{\sim}{y}$). Along with this, vectors require either the notation "~" (tilde) underneath or an arrow over the top of a lower-case symbol.

For this question it was a requirement to acknowledge that $\underset{\sim}{a} \times \underset{\sim}{a}$ and $\underset{\sim}{b} \times \underset{\sim}{b}$ result in the null vector of zero ($\underset{\sim}{o}$). It was also good practice to recognise that $\underset{\sim}{a} \times \underset{\sim}{b} = -\underset{\sim}{b} \times \underset{\sim}{a}$.

(b)(i) was very well done overall.

(b)(ii) Since this question is a 'show that' style, clear logic and preferably acknowledgement of part (a) was required.

(b)(iii) Clear logic again was required for this 'show that' question. Some students did not use brackets, which meant their work did not follow through to further lines of working, and some dropped the modulus notation.

(c) Many successful students found the vector (cross) product either using the calculator or an algorithm, and some successfully moved on to find the required area.

Question 6

This proved to be the most challenging question in the entire examination, as the concept of routine complex sets does not appear to be well understood by some students.

In parts (a), (b)(i) and (ii) the most successful students were able to draw the ray defined as $\arg z = \frac{\pi}{4}$ correctly from the origin (but not including the origin) and through (k, k). Following from this, the next two parts of (b) were routine using the knowledge of the right-angled trigonometry of the isosceles triangle with angles $\frac{\pi}{4}, \frac{\pi}{4}$ and $\frac{\pi}{2}$.

(c) The most successful response came from students who read the question carefully. Some supplied a Cartesian form of a circle rather than that in terms of C_n and z as required.

(d) This 'show that' style question required logical reasoning, which some students did quite successfully. The simplest approach was to show that the distance from the point (4, 0) to the complex number v is $\sqrt{10}$ which is less than 4.

(e) Different approaches were seen for this question. A similar approach to that taken in part (d) may have been used. The most successful students displayed good reasoning in their working towards finding n=3.

Question 7

This question offered opportunities for students to display good knowledge of functions and graphs and integration techniques. This combination of the course topic content is common, allowing complexity to arise with some initial routine work.

(a)(i) This 'show that' question was quite well done, provided brackets were employed for the trigonometric identity.

(a)(ii) The 'hence' and the 'show that' meant students were to use part (a)(i) as well as show evidence leading towards the given result of 5/24. The most successful students set up the integration correctly and showed the substitution of the bounds of integration well. However, some students did not use appropriate notation for the integration, leaving out the required 'dx' component of the integral.

(b) Sketching and labelling of the inverse onto the set of axes provided was quite well done, except for some not adhering to the restriction on x and therefore including arrows. Some students were not careful with their sketch, and some used non continuous lines.

(c) Many students successfully chose the correct response for this question.

(d) The most successful students recognised the symmetry within the given diagram and were able to bring in the integration from part (a)(ii).

For many students the first booklet provided opportunities for success in routine and complex parts. Those who were well prepared, and who had a good grasp across all aspects of the coursework, managed to display their knowledge and communicate their reasoning well.

Booklet 2

Booklet 2 offered students opportunities to display their knowledge in the areas of vectors, parametric curves, and vector calculus and differential equations. The most successful students used correct notation and clear, correct algebraic reasoning throughout their work.

Question 8

This vectors question gave students opportunities to gain marks with small steps leading towards bringing the entire problem together in the final parts.

(a)(i) The most appropriate answers were set out clearly with the substitution of the given point into the left-hand side of the plane to show that the right-hand side was found. However, many students set up their work with the left and right-hand sides equal, which is not logically valid.

(a)(ii) Many students stated the required result as a rule without any reasoning involved.

(b)(i) This question required using the result from (a)(ii) which was given. Often, the question was approached successfully.

(b)(ii) Some students confused the need to find a normal line with finding a plane, but the majority were successful in their response.

(b)(iii) The most successful approach by students was to substitute the parametric coordinates of the normal found in part (b)(ii) into the plane to find the value of the parameter, then use this value in all parametric coordinates of the normal line to gain the point B. Students who worked backwards using the given point B, often did not validate the value of the parameter in both the normal and the plane.

(c) Many students found the required plane had to be of the form $2x-y+z = \text{a constant}$, but finding the value of 35 for the constant using the ratios of the distances between parallel planes proved challenging for some students.

(d)(i) The requirement for this question was to recognise the use of the triangle inequality, and many students did make that statement.

(d)(ii) This question could be approached using the ratios set up by the previous work or by substituting the normal into plane 3. A mixed response was seen from students, but a common issue was arithmetic mistakes.

Question 9

This question brought vector calculus, graphing, and using trigonometric formulae together. Some candidates managed very well, but others struggled to show their reasoning clearly and accurately.

(a) For this 'show that' style question, students had to employ their knowledge of the double angle formulae: $\cos(2x) = 2\cos^2 x - 1$. The most successful students used this formula and displayed the logic required to show the development of the right-hand side.

(b) Good use of the graphics calculator and careful use of the correct scale assisted students to draw the required curve well. For the 3 marks it is worth spending the time to carefully establish endpoints for the given interval for the parameter and to find more points on the curve for a more accurate result.

(c)(i) This 'show that' style question required clear logical reasoning from students. The most successful responses did this well, but others merely wrote down the required result.

(c)(ii) The previous part of (c) allowed students to use the result to set up the formula for finding the arc length of the curve. Notation again was poor, with some students not using 'dt' with the integral. Many students managed the first step of the working, but some struggled with manipulating the trigonometric identity and constants to develop the result.

(d)(i) Many students found this question difficult. Often the connection to parts (a) and (c)(ii) was not recognised. Some students did manage to find that $l = 8a$ but only the successful students went further to establish that $k = 2$ using $l = k \times 4a$.

(d)(ii) This question was very well done by the majority of students.

Question 10

This final question led students through setting up to solve a differential equation. Some found the integration techniques required to solve the differential equation quite challenging, but many worked through to the end and successfully drew a solution curve as requested.

(a) This very simple differential equation was handled well by some candidates, but some did not see the routine approach required to set up to find the solution and find the constant. That is, some did not recognise

$$\int \frac{dA}{dt}\,dt = \int -\frac{1}{4}\frac{dX}{dt}\,dt$$

$$\therefore A = -\frac{1}{4}X + c$$

Following from here, students were required to show reasoning for c=2 when X=0.

(b) Some students successfully manipulated the algebra of $\frac{1}{3}\left(-\frac{1}{4}X+2\right)\left(-\frac{3}{4}X+3\right)$ to be expressed as the required $\frac{1}{16}(X-8)(X-4)$. The most successful approaches engaged correct use of brackets and correct arithmetic and algebra. Some students did not supply enough evidence and wrote the final result without logical reasoning to support their statement.

(c) The most successful responses were seen working from the given right-hand side to develop the left-hand side. Again, care must be taken with brackets, with some students ignoring their use and the obvious impact. For instance, some <u>incorrectly</u> wrote $\frac{1}{4}\left(\frac{1}{X-8}-\frac{1}{X-4}\right)$ as $\frac{1}{4}\left(\frac{X-4-X-8}{(X-8)(X-4)}\right)$.

(d)(i) This question would be considered complex, but the 'hence' requirement should have allowed students to use previous given results to get started. Some students made good progress with correct separation of variables and integration techniques required. Some poorly set out work involved the lack of integral signs, the lack of 'dX' and 'dt', and missing modulus signs. Some students progressed well and found the required result with thorough and well set out reasoning.

(d)(ii) The most successful students chose to start with the right-hand side and combine to one fraction to produce the required result for the left-hand side as it was stated in part (d)(i).

(d)(iii) Many students successfully stated the limiting value of X to be 4, whether this was by using (d)(ii) or the graph drawn in part (e).

(e) Most students drew an appropriate solution curve, but some did not display the asymptotic behaviour whilst some drew to the left of $t=1$ even though the question stated the curve "**starts**" at $t=1$.

Overall, students performed slightly better in booklet 1 than booklet 2. This is understandable given the nature of the increase in complexity as the exam questions progress through the two booklets. It is important to note that within complex questions there are always routine marks to be achieved, and the ability to progress through the question is aided by the 'show that' style parts within longer questions. This style of questioning, along with a balance of routine and complex questions, is recommended at the school level so that students may produce their best reasoning and communication of their knowledge in the school assessment, as well as in the external assessment.

Students should be aware and take heed of the general comments at the commencement of this section on the Assessment Type 3.