# Government of South Australia LogoSACE Board Logo2024 Mathematical Methods 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

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

* thoroughly checking that all grades entered in Schools Online are correct
* completing performance standards records (PSRs) consistently for all relevant performance standards for all students in the moderation sample. If a performance standard is present in the learning and assessment plan (LAP), it must be indicated in the PSR unless it is removed for all students with rationale provided in the Addendum section of the LAP.
* ensuring the uploaded files are a reasonable scan quality, the work has the correct orientation, and blank pages and student notes have been removed
* uploading all skills and application tasks (SATs) as a single scanned file for ease of moderation
* preferably providing a summary of student results in each of the SATs on the first page of the uploaded SATs file
* filling in the variation form if a student did not complete one or more skills and applications tasks or mathematical investigation(s)
* providing clearly marked student work showing which mathematical calculations are fully or partially correct and which are incorrect as a requirement of moderation. Showing marks and totals for SATs is also helpful
* ensuring the application of the subject adjustments in removing a skills and applications task is restricted to the entire class having the same task removed. It is not appropriate for teachers to allow removal of the SAT with the lowest score for each student.

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

Students complete five or six skills and application tasks 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.

In 2025, the requirement for the equivalent of one task to be undertaken without the use of either a calculator or notes has been removed.

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:

* using varied assessment questions that provide a mix of routine and complex problems to assess a range of skills and understanding
* avoiding the use of questions from past examinations and textbooks, as these provide limited opportunities for authentic student engagement
* providing *multiple* opportunities for:
	+ contextual interpretation of results
	+ assessment of the reasonableness of results
	+ demonstration of conjecture development and proof
* using appropriate verbs, such as state, explain, and interpret to guide students to form an appropriate response
* providing students with axes and grids when asking them to sketch graphs.

The more successful responses commonly:

* demonstrated clear understanding and logical steps in problem-solving
* included appropriate working for ‘show’ type questions
* used technology appropriately, using the space allocated proportionately to the marks allocated
* responded well to questions that allowed for contextual interpretation and reasoning
* followed the structure of questions that provided scaffolding towards complex mathematical reasoning, leveraging results of earlier parts of questions to answer subsequent parts.

The less successful responses commonly:

* showed a reliance on routine processes without deeper contextual understanding
* left questions blank, indicating a lack of familiarity with foundational concepts
* failed to annotate or label graphs properly, leading to contextual misunderstandings
* provided a decimal approximation instead of presenting the exact solution as requested
* did not effectively use technology when appropriate and instead applied algebraic techniques.

Assessment Type 2: Mathematical Investigation (20%)

Students complete one mathematical investigation with minimal teacher direction. The task must afford students the opportunity to extend the investigation in an open-ended context. The task should be written in a format that allows the student to conduct their own open-ended investigation. It must be completed in report format (if written) and must be no longer than 15 single-sided A4 pages. Appendices should be used for repetitive calculations only.

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:

* providing clear entry points that demonstrate appropriate connections to real-world contexts, application of models to find solutions, and interpretation of results in the context of the problem
* reducing over-scaffolding to allow students to explore and develop models in their own context
* designing tasks that encourage students to link mathematical techniques to real-world contexts that will allow them to demonstrate meaningful application and interpretation of results
* encouraging students to demonstrate clear reasoning processes in mathematical proofs and model development
* providing opportunities for open-ended investigation that require students to demonstrate the refinement and evaluation of mathematical models
* encouraging students to justify choices made throughout their investigation, particularly in relation to parameter choices for mathematical models
* ensuring tasks allow for differentiation between student responses, avoiding tasks that inherently lead to uniform results or mathematical processes:
	+ The mathematical investigation on mouthwash is unsuitable for the current course. Teachers who continue using this investigation disadvantage students because it lacks opportunities for upper-grade achievements.
	+ A new mathematical investigation investigating areas of paper triangles also disadvantaged students as the complexity of the mathematics was limited, and additional paper sizes are a scalar multiple of each other, thus resulting in a repetitive process with little diversity in student outcomes.
* ensuring tasks adequately address the content within the subject outline, avoiding tasks that require substantial application of mathematical techniques covered in other courses:
	+ Tasks related to volumes of revolution require knowledge and understanding that should be assessed in the Specialist Mathematics course.
	+ Tasks heavily reliant on regression modelling, particularly using technology, do not provide students with the opportunity to demonstrate the mathematical techniques covered in the course.

The more successful responses commonly:

* demonstrated a connection between mathematical results, real-world implications, and applications
* used effective notation and terminology, such as labelling of graphs and consistent and accurate use of mathematical language
* included detailed model development and refinement processes when creating, testing, and improving mathematical models
* presented clear and structured mathematical reasoning when deriving mathematical models or completing mathematical proofs
* leveraged technology effectively to support calculations and provide graphical representation
* identified and discussed limitations of models by providing insightful and specific contextual critiques
* made effective use of graphs and labels to communicate findings visually
* displayed connections between different parts of tasks, leveraging earlier findings in later sections.

*The less successful responses commonly:*

* relied heavily on scaffolding, failing to investigate beyond the prescribed steps of the task
* replicated examples without innovation or personal insight
* lacked contextual connections to meaningful real-world contexts
* presented findings without an understanding of the broader contextual implications
* skipped steps in mathematical reasoning, jumping to conclusions or lacking intermediate steps in algebraic processes
* misused notation or lacked clear labelling in graphs
* neglected to support their mathematical conclusions using graphical evidence
* relied on proofs that are easily accessible through textbooks or online
* overlooked the limitations of their mathematical models, ignoring or minimally addressing the assumptions or constraints of the models and the limitations of the findings.

# External Assessment

Assessment Type 3: Examination

The markers of the examination endeavour to ensure students are awarded marks for evidence of understanding in responding to questions wherever possible; however, the following dot points are given below to allow students to achieve improved results overall more consistently. It’s worth noting that several of the dot points listed below have been listed previously for past examinations; however, they are listed again as the examination markers continue to unfortunately see students not gain marks that they were seemingly capable of.

When completing their examination, students should:

* not 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
* clearly let markers know if they complete a question on one of the blank pages available to ensure that it is considered as a possible response to a question
* pay closer attention to the wording of questions. Words or phrases such as ‘exact’, ‘hence’, ‘show’, or ‘using an algebraic process’ are used to help guide a student’s approach in finding a solution
* ensure that their answer makes sense in the context of the problem. In instances where a trivial error leads to an unrealistic answer, a mark may be awarded if the student shows recognition (via comment) of a likely error in their method. An example of an unrealistic answer would be when calculating a probability through an integral, resulting in a value that is greater than
* take greater note of the allocated marks and space provided in a question to determine if they can use technology or simply state the answer (rather than show any mathematical process)
* understand that even if they do not successfully solve one part of a question, they can generally continue to attempt to solve the following sections. Great care is taken during the writing process to allow multiple entry points into questions wherever possible. Where a student requires a previous answer which they were unable to find, to continue with the next part of the question, they are encouraged to ‘make up’ a reasonable result and use this to continue with all future parts for which it is relevant
* be more careful when rounding numbers appropriately. It is an expectation of the course that answers are given to three significant figures (unless otherwise stated). To not unfairly penalise a student multiple times throughout both booklets, the examination writing team identify a specific question and only penalise rounding errors there
* sketch graphs more carefully using a pencil. Students should take note of the key aspects of the graph they wish to plot and ensure that they are accurately plotted. These include shape, axes intercepts, intersections with the graphs of other functions, critical points (for example turning points), asymptotes, and the end points of functions on a domain
* not make definitive statements about the population parameter when performing analysis using a confidence interval. Although it is possible to say ‘yes’ when asked if a given ‘claim’ can be supported (with % confidence) under correct conditions, it cannot be definitively stated that the population parameter has increased, decreased, or not changed.

Question 1

It was noted that the absence of a purely algebraic calculus question to begin the exam this year was unexpected for many students. However, this question, which focused on the normal distribution (with no context) and the distribution of sample means, for the most part was well completed by students. As with past exams, students continue to find it challenging to accurately draw graphs. On average, students scored 7 out of the 9 marks on offer, with most marks being lost when sketching the distribution of in Part (d)(ii).

The more successful responses commonly:

* used technology to calculate the relevant probabilities and values in Part (a) and Part (b)
* correctly implemented the rules for the distribution of when calculating its mean and standard deviation in Part (d)(i)
* used a *pencil* to draw a symmetrical bell-shaped curve in Part (d)(ii) that:
	+ was centred about the mean
	+ had a reduced standard deviation (i.e. ‘thinner’)
	+ accounted for area remaining unchanged with the smaller standard deviation (i.e. taller).

Note: A choice was made to be rather lenient with the marking of this graph; however, a correct graph of the probability density function for should have been twice as tall at its centre (in comparison to ) and should have approximately ‘reached’ the -axis by and (i.e. ).

The less successful responses commonly:

* incorrectly calculated instead of the required in Part (a)(ii)
* did not see that Figure 1 and Parts (c) and (d) related to Parts (a) and (b). In this case, students seemed to think the questions on page 3 of Booklet 1 were separate to those on page 2 of Booklet 1
* filled in the boxes requested in Part (c) with -scores
* found the distribution for the sample sums, i.e. in Part (d)(i) instead of the required . It was hoped that any student who made this error would have self-corrected their mistake when they were unable to accurately plot its probability density function on Figure 1.

Question 2

This integral calculus question involving kinematics was generally well completed by students, with approximately 60% of students achieving 6 or more out of the 9 marks on offer. This question in particular rewarded students who read the question carefully and hence optimised their method in finding a correct solution through the use of technology.

The more successful responses commonly:

* used technology to quickly find solutions to Part (a), Part (b)(ii), and Part (c), and the calculation of the distance travelled by Car B in Part (e)
* showed clear and logical steps to reach the given results in Part (b)(i). As this is a ‘show’ style question, the student must demonstrate sufficient steps
* used a *pencil* to draw an accurate graph of in Part (c), taking note of the aspects of the graph (as outlined in the introduction). In this case, the graph should be concave up, pass through the origin, intersect the graph of at approximately , and reach a left most coordinate of approximately . Students are encouraged to set up their domain and range on their graphics calculator to match the axes provided, in conjunction with plotting both and in their calculator at the same time to see how they interact.

The less successful responses commonly:

* wrote the inequality in Part (d) the wrong way around (i.e. instead of )
* attempted to solve Part (e) using ill-constructed logic or without any mathematical justification. Some examples of incorrect responses were:
	+ car A travelled the furthest as it was going the fastest at the end
	+ car B travelled the furthest as it was going faster for longer.

It’s worth noting that difference in the distance travelled by the two cars was small enough to not allow a purely visual argument based on the graphs of and in Figure 2; instead, algebraic evidence was required.

Question 3

This differential calculus question involving logarithms started with some very routine questions; however, later parts required careful reading and thought. Students were generally successful in the first two parts, but often found it challenging to find the correct value of in Part (c) and use this value to state the appropriate transformation. Data suggests that students found this question more challenging; however, despite this, more than one quarter of students achieved full marks.

The more successful responses commonly:

* showed good knowledge of the derivative rules in Part (a) and Part (c)
* implemented a clear and correct process in Part (c) to find the value of involving the derivative of and their answer to Part (b)
* took into account the ‘hence or otherwise’ stated in Part (d) to help realise that the requested transformation relates to the answer of Part (c), and not directly to the 2 units stated in the text preceding Part (c).

The less successful responses commonly:

* misinterpreted the question in Part (c) as a result of not carefully reading the paragraph preceding Figure 4, which indicated that these were the graphs of the derivative and not the original function
* used vague wording such as ‘stretched’ (still marked as correct) or incorrect terminology such as ‘increased amplitude’ when describing the requested transformation in Part (d). Students are encouraged to become more familiar with concise terminology to better answer this type of question. In this case it was a ‘vertical dilation about the -axis by a scale factor of ’.

Question 4

Although visually this question looked rather intimidating at first sight, it contained many routine concepts such as the calculation of a confidence interval using technology and basic binomial calculations. Although the application of the binomial distribution in the later parts of the question was set in a slightly less routine scenario, students performed well in this question, with approximately 50% of students earning 75% or more of the marks on offer.

The more successful responses commonly:

* used technology to calculate the limits of the confidence interval in Part (a)(i) and the requested probabilities in Part (c)(ii)
* correctly interpreted the word ‘contradict’ in Part (a)(ii) to tick ‘yes’ stating an appropriate justification in Part (a)(iii) (i.e. as is outside/above the confidence interval)
* used a well-structured ‘trial and error’ approach to quickly solve Part (d). To achieve all marks on offer, when using a ‘trial and error’ approach, students must have shown:
	+ a probability relating to the largest value of which does not satisfy the constraint (i.e. when , which is less than the desired )
	+ a probability relating to the smallest value of which does satisfy the constraint (i.e. when , which is greater than the desired )
	+ a clear choice that the minimum number is hence .

The students who used a more algebraic approach often encountered errors due to its complexity. This was particularly evidenced when students used an inequality throughout (as the inequality ‘swaps direction’ when dividing by [as this is a negative number]).

The less successful responses commonly:

* wrote the mean and standard deviation of in the boxes supplied in Part (c)(i). As this is a binomial distribution, the required parameters are (the number of trials) and (the probability of success). It became clear to the markers that students were not familiar with this notation, as despite errors in writing these parameters in Part (c)(i), the probabilities that followed in Part (c)(ii) were correct
* incorrectly considered the value of to be in Part (c) and (d) (taken from the confidence level of the given intervals). It was hoped that any student who made this mistake would have self-corrected when many of the calculated probabilities that followed were either or
* did not read question Part (d) correctly, instead using the sample size formula (which is no longer directly stated in the curriculum) to attempt to find a solution.

Question 5

The first principles question focused on a relatively routine function that was attempted well by students. Those well versed in this aspect of the curriculum did well, with 55% of all students earning full marks and only 27% earning 2 marks or fewer.

The more successful responses commonly:

* used correct limit notation throughout, ensuring that once using the formula
 there was a ‘limit’ for all lines of working with a , and no ‘limit’ once tends towards zero
* showed clear steps of logic in Part (a). As can be easily found using the quotient rule, the onus is on the student to show appropriate working in their solution. Important steps in this case that students should include are:
	+ correct substitution of and into
	+ evidence of a correct common denominator of the functions and
	+ clear cancellation of terms in the numerator and the cancellation of (best done over two separate lines)
	+ clear implementation of the limit to find
* checked their answer to Part (a) using the product rule
* used technology to find the answer to Part (b) (even when Part (a) was not completed).

The less successful responses commonly:

* made algebraic errors in simplifying , such as:
	+ being unable to place and on a common denominator, or finding an incorrect denominator
	+ not carrying the negative through the second term of the numerator
	+ inconsistent lines of working
* did not read question Part (b) correctly, instead finding the equation of the tangent.

Question 6

This question involved a probability density function set within a context. Additionally, as the function was of the form , once integrated, understanding of natural logarithms and the associated laws was needed to successfully solve questions. Students were required to find solutions using algebraic processes and technology and interpret their answers within the context given. In the final section of the question, a confidence interval for the mean was calculated and used to justify if the student would support a given claim with % confidence. Among the questions in Booklet 1, this question appeared to be particularly challenging for students, as it had the lowest percentage of marks gained with only 30% of students achieving 10 or more of the 12 marks available.

The more successful responses commonly:

* showed clear and logical steps to reach the given results in Part (a) and Part (c). This included clear evidence that the rule was used in Part (a), and that the integral was found before substituting in and in Part (c)
* correctly interpreted the value calculated in Part (b)(i) in their answer to Part (b)(ii). Students were required to address that it was both a probability and to link the bounds of the integral to the context of the question (i.e. the net weight of sand in a randomly selected bag is between and grams)
* made a clear statement of ‘No’, followed by a brief justification in Part (d)(ii). By being brief in their justification, it reduced the possibility of a student contradicting themselves or making an incorrect statement
* clearly referenced the correct parameter of interest in Part (d)(ii) (i.e. the given mean in Part (c)). Students who calculated a decimal representation of (correct to three significant figures) were more likely to successfully answer this question.

The less successful responses commonly:

* struggled to link the properties of a probability density function (i.e. for ) to construct an appropriate method to find
* incorrectly entered the integral statement provided in Part (b)(i) into their calculator. It was hoped that students who entered the denominator without the given brackets would have self-corrected their answer due to the answer being greater than , further to this error, if they had a value greater than in Part (b)(i), students could not get Part (b)(ii) correct when interpreting this value as a probability without commenting they understood their answer was not valid
* did not cancel the ’s in the integral for the mean of in Part (c) before integrating resulting in errors
* used incorrect notation in their confidence interval in Part (d)(i) such as , , or rather than the required or
* incorrectly interpreted their confidence interval from Part (d)(i) in relation to the companies claim in Part (d)(ii). Some examples of incorrect interpretations resulted from:
	+ referencing the wrong value to justify their claim (i.e. (the sample mean) instead of given in Part (c)), or making only a vague reference to ‘the mean’
	+ responding with a ‘yes’ thought to be based on the value stated in the claim being inside the confidence interval. The recurring problem lies in the misconception among many students that if the given value is ‘inside’ the confidence interval, it implies the claim is supported, whereas ‘outside’ the confidence interval implies that the claim is not supported. This is not correct
	+ responding with a vague statement that was not a clear ‘yes’ or ‘no’
	+ following a correct response of ‘no’ with a statement that was too definitive. For example, ‘No, the mean net weight of sand in the bags is more than .

Question 7

Although early parts of this question involved the routine concept of finding the equation of a tangent to a function, it shifted into a conjecture style question involving the chain rule worth a considerable number of marks. Students should be ready for a conjecture style question and familiar with their structure as they have been a regular feature in Mathematical Methods examinations. As the complexity increased in the final part of the question, many students lost marks, often as a result of confusing the constant with the variable . The mean number of marks achieved by students was approximately 6.06 out of the 10 marks available.

The more successful responses commonly:

* expressed and in index form (i.e. , ) before finding their derivatives in Part (a) and Part (d). Some students attempted to use the quotient rule for both of these questions; however, this increased the likelihood of errors
* implemented one among several correct algebraic methods to correctly find the equation of the tangent in Part (a) and Part (d), showing clear substitution of the coordinate and the corresponding slope. Methods which found the equation of the tangent in general form were of advantage in this question as there were less fractions and the -intercept could be easily found
* expressed each of the given -coordinates of the -intercepts in Table 1 on page 3 of Booklet 2 as a fraction with a denominator of to match the other entries (i.e. ). This helped with the pattern spotting required in Part (c) and allowed them to write the requested conjecture in simplest form.

The less successful responses commonly:

* found the -intercept in Part (b)
* expressed the conjecture in Part (c) in a convoluted form clearly taken from their (often attempted) solutions for Part (d), or expressed the pattern too vaguely in words, writing sentences such as ‘the -coordinate of the -intercept increases by each time’. Although this is indeed a correct statement, it does not connect the -intercept to the value of .
* made errors in Part (d) as a result of the challenging algebra. These included but were not limited to:
	+ not treating as a constant when differentiating
	+ incorrectly expressing the fraction as
	+ committing the ‘age old’ mistake of expanding the denominator of the derivative from
	+ incorrectly setting , rather than finding the equation of the tangent
	+ confusing the constant with the variable
	+ setting (rather than )
	+ not setting in their derivative function; hence, when it was used to find the tangent, a non-linear function was created (i.e. if , therefore )

Much effort was made to allow students to achieve follow-through marks for all remaining sections of the question after they made an error, and students were still able to achieve the final mark if they commented that their result did not match their conjecture stated in Part (c). Although in this question the derivative in Part (d) increased in complexity to involve the chain rule (in comparison to the simpler derivative in Part (a)), students are reminded that the process required to prove their conjecture, more often than not, is present in earlier parts of the question. Several markers also commented that many students were able to successfully master the more challenging conjecture, but their tangent equation found in Part (a) contained errors.

* showed their conjecture worked for (or another number not in the table). Unfortunately, this only shows that it works for this value and does not prove it for all non-negative integers.

Question 8

This question was a ‘twist’ in the conventional rate-in/rate-out of a closed system question. Rather than supply the functions, information was presented in both graphical form and a table. The second part of the question transitioned into a probability table and a question involving distribution of the sum of vehicles using a normal distribution. Students seemingly engaged well with this question, and it had the highest percentage of marks achieved for any question on average in Booklet 2, with 30% achieving 10 or more marks of the 12 on offer.

The more successful responses commonly:

* resulted from careful reading of the information presented on page 4 of Booklet 2, leading to a good understanding of the context of the question. This allowed them to correctly identify the requested information in Part (a)
* correctly completed the table in Part (b)(i) and created a correct equation in Part (b)(ii) based on these values
* identified that Part (b)(iii) related to the sum or average of the weights of vehicles ( or ) taken from the given value in Part (a)(iii) when calculating the requested probability. Many students did not take note of the refence to the ‘central limit theorem’ and hence, incorrectly calculated the probability of (one vehicle) being greater than tonnes
* made the appropriate conclusion as to whether the engineers would be concerned based on their correct (or otherwise) probability calculated in Part (b)(iii).

The less successful responses commonly:

* made errors in the interpretation of . Some common errors included:
	+ interpreting as the number of vehicles rather than a rate of vehicles
	+ interpreting the in as covering all of the first hours, rather than at hours after midnight
	+ writing ‘at ’ rather than an appropriate link to the context of the question
	+ using a standardised interpretation of a rate function that did not apply to this context.
* had two values listed in Part (a)(ii)(1) (i.e. and ) for each of the local maximums of
* wrote for Part (a)(iii), which was based on the global maximum of rather than the intersection of and
* did not check that their expected value in Part (b)(ii) matched the given value if their table contained errors
* used the inverse normal menu of their calculator in Part (b)(iii). Although there is a correct solution possible using this method, it is less intuitive than simply finding the probability, and hence often led to errors.

Question 9

Despite the routine nature of the concepts addressed in this question (i.e. stationary point, 𝑦-coordinate of this stationary point), it represented one of the more sophisticated algebraic challenges in recent examinations, rewarding students who demonstrated precision and ingenuity in their algebraic solutions. However, across the board, students struggled with this complexity, especially in Part (b)(ii)(1). Disappointingly, many students made no attempt to re-enter the problem in Part (b)(ii)(1) and Part (b)(ii)(2) despite the results of preceding questions been given. Except for the last question, this question had the lowest percentage of marks achieved, being approximately 41%.

The more successful responses commonly:

* used technology to quickly find the -coordinate of the points requested in Table 4 for Part (a).
* found the -coordinate of the stationary point requested in Part (b)(i) through a careful algebraic process. Although there were several correct methods in finding this -coordinate, initially students needed to:
	+ find in terms of and
	+ set to be equal to zero.

After this point the methods of students varied. Some examples of correct processes are:

* + ‘taking out’ a factor of or dividing both sides by (as it is non-zero) to get the exponent of into a desired form
	+ using natural logarithms carefully to remove all indices
	+ ‘taking out’ a factor of in the expression .

Some students in this question ended up with variation of the requested answer (i.e. ), which did not receive full marks without evidence of process to match the given form. Also, markers observed that many students manipulated equations of the form to become , which although correct and received the marks allocated, it is seemingly derived from an incorrect application of the rules of logarithms.

* found the -coordinate of the stationary point requested in Part (b)(ii)(1) through a careful algebraic process. Although there were several correct methods in finding this -coordinate initially students needed to:
	+ substitute in the given -value from Part (b)(i) into

After this point the methods of students varied. One possible example of a correct process is:

* + placing the coefficients of the exponents of each of the terms with base into the exponent of the argument of the natural logarithm (introduced through the substitution of the -cooridnate). This allowed for the correct removal of and the natural logarithm in each term:

i.e.

* + ‘taking out’ a factor of from both terms with evidence that the index of the first term became

i.e. (noting the index , which was often initially expressed as )

* + expressing the remaining factor of on a common demoninator
	+ ‘taking out’ a factor of a from both terms.
* used the factors of the given -coordinate in Part (b)(ii)(1) to construct a concise argument. The optimal approach was to use the fact that as for all positive values of , in order for the -coordinate to be positive. This inequality could then be easily manipulated to find an inequality for the requested values of .

The less successful responses commonly:

* missed the negative in the -coordinate of point in Part (a)
* struggled with the algebraic rigor of Part (b)(i) and Part (b)(ii)(1). Some common errors included:
	+ incorrect application of the rules of logarithms
	+ incorrect factorisation
	+ incorrect index laws
* attempted to reverse engineer the solutions using the given results in Part (b)(i) and Part (b)(ii)(1). Although this method is a valuable skill in complex questions of this type, often it was clear to markers that the student was lacking the knowledge skills and understanding required to achieve all marks.
* included the in their domain for in Part (b)(ii)(2) (i.e. instead of the correct ).

Question 10

This final question borrowed from several topics of the course outline to create a unique question with unfamiliar processes involving integrals. The functions , and (which included both exponentials and trigonometric aspects) were differentiated and used to find the exact value of a requested area. The traditional approach of ‘differentiate, hence integrate’ was not used; instead, students needed to note the relationship between each function and its integral. Although initially thought to be more challenging due to its unfamiliar processes than the challenging algebraic manipulation in Question 9, many students achieved success in this question. Overall, approximately half of all students achieved 4 or more of the 12 marks on offer.

The more successful responses commonly:

* used clear and logical algebraic processes to find the values of that satisfy the equations in Part (a) and Part (b)(ii). Some common steps that led to success were:
	+ removing a factor of from both sides of the equation (as is non-zero)
	+ manipulating the equation to be equal to zero before ‘taking out’ a common factor of

Note: as all parts of this question had a domain of (and all trigonometric functions had an argument of ) there was no expectation to reference to ‘ where ’. Hence after algebraic manipulation all trigonometric equations could be solved using inspection if students had a good knowledge of the unit circle

* took note of the ‘use Part (a) and Part (b)(ii)’ in Part (c) to construct an appropriate answer. Students who only commented on properties of the graph in Figure 10 could not earn the mark here
* used concise and clear steps in finding the exact difference in area in Part (d). The best answers from students often:
	+ wrote an integral expression without any reference to the right most intersection point of and . Due to properties of integrals a statement of finds the requested difference in area
	+ did not create separate integrals for region and region . Although it was possible to reach the requested exact answer, most attempts of with the split regions normally resulted in errors or a non-exact area being found
	+ didn’t substitute the equations of the functions into , and until much later in the question. For example,
	+ showed clear evidence of substitution, using the fact that (from earlier parts of the question) to quickly simplify the expression.

The less successful responses commonly:

* relied too heavily on technology to solve equations in Part (a) and Part (b)(ii)
* used incorrect logarithm rules, often finding the correct solution based on an incorrect process. A common solution containing incorrect steps in Part (a) was of the form: , (incorrect application of taking the natural logarithm of each side), , …)
* made errors in implementing the product rule in Part (b)(i) or didn’t show clear substitution of (or similar) to achieve all marks
* incorrectly simplified the equation to or showed no evidence of null factor law in Part (b)(ii)
* misread the question as rather than the required in Part (b)(ii)
* did not list all solutions in Part (b)(ii), with many students missing the
* did not take note of the ‘exact’ or ‘use an algebraic approach’ stated in Part (d), but instead, merely used technology to find the difference in area as (correct to three significant figures) rather than the required .