Assessment Report

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

New Zealand Scholarship Calculus 2023

Performance Standard 93202

General commentary

This year's examination had a good balance of content covering Level 8 of the New Zealand Curriculum, giving enough opportunity for able students to display their skills and understanding across a wide range of its strands. The paper also included enough rigour to identify the top candidates, the very top demonstrating truly admirable mathematics.

The move to four questions appeared to be a welcome change. It allowed candidates to focus their time better across the paper and, possibly as a result, all questions were answered equally well. However, it was frustrating to see many candidates score zero, despite each question including at least one very simple sub-part, which would not have been out of place in a regular Level 3 NCEA paper.

Candidates achieving Scholarship were able to apply their knowledge and skills to problems in unfamiliar contexts, and their proficiency in algebra allowed them to rearrange and solve complex equations. These candidates were also comfortable working with expressions in exact form. Students who were unsuccessful typically demonstrated poor algebra skills, made careless errors, included solutions that were nonsensical in their responses, and appeared to rely heavily on a graphical calculator to "solve" problems. Candidates would benefit in gaining confidence from practising past Scholarship questions under exam conditions.

As in previous years, it is important to stress that the Scholarship examination assesses the breadth of the curriculum and so it is not strictly limited to a selection of the Achievement Standards. However, students with a strong grasp of the three externals standards, conic sections, and trigonometry should have found much of this examination accessible.

Report on performance standard

Candidates who were awarded Scholarship with **Outstanding Performance** commonly:

- showed clear communication, setting out their solutions in an elegant, logical manner, including diagrams where appropriate to introduce variables
- displayed a high level of abstract thinking, and a thorough understanding of the curriculum
- found quick ways to solve problems, e.g. using symmetry to generalise the coordinates in Question One (a) and implicit differentiation to differentiate the equation formed in Question Three (b)
- checked that their solutions made sense and recognised when other solutions existed, e.g. Question One (b)
- persevered through lines of algebra to complete a proof (Question One (c), Question Two (d))
- manipulated trigonometric expressions succinctly and accurately (Question Two (a), Question Four (c))
- demonstrated the ability to grasp (potentially) unfamiliar mathematical concepts (e.g. Euler's identity in Question Two (c), the improper integral in Question Four (b) and the use of the Fundamental Theorem of Calculus in Question Four (d))
- showcased a wide array of problem-solving skills to approach challenging problems, such as devising a mathematical model in Question Three (c)
- introduced and used mathematical notation throughout their responses, such as the correct use of limits in Question Three (b) and Question Four (b).

Candidates who were awarded **Scholarship** commonly:

- were able to solve a simultaneous equation involving logarithms using various algebraic techniques such as substitution (Question One (b))
- displayed proficient use of trigonometric identities and could relate various trigonometric expressions together
- applied the binomial expansion formula or De Moivre's theorem to correctly power complex numbers (Question Two (b), Question Two (c))
- were able to use calculus to find the stationary point on a parametric curve and justify its nature with the correct use of a derivative test
- formed equations to link variables together and differentiated them to find a related rate (Question Three (b))
- found the area between curves by integrating the difference between the two functions (Q4a)
- chose correct limits of integration to evaluate the definite integrals in Question Four (b) and Question Four (c).

Candidates who were **not awarded Scholarship** commonly:

- left the examination early without completing the paper
- abandoned questions too early or fell into traps of circular reasoning
- relied heaviliy on a graphics calculator without showing the necessary working to arrive at non-exact answers in Question Two (a), Question Two (b) and Question Two (c).
- lacked the algebra skills needed at this level and often 'fudged' working to arrive at a result
- were unable to solve a simple simultaneous equation (Question One (a))
- incorrectly applied log rules, (e.g. $\log(8x^3) \neq 3\log(8x)$ in Question One (b))
- ignored the sign of the relevant quadrant when working with general coordinates in Question One (c) and the trig ratios in Question Two (a) and Question Two (b)
- seemed unfamiliar with the correct use of trigonometric identities
- applied derivative tests incorrectly in Question Three (a) (i.e. not realising the parameter of the function increases from right to left, or forgetting the dt / dx factor in finding the second derivative)
- made mistakes differentiating simple expressions, e.g. the product in Question Three (a) or composite functions in Question Four (c)
- were unable to solve a typical related rates problem or differentiate a function with two variables by first reducing it to one
- were unable to find the area between two curves, often over-complicating their working by considering multiple regions, some of which were under the x-axis (Question Four (a))
- confused themselves with the mathematical notation in a question or in their own answers
- did not answer the question being asked (e.g. finding the equation of PQ instead of QR in Question One (a))
- became lost in pages of algebra, when a shortcut could see the problem completed in a few lines, e.g. Question One (a) and Question Four (a)
- gave nonsensical answers such as a negative areas for Question Four (a) or a perimeter of zero for Question Four (c) (this happened if limits of 0 to 2p were chosen).