NZQA
New Zealand Qualifications Authority
Mana Tohu Matauranga O Aotearoa

LIVE

Assessment Report

On this page

Level 3 Calculus 2020

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Standards 91577 91578 91579

Part A: Commentary

The 2020 papers followed a similar format to recent years' papers. Overall candidate performance was also of a similar standard, although there were fewer with very low scores. As usual there were candidates who displayed good skills and the ability to solve problems in both conventional and innovative manners.

Common points made by panel leaders were:

- Sound, reliable algebra skills are the first requirement for success in calculus. They are needed in the setting up of a problem, and in the solving which follows any differentiation or integration.
- Setting out of working in a clear, logical manner is a real advantage when trying to solve problems, in particular problems with which require an extended chain of reasoning.

- A number of candidates attempted to gain an Excellence grade by only attempting the questions that they interpreted to be ‘excellence’ questions. This is not a good strategy as errors in the questions they attempted, and with no ‘back-up’ questions answered, often resulted in a disappointing final grade.
- A number of candidates gave multiple answers for a problem. It was not always clear which answer they wanted to be marked. In this case their answer will be marked as incorrect.
- A number of candidates who Not Achieved answered only one or two parts of each question. By doing this, they missed opportunities to gain credit for making some progress in higher level questions.

Part B: Report on standards

91577: Apply the algebra of complex numbers in solving problems

Candidates who were awarded **Achievement** commonly:

- successfully used the algebra skills necessary to factorise, solve, expand and simplify
- identified real and imaginary terms in an expression and could group them correctly
- manipulated complex numbers successfully in both rectangular and polar form
- successfully used the remainder or factor theorems
- successfully found the modulus of complex numbers
- applied the rules relating to discriminant and could set up an appropriate expression to represent it
- squared both sides of an equation correctly
- expanded an expression involving surds
- understood the notation for a conjugate and could manipulate generalised complex numbers to simplify.

Candidates whose work was assessed as **Not Achieved** commonly:

- could not manipulate complex numbers in either polar or rectangular form
- did not recognise when the discriminant should be used over the quadratic formula
- could not expand and manipulate surds correctly
- misunderstood how and when to use the remainder theorem
- included ‘i’ in their moduli calculations or attempted to square the entire complex number
- lacked the basic algebra skills needed to solve, simplify, expand, and factorise
- failed to complete enough of the paper
- misread the question and started their working incorrectly
- changed their mathematical statements between lines of working
- expanded brackets incorrectly
- had little understanding of the real and imaginary parts of a complex number
- failed to accurately divide polar form complex numbers
- made careless arithmetic errors
- could not find the modulus of a complex number.

Candidates who were awarded **Achievement with Merit** commonly:

- were accurate in their algebra when solving equations or manipulating expressions
- understood the meaning of modulus and argument and were able to express statements using these features correctly
- understood how to use De Moivre’s theorem and could apply it correctly
- knew the difference between the factors and solutions of an equation and understood the algebra around this
- understood the meaning of “purely real” or “purely imaginary” complex numbers and could form and solve the equations that resulted

- could apply the process of adding fractions with different denominators to complex number problems and simplify the result
- removed surds and gathered terms correctly.

Candidates who were awarded **Achievement with Excellence** commonly:

- communicated their thinking clearly and accurately about what they were doing while completing multi-step problems
- completed the required proof by making connections between factors and roots and then manipulating the resulting expressions
- knew to manipulate both moduli equation given, as well as fraction given, to arrive at correct proof
- solved problems that involved several stages of reasoning
- recognised the need to set up the parts of a proof so that common factors could be cancelled and avoid complex calculations that led nowhere
- worked fully through questions to prove the required statement.

Standard specific comments

Candidates needed to be careful with their answers for questions requiring the use of De Moivre's theorem when finding solutions to an equation. Care needed to be given to setting up a general solution with a correct initial angle. The error of a negative modulus as part of the solution occurred often. Questions requiring the application of De Moivre's theorem occur regularly in this standard so candidates should be well prepared.

The requirement to show an answer in terms of a specific variable or in in a specific form is not understood or ignored by some candidates. Preparation for these types of questions could be made easier if candidates took notice of past papers and past exam schedules.

The need for multiplying by a conjugate fraction was required several times in this examination. It should be a skill that is well practised by candidates in its various forms as it will undoubtedly be needed in future years.

The skill of understanding the modulus of a complex expression was required several times in the paper. Many candidates lacked the ability to form the expression needed to solve the problem that resulted or understand the algebra required to make progress toward an answer.

Candidates should answer the question completely. This may require an explanation at the end of a calculation or a short concluding statement.

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91578: Apply differentiation methods in solving problems

Candidates who were awarded **Achievement** commonly:

- used the chain rule, product rule and quotient rule correctly in combination with power functions, trigonometric functions, exponential and logarithmic functions
- found the first derivative of parametric functions, applying the chain rule correctly
- were able to use their calculator to evaluate trigonometric and exponential functions
- found the corresponding *x*-value for a given gradient
- set up a correct model for an optimisation problem and managed to correctly differentiate their equation
- simplified differentiated functions without making errors
- displayed the algebra skills necessary to set up problems for differentiation and solve problems after differentiation.

Candidates whose work was assessed as **Not Achieved** commonly:

- were unable to differentiate problems using the chain rule
- did not recognise when to use the product or quotient rule
- could not use an appropriate form of the quotient rule
- were unable to apply the product rule or quotient rule in combination with power, trigonometric, exponential and logarithmic functions
- could not manipulate negative indices and surds
- could not use their calculator correctly to solve problems even though they had found the correct derivative
- could not use their calculator to correctly evaluate trigonometric functions, often mixing up the angle mode required when it should have been radians,

not degrees, and not using brackets in appropriate places

- made errors simplifying their answers when the question clearly stated that they did not need to simplify their answers
- demonstrated poor algebraic skills and were unable to correctly manipulate the expressions prior to and / or after finding the required derivative
- demonstrated poor knowledge of trigonometric equations, thinking that the inverse of tan x was the same as the reciprocal of tan x.

Candidates who were awarded **Achievement with Merit** commonly:

- successfully used the product, quotient, and chain rules when differentiating challenging functions
- manipulated equations involving logarithmic and exponential functions correctly, demonstrating good algebraic skills
- recognised that if $\ln(x) = 0$ then $x = 1$
- could find the equation of a tangent given the function and the point of contact and show that their equation matched the provided equation
- successfully set up models for optimisation questions in terms of 1 variable, before correctly differentiating and using their model to consistently solve problems
- were able to use their calculator correctly when solving problems, especially when evaluating problems involving surd, exponential and trigonometric functions
- manipulated trigonometric functions correctly by using identities
- found the second derivative of a parametrically defined function correctly
- found the second derivative of a power function correctly
- demonstrated a good understanding of the relationship between the gradient of a tangent and the gradient of a normal and were able to apply this knowledge appropriately to locate the unknown x-intercept
- demonstrated reliable algebra skills when solving problems.

Candidates who were awarded **Achievement with Excellence** commonly:

- displayed the ability to model a volume of a cylinder, find its derivative, and them maximise the volume for the given object

- successfully used related rates of change to solve a problem involving the evaluation of a required derivative
- used the second derivative of a function defined parametrically to find the coordinates of a point corresponding to the given value for the second derivative
- could use differentiation to locate the stationary points of a given power function, involving the manipulation of negative indices
- could use the first or second derivative test to determine the nature of the stationary points of the function provided
- correctly completed a proof showing that LHS = RHS using logical, clear working
- demonstrated excellent algebraic skills when solving problems, especially when simplifying expressions.

Standard specific comments

Many candidates did not understand the importance of brackets and how the lack of them changes the meaning of what they are writing.

Many candidates did not set out the proofs well. Few candidates set out their response for Q3(e) as a proper proof, involving LHS and RHS.

Few candidates gave exact coordinates for the point P as required by the instructions of Q2(e).

To do well in this paper also involved good algebra skills; the ability to correctly differentiate a function is only one step on the path to solving a problem.

There were many candidates giving multiple answers for the problems. It was not always clear which answer the candidate wanted to be marked.

91579: Apply integration methods in solving problems

Candidates who were awarded **Achievement** commonly:

- successfully integrated polynomials, exponential, trigonometric, and straightforward rational functions
- wrote surd expressions in exponent form correctly
- correctly found the constant of integration given the necessary information
- correctly used Simpson's rule.

Candidates whose work was assessed as **Not Achieved** commonly:

- could not find the correct value of *h* when applying Simpson's Rule
- incorrectly integrated straightforward rational and trigonometric functions
- forgot to include the arbitrary constant or assumed incorrectly it was zero
- failed to integrate and just used their graphics calculator to calculate answers for definite integrals
- integrated any function with f(x) in the denominator to ln(f(x))
- forgot to divide by coefficients of x when integrating using trig.

Candidates who were awarded **Achievement with Merit** commonly:

- correctly found an area under a curve
- solved differential equations by separating the variables, including calculating the value of the constant of integration
- correctly integrated a rational function correctly either by using long division or integration by substitution
- successfully derived the solution of the differential equation dN/dt = kN, showing all the required steps, then correctly used the other information given to evaluate the two constants that are required.

Candidates who were awarded **Achievement with Excellence** commonly:

- developed and used a strategy to successfully solve a problem involving areas
- solved differential equations by separating the variables, including calculating the value of the constant of integration
- used trigonometric identities correctly

- understood the concept of ‘signed’ area and applied it successfully to solving problems.

Standard specific comments

Many candidates were able to select the correct techniques to solve a problem, however poor algebraic manipulation skills prevented them arriving at the correct solution.

A number of candidates attempted to gain an Excellence grade by only attempting the questions that they interpreted to be ‘excellence’ questions. This is not to be recommended as errors in the few questions they attempted, and no ‘back-up’ answers, regularly resulted in a disappointing final grade.

A requirement of this standard is that candidates should communicate using appropriate representations and mathematical statements. There were many candidates that did not use appropriate notation and who did not communicate clearly what they were doing at each step of working.

Mathematics and Statistics subject page

Previous years' reports

2019 (PDF, 152KB)

2018 (PDF, 125KB)

2017 (PDF, 48KB)

2016 (PDF, 255KB)