

# Junior Mathematics Competition

The University of Otago Junior Mathematics Competition 2023

## 2023 Competition Report

### General Comments

The 2023 competition saw the continuation of the two part competition structure. Much like last year there were no major technical issues, and for the vast majority of schools the first part of competition ran smoothly.

There was a slight increase in the number of pupils taking part in the Part One of the competition this year: around 4800, up from around 4500 in 2022. This year we had candidates sit the competition at 117 schools, a decrease on last year's 140 schools. Part Two of the competition had around 1200 pupils sitting, up from 700. This is due to the expanded invitation system we adopted for this year's competition.

A reminder that this year (like in 2021 and 2022) we will not award Top 100 and Top 200 certificates at all. Like for the last two years we award Distinction certificates to roughly the top 15% of participants in each year level, and Merits to roughly the top 50% of participants in each year level. Note that to achieve a Merit or Distinction, a given pupil must place in the top 50% or 15% respectively in *either part of the competition*. This means that some pupils on your Part Two results sheet will receive Distinctions having earned a lower mark in the second part than other students who have only received a Merit.

This year's competition was notably longer than last year's competition, and as a result marks were down across the board for all three year levels. For the overall 2023 Part Two scores see the table on page 3.

We continue to emphasise that doing as much as possible in a question before moving onto another question is better than jumping back and forth between questions. Another good idea is to write the answer down with the minimum working possible. Students can return to 'pad' the working out when they have done as much of the competition as they can do. Once again several 'capable' students answered the early questions nearly perfectly but ran out of time and could not do justice to the later ones, mainly because they wrote too much at the beginning. There is a fine line between explaining and over-explaining your answers.

### Future Competitions

Due to resourcing issues, at this point in time we do not know if a competition will be held next year, nor do we know what structure the competition will have if it does occur. Ways of running a competition next year (if not beyond) are under active consideration. Please keep an eye on our website for future developments (although we will email schools in the normal manner at the start of next year if the competition is to proceed).

Any feedback (positive and negative) you have about the structure of the competition will be welcomed (although note that the chances of the competition returning to a pre-2020 structure is highly unlikely).

FOR FURTHER INFORMATION CONTACT:

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## Brief Comments on Individual Questions

### Question One (Year 9 and below)

This was mostly well answered. The question was designed so that part would only be answerable by those with mathematical knowledge beyond basic arithmetic.

### Question Two (Year 10 and below)

This was the easiest question in this year's competition, with an average grade of 7 out of 10. Typical mistakes were mixing up which of  $e$  and  $h$  were even or odd and getting the order of the inequalities reversed.

### Question Three

This proved to be harder than last year's Question Three, although overall this was mostly well done. Many students struggled to explain their answers in parts (c) and (in particular) (d). It was not uncommon to see a formula appear as if by magic.

### Question Four

Once again this proved to be harder than the previous year's equivalent question. One of the major issues in (b) and (d) was the miscounting of primes — it was not uncommon to see 43 listed as the thirteenth prime rather than the fourteenth. The 'trick' to (e) was to consider numbers of the form  $x^6$  for some  $x$  (such as  $2^6 = 8^2 = 4^3$ ) — many students felt there was no solution as  $n^2 \neq n^3$  for  $n > 1$ , even though the question never considers the square or cube of  $n$ .

### Question Five

This was the 'book work' question in this year's competition, and proved to be far too hard overall, with average grades half that of the equivalent question in 2022. Many students skipped the question entirely; of those that attempted it the majority only did (a). Frequently students who attempted (b) did not prove the general cases but instead used specific instances. Part (c) was designed as a bit of a trick question, and in fact only a few students realised the numbers could all be identical.

### Question Six

This question was one of two questions were students on average did better than the equivalent question in 2022. (The other such question was Question 8, although there the sample size is small.) There was an initial fear that the complicated instructions (including some potentially confusing shorthand) would be too much for most students, but these fears proved unfounded, and most students did rather better here than in Question Five. (Originally the two questions were reversed in the paper.) Some students gave 'out by one' answers in parts (a) and (b). Many students missed that you could change the order in which you took the lifts between (c) and (d). Part (e) was seldom answered correctly; in part because there is only one answer, but also (in fairness to most students) there are easier marks to be gained elsewhere given the time constraints.

### Question Seven (Years 10 and 11)

This was a continuation of a question given to students in Part One of the competition. In fact this question was written before the question in Part One; the latter was put in so that we could be sure students had at least some familiarity with Pascal's Triangle. The question setters learnt their lesson from a prior competition — don't ask questions about binary numbers early on. Most Year 10 and Year 11 students who answered this question understood the basics, although part (d) proved beyond most.

## Question Eight (Year 11)

This was clearly the hardest question presented to students sitting part two this year, although it was slightly easier than the equivalent question in 2022. Student who attempted this question typically made some progress beyond the relatively easy (a), but it was easy to get tangled up in the various additions and subtractions of the areas involved in the latter three parts to the question.

## Percentiles

The percentiles for Part Two of the competition at each level are given below. (The total possible marks for all candidates was 100.) Note that the top papers (about 18% at each level) have been check-marked by experienced members of the Mathematics and Statistics Department of the University of Otago. This does use up considerable time in returning results, but we feel that the greater accuracy in final marks makes the check-marking justified.

	2023			2022		
	Year 9	Year 10	Year 11	Year 9	Year 10	Year 11
<b>Distinction (85%ile)</b>	41	43	40	62	63	66
<b>70%ile</b>	36	36	34	54	56	57
<b>60%ile</b>	32	33	31	51	52	53
<b>Merit (50%ile)</b>	29	31	28	47	49	50
<b>25%ile</b>	22	23	21	34	40	40

A direct comparison to last year's competition is always difficult, but it appears that this year's competition was harder than last year's competition. Possible reasons for this include the difficulty of Question 5 and the overall length of the competition, although it should be noted that the Part Two of the competition is intended to be more difficult than Part One in general.

Please check the marks of your students against the marks given above for Distinctions and Merits and let us know if anything seems incorrect about your results.

*Note:* Students received a Merit or Distinction based on their *best* performance across both parts of the competition. This means that it was entirely possible to do poorly in the second part of the competition and receive a Distinction if a pupil did very well in the first part of the competition.

## A Note on Calculators

We continue to stress how difficult it is for students without calculators to cope in a Mathematics competition. Even a simple calculator with the 'four basic functions' would save much time. Certainly Years 10 and 11 students cannot be expected to work out the more complicated problems towards the end without a calculator.

## Explanation of the Symbols on the Mark-Sheets

The following symbols have been utilised on the mark sheets:

Questions 3, 4, 5, and 6 (up to 20 marks each):

<b>(blank)</b>	No work presented.
<b>0</b>	Work presented, but ungradeable, or fundamentally incorrect.
<b>-</b>	Minimal partial credit (1 – 5 marks).
<b>+</b>	Significant partial credit (6 – 13 marks).
<b>✓</b>	Near complete solution (14 – 17 marks).
<b>✓✓</b>	Full, or near full credit (18 – 20 marks).

Questions 1, 2, 7, and 8 (up to 10 marks each):

<b>(blank)</b>	No work presented or not applicable.
<b>0</b>	Work presented, but ungradeable, or fundamentally incorrect.
<b>-</b>	Minimal partial credit (1 – 4 marks).
<b>+</b>	Significant partial credit (5 – 8 marks).
<b>✓</b>	Near complete solution (9 – 10 marks).

## First, Second, Third, and Top 30 Prizes

Schools with students who have received monetary prizes have been contacted with their results. We hope to send out prize packs to schools via courier as soon as all the certificates have been printed. Apart from certificates each prize pack contains Prezzy cards and physical copies of the model solutions for each student to keep. The unlock code for each Prezzy card will be sent in a separate email - it is most important that you **retain a copy of this email** and pass on the unlock code to your students as soon as they have their physical prizes.

## Our Website and email

Please remember to check the front page of our website (particularly the News section) regularly for updates on the availability of results. You should monitor the website before emailing us for information which is already on there. We have emailed results to all schools. Many thanks to those who continue to use email – we have found this to be the most effective form of communication by far, and has reduced our administrative burden no end.

## Final comments

Like last year's competition, this year's competition ran smoothly. Once again it was a team effort involving several members of the Department of Mathematics and Statistics.

Thank you to all the schools that have entered the competition over the years. With any luck we hope to see you all next year!