

Junior Mathematics Competition

The University of Otago Junior Mathematics Competition 2022

2022 Competition Report

General Comments

The 2022 competition saw the return of the two part competition structure. This year the technical issues that affected the first part of the competition last year were rectified, meaning that for most schools that part of competition ran much more smoothly than last year.

The number of pupils taking part in the competition in 2022 was basically the same from last year, at around 4500 students; the main difference was that candidates came from 126 schools all told, compared to 140 schools. The second part of the competition had around 700 pupils sitting, down from 1600 in the previous year. This discrepancy can be explained by the fact that last year we had to invite more students than planned to sit the second part of the competition due to the aforementioned technical issues. Having said that, we may tweak the invitation criteria used this year to allow more students to sit the second part of the competition next year. (If this happens the criteria for being invited to the second part of the competition will be included in next year's Initial Invitation letter.) Once again Covid restricted the numbers of potential students; both due to on the day absences and the fact that at the start of the school year most schools had no new international students enrol.

We believe the timeslot system implemented this year for the first part of the competition meant the competition ran more smoothly as a result. We intend to retain the timeslot system for next year, although with any luck schools will be informed about what time slot they end up with a lot more quickly than happened this year. It is likely that we will no longer offer early Monday morning timeslots to schools in future years due to logistical issues.

A reminder that we no longer award Top 100 and Top 200 certificates at all. This may change in future years, at least for the Top 100 certificates (it is highly unlikely that Top 200 certificates will be awarded again), but only if the numbers in all levels justify it. Once again, 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.

As a whole most candidates found the first part of the competition relatively easy, while the second part was much harder (which was the intent). For the overall part two scores in 2022 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.

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Next Year's Competition

We have no plans to change the overall two part structure of the competition for next year, aside from what has been mentioned above. (In particular due to cost restraints we have no realistic way of running only a single part, paper based competition.)

Next year, the first part of the competition will be held on the week starting **Monday, the 27th of March**, while the second part of the competition will be held on **Wednesday, the 3rd of May**. Note that part one will continue to not have any prizes. (The dates for the first part have been chosen as the following week ends on Good Friday.)

Like this year, each part of the competition will run for **50 minutes** in total. Our apologies for any confusion about this caused by the version of the questions distributed to schools.

Each school will again nominate timeslots for which they would like to run the competition. Next year we hope almost every school will receive their preferred timeslot for each group of students sitting (which is what happened this year).

As mentioned above, we will look at modifying the invitation criteria for the second part of next year's competition. As it stands, students who reach the top 15 percent of their year level nationwide in the first part of the competition will automatically be invited to sit the second part of the competition. Also like this year, students who receive the top score above the Merit threshold at their school for their year level will also be invited if nobody in their year level has received a Distinction in part one from their school. (This year there were only a handful of students who received a Merit in the first part of the competition but a Distinction or above in the second part of the competition.) Even if we change the invitation criteria, it will still include the criteria set out in this paragraph.

Schools may opt to do either both parts of the competition, or only the first part — there is no direct entry into the second part alone.

The cost per pupil next year will not raise above \$5.

Brief Comments on Individual Questions

Question One (Year 9 and below)

This was mostly well answered. The algebra in part (b) was the only place where pupils struggled.

Question Two (Year 10 and below)

This was the easiest question in this year's competition, with an average grade of 8 out of 10. When students made errors, it was mostly due to misreading the question — in (c) quite a few students gave the area for C rather than its perimeter.

Question Three

Unlike last year's Question Three, this was mostly well done. The major issue (which isn't really surprising) was determining what is and isn't prime. In (d) 169 was a common incorrect answer (961 is the square of 31), while in (e) 11 was often missed out, and 19 and 91 (the latter having factors of 7 and 13) were sometimes included instead.

Question Four

Students also found this question easier than the equivalent question last year. In too many cases students did not explain their answers, particularly in (c) where too many students simply stating 'there are 3 happy numbers' without any real justification for their answer. Another common mistake in (c) was the omission of 10.

Question Five

This question consisted of two 'sections'. The first section (parts (a) through (d)) was basically bookwork, and many students excelled in this section. Part (e) was the section where most pupils struggled. There was a setup for a 'simple' solution given

by part (b), but most students missed this. In fact most of the students who received full marks in this question noted that the factors of 272 include 4 and 17, both numbers in known Pythagorean triples (3, 4, 5 and 8, 15, 17).

Question Six

Much like last year's Question Six, here many students could find the correct answers, but failed to adequately explain them. Although part (a) was straightforward to explain, in parts (b) and (c) it was better to systematically go through all the possibilities and choose the optimal one in each case. The answer for part (c) could be explained without such an approach (since the box can be oriented in such a way that in no dimension a gap is left), but typically the explanations given were poorly worded. (Most of the top students elected for a systematic approach to part (c).)

Question Seven (Years 10 and 11)

To earn full marks here, students had to have a good understanding of three different parts of mathematics. For the most part only (c) was well answered, although it certainly wasn't uncommon to see full marks from especially Year 11 students. It was evident that drawing a diagram joining the three parts together helped here. A few students missed the fact that the answers in (c) needed to be *subtracted* from the combined answers of (a) and (b).

Question Eight (Year 11)

This was clearly the hardest question presented to students sitting part two this year. Not many students could obtain the correct answer, and only a handful could also explain their answer (and thus obtain full marks for this part). We did see a few different approaches from those students who produced the correct answer, which was quite pleasing.

Percentiles

The percentiles for the second part 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.

| | 2022 | | | 2021 | | |
|-----------------------------|--------|---------|---------|--------|---------|---------|
| | Year 9 | Year 10 | Year 11 | Year 9 | Year 10 | Year 11 |
| Distinction (85%ile) | 62 | 63 | 66 | 54 | 55 | 66 |
| 70%ile | 54 | 56 | 57 | 46 | 48 | 57 |
| 60%ile | 51 | 52 | 53 | 42 | 45 | 52 |
| Merit (50%ile) | 47 | 49 | 50 | 38 | 40 | 48 |
| 25%ile | 34 | 40 | 40 | 26 | 28 | 38 |

A direct comparison to last year's competition is always difficult, but it appears that this year's competition was easier than last year's competition for Year 9 and Year 10 pupils, while there was no real difference in difficulty between years for Year 11 candidates.

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):

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

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

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

First, Second, Third, and Top 30 Prizes

Due to logistical issues there will be a slight delay in getting these out to schools (although given the main results are out earlier this year in effect you will receive them at the same time or earlier than last year.) Like last year all Top 30 and above certificates will be couriered to schools, along with physical copies of the model solutions for each student to keep. Please check the names of your students receiving a Top 30 or above prize as soon as you can and contact us with any corrections.

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

This year's competition ran more smoothly than last year's competition, to the relief of everyone involved here. Once again it was a team effort involving several members of the Department of Mathematics and Statistics.

We appreciate your feedback about the competition — indeed, without your feedback the competition would not have worked as well as it did this year. We already have received some good feedback for next year's competition, which we will put into place, but more feedback is encouraged and welcomed.

We hope to see you again next year!