OCMC
Ontario Competitive Mathematics Committee
OMC

Ontario Invitational Mathematics Examination

RESULTS

2023

Overall Comments

To all of the participants in the 2023 Ontario Invitational Mathematics Examination, congratulations. It is a feat to simply qualify for this contest. Although the problems were very challenging, we were pleased to see that there was much success in solving even the most difficult problems. The average score was 25.5, and the top score was 65.

Specific Comments

A1. Average: 4.50/10
Participants used a variety of strategies when approaching this problem. Most correct solutions solved the problem using Euclidean geometry, with some solutions also using trigonometry or vectors. Full marks were typically awarded to those who had a valid strategy, with the exception of a few solutions that had calculation errors. Partial marks were awarded for recognizing the symmetry present. Unfortunately, many participants made incorrect assumptions about certain angles and side lengths at the very beginning, and as a result, were awarded minimal marks.

A2. Average: 4.42/10
Many participants correctly identified a relationship between a, b, $\gcd(a, b)$ and $\operatorname{lcm}(a, b)$, and partial marks were awarded for this. However, the critical step lies in finding a key factorization of the equation, which most participants struggled with. Some participants attempted arguments involving parity and inequalities, which were mostly unsuccessful.

A3. Average: 4.12/10
Most participants were able to get started on the problem by using Vieta's formulas. However, many struggled with correctly squaring and cubing roots in order to reach sixth powers or made calculation errors when computing the rest of the terms. Some participants obtained partial marks for recognizing Newton's sums and computing some correctly.

A4. Average: 2.58/10
Some contestants were able to tackle the problem by considering one vertex. Many contestants that did not use this approach found themselves stuck and struggled to proceed.

A5. Average: 1.73/10
Most students found this problem very difficult. Although a few students earned partials by finding the general form of a_n, most didn't arrive at a full closed form formula or prove their lemma through induction. Many students also overlooked the negative cases for n. Overall, only a handful of contestants received full marks.

A6. Average: 1.88/10
This was a difficult problem. Of the participants that attempted this problem, many used similar triangles and a few created inequalities. Some individuals performed vast amounts of computation which often contained errors. A few papers contained a technically valid maximizing condition but did not have any justification.

A7. Average: 0.42/10
Only a few contestants attempted the problem, with most receiving no points for their attempts. One point was awarded for calculating the altitude.

Comments on the Paper

B1. Average: 2.12/10

Most students recognized the use of graph theory to solve the problem, and many of these also recognized that out of 3 people, they cannot all have the same relationship. A handful of students recognized the use of the Pigeonhole Principle to complete the proof that you cannot have 6 people. Partial marks were awarded for a solution that presented a construction that proved that it is possible with 5 people. Only a few students received full marks.

B2. Average: 3.19/10

This problem was relatively approachable for its position. Many students rewrote b as the solution to a quadratic, and redefined the problem to the discriminant being an integer square. From here, some successful participants noticed a Pell's equation and used this to find the solutions. Many other participants used trial and error instead, for which they either received partial marks, or full marks if they showed their trial and error work.

B3. Average: 0.54/10

This was a very challenging problem that was rarely attempted. A few participants were able to construct a valid orbital sequence that covers all the divisors of n. Very few participants were then able to obtain a lower bound on the sum of this sequence, then show that the lower bound can become arbitrarily large to conclude the proof.

Please visit our website at https://www.ontariocmc.ca/past-contests to download the OIME, plus full solutions.

Awards

Champion	Leo Wu	Bayview Secondary School	Grade 9
Second	Andrew Ma	University of Toronto Schools	Grade 10
Third	Ansh Agarwal	Marc Garneau Collegiate Institute	Grade 10
Fourth	Jeff Sun	University of Toronto Schools	Grade 10
Fifth	Lei He	Oakville Trafalgar High School	Grade 9

N.B. The Ontario Competitive Mathematics Committee will award the *Champion* of the OIME with a prize of $100; the *Second*-place, $80; and the *Third*, *Fourth*, and *Fifth*-place, $40 each for their achievements.

Ontario Invitational Mathematics Examination 2023
Contestant Honour Roll

Name		Score	School	Grade
Leo	Wu	65/100	Bayview Secondary School	9
Andrew	Ma	60/100	University of Toronto Schools	10
Ansh	Agarwal	52/100	Marc Garneau Collegiate Institute	10
Jeff	Sun	48/100	University of Toronto Schools	10
Lei	He	46/100	Oakville Trafalgar High School	9
Christopher	Li	44/100	Markville Secondary School	10
Jiahao	Yu	39/100	Oakville Trafalgar High School	11
Alexander	Zhang	39/100	Marc Garneau Collegiate Institute	10
Zheng	Wang	34/100	Iroquois Ridge High School	11
Daria	Picu	27/100	University of Toronto Schools	11