

2024 Samuel Beatty Report  
65th International Mathematical Olympiad in Bath, United Kingdom  
Emily Ma

The International Mathematical Olympiad is a challenging math competition held annually with students from over 100 countries attempting to solve six problems over two days. This year, the IMO was held in the United Kingdom, with 609 students from 108 countries participating. I had the honour of representing Canada along with Xuezhi (Jerry) Wang, Marvin Mao, Ming Yang, Warren Bei, and Ryan Bai. The team was chosen based on performance on the Canadian Mathematical Olympiad, Asian-Pacific Mathematical Olympiad, and Canada's IMO Team Selection Test.

Before we left for the United Kingdom, we participated in a training camp at the Banff International Research Station (BIRS) for two weeks. Alex Song, Howard Halim, Kateryna Tretiakova, Anna Kelley (deputy leader), Eric Shen (observer with the deputy), and Victor Rong (leader) led the camp as trainers.



*From left to right: Ming Yang, Marvin Mao, Warren Bei, Emily Ma, Jerry Wang, Anna Kelley, Ryan Bai, Victor Rong, Eric Shen*

On the first day, we met each other and discovered the amazing food and view at BIRS: the buffet was unmatched, and we could see mountains from the large window at the back of the classroom. Starting on the second day, we had classes on topics including grids, inversion, Diophantine equations, and multivariate polynomials. Every other day, we wrote mocks where we simulated contest conditions, then received detailed feedback in time for the next mock. I loved interacting with such a wide range of theorems and problems during classes, and I really appreciated all the trainers'

willingness to discuss and explain problems on the mock or whatever problem I was working on.

The trainers organized many amazing activities during free time, such as watching a piano concert or visiting hot springs. I really enjoyed walking to downtown Banff to watch the Canada Day parade and to have Cows ice cream! Being in Banff, we also couldn't resist the opportunity to hike the mountains that were around us: halfway through camp, we spent the day hiking and playing games.



*View from the top of Tunnel Mountain*

Victor had already left Banff a few days earlier to vote on contest problems, so on July 14, the team, along with Anna and Eric, flew to the London Heathrow Airport. Our flight arrived in London around noon, meaning that we were relatively well-rested from sleeping on the plane. After we took a shuttle to Bath, we received our lanyards and keys to the dorms. We were lucky to have single rooms in the same building, and after we settled in we walked to the Hub to meet other teams. The Hub had lots of snacks, along with games such as Connect Four, chess, and Jenga. We talked to teams from other countries and played games, before stocking up on snacks for the contest.

Before walking to the testing building on the first day of the contest, we had breakfast and headed to the store briefly. For the contest, we were placed in a large room with hundreds of desks split into sections by number, and we then worked on three problems from 8:30 am to 1 pm.

The first problem was an algebra problem involving a sum of floor functions. Our team did quite well on this question, with everyone using different approaches from induction to bashing. After that was a number theory problem where we were asked to

characterize all pairs  $(a, b)$  such that a certain greatest common divisor became eventually constant. Since this problem had one main idea that wasn't immediately obvious, only Marvin and Ming were awarded 7 points, and I was docked 2 points due to not considering edge cases. After we found out our points, we were very glad that all members of the team were able to earn points for their progress. Third was a combinatorics problem about proving that a certain sequence was eventually periodic, and Jerry, Marvin, and Warren earned partials for proving key claims.

For the rest of the day, Eric, Marvin, Ryan, and I walked around campus. However, while we were at the lake, it started raining pretty hard so we took refuge in the first building we could find. Once we entered, we were proudly presented with very detailed solutions to Problem 3 (which were actually blank sheets of paper), then invited to join a game of baseball using more blank paper as the ball and bat. We had lots of fun attempting to throw the paper ball, which had to be continually reinforced! We eventually made it to the Students' Union building, where Marvin bought a comically large "clear plastic wallet" to hold his belongings during Day 2 of the contest.

On the second day, we immediately saw our first geometry problem, Problem 4, asking us to prove an angle condition within an interesting diagram. Fortunately, our entire team solved this problem, with most finding a solution that involved using a rhombus to prove the result. Warren took a more computational approach, and I used trigonometry to prove that two pairs of triangles were similar which led to the desired angle condition (in fact, Eric had predicted that I would use this approach). The next problem was a combinatorics problem about Turbo the snail trying to make it to the bottom of a grid while avoiding monsters. However, one of the tricky parts of the problem was determining what the right answer was. Ryan was the only one on our team who solved this question, with Warren and I earning partial points: Warren earned 3 points for proving a constant bound, and I earned a point for partial progress in proving that 3 attempts were sufficient. Finally, Problem 6 was an interesting functional equation that didn't provide an exact equation, rather, we were given that at least one of two equations was true for each possible input. Ming, Ryan, and I earned partials for proving claims, and Warren earned 6 points for completing most of the proof. Overall, we were happy that many of us were able to solve the earlier problems, and that we made significant progress on the more challenging ones too.

At dinner, the race was on to hand out Canadian IMO pins: we had 200 pins, and only a few days to give them out! We went around meeting teams from other countries while distributing pins, and we even received some souvenirs in return. The pins looked amazing and were a great way to start a conversation with other contestants.

Throughout the IMO, we attended many talks on fascinating topics like AlphaGeometry, AI in mathematics, and considering 2D problems in 3D space. There was also a wide range of excursions we could choose to go on, such as visiting Stonehenge, Bletchley Park, and even the Buckingham Palace. The day after the contest, Jerry, Marvin, and I went on a walking tour of London. We loved taking the Tube, seeing Tower Bridge, the London Eye, the Big Ben, Westminster Abbey, and exploring London and Westminster! The day after, we visited downtown Bath, where we chose between fish and chips or pizza (with lots of toppings, such as jam!). I chatted with my teammates outside while enjoying quintessential British food: fish and chips along with a steak pie.

Before the closing ceremony, we found out the medal cutoffs: Marvin, Ming, Warren, and Ryan won a silver medal, I won a bronze medal, and Jerry won an Honourable Mention. During the ceremony, we listened to speeches and received medals while proudly holding up Canmoo, our team mascot (a moose plushie)!



*After the closing ceremony, featuring Canmoo on Jerry's head*

Once we got back to the University of Bath, we went to the closing party. The party was definitely a highlight of the trip: there were many tents/trucks with delicious food (noodles, loaded fries, pies, rolled ice cream, churros, and more), along with amusement rides. I went on two spinning rides with Marvin and Eric, and the whole team, along with all the leaders, had fun in bumper cars. Afterwards, we watched fireworks and returned to the dorms. We said goodbye to the other teams, playing games like poker and Avalon with them late into the night.

IMO was truly a once-in-a-lifetime experience, and I'll always remember how much I enjoyed trying new and interesting problems, exploring the University of Bath with my teammates, and meeting many amazing students from all over the world. I'm immensely grateful for the opportunity to represent Canada at the IMO, and I'm thankful to everyone that's joined me on this journey:

I'd like to thank my family and friends for always believing in me.

I'd like to thank my teammates—Jerry, Marvin, Ming, Ryan, and Warren—for being so awesome and supportive.

I'd like to thank our leaders, Anna, Eric, and Victor for giving us pep talks, contest advice, and for making the IMO a great time for all of us.

I'd like to thank Alex, Howard, and Kate for creating such detailed lectures and leading lots of fun activities during camp.

I'd like to thank James Rickards and everyone at the CMS for their hard work and dedication in organizing countless competitions, training camps, and teams.

Finally, I'd like to thank the Samuel Beatty Fund for their generous support. Thank you so much for making this unforgettable experience possible!