

# Report on Canada's participation in the 44<sup>th</sup> International Physics Olympiad, Copenhagen, Denmark

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The 44th International Physics Olympiad (IPhO) was held from 7 to 15 July in Copenhagen, Denmark, the birthplace of Niels Bohr, a founder of quantum mechanics. The Canadian Olympiad team was chosen in a two-step competition. First, 879 students from 170 Canadian schools wrote the Canadian Association of Physicists High School Exam. Next, the top 11 students from this exam and one recommended by the organizers of the Physics Outreach Program in TORonto (POPTOR) were invited to the Canadian Physics Olympiad finals camp.

The Canadian Physics Olympiad finals camp took place in Vancouver from May 19 to May 25, 2013. The students worked very hard. The week was filled with lectures, tutorials, and long IPhO-like experimental and theoretical exams. The students had a chance to visit Triumph, Canada's national laboratory for particle and nuclear physics, as well as D-Wave Systems, the quantum information company. At the end of the week, the best five students were chosen to represent Canada at IPhO 44.

The members of the Canadian team this year were:

- Henry Wu, University of Toronto Schools, Toronto
- Bailey Gu, Lisgar Collegiate, Ottawa
- Hao Zhe Sheng, Bayview Secondary School, Toronto
- Jiaxi (Jannis) Mei, University of Toronto Schools, Toronto
- Shun Da Suo, Victoria Park Collegiate Institute, Toronto

The leaders were Dr Andrzej Kotlicki (UBC) and Mohammadreza Mohammadi (UofT). Before the Olympiad, the team went to Cambridge, England, to train for three days with the British team. They all stayed and worked in the famous Trinity College.

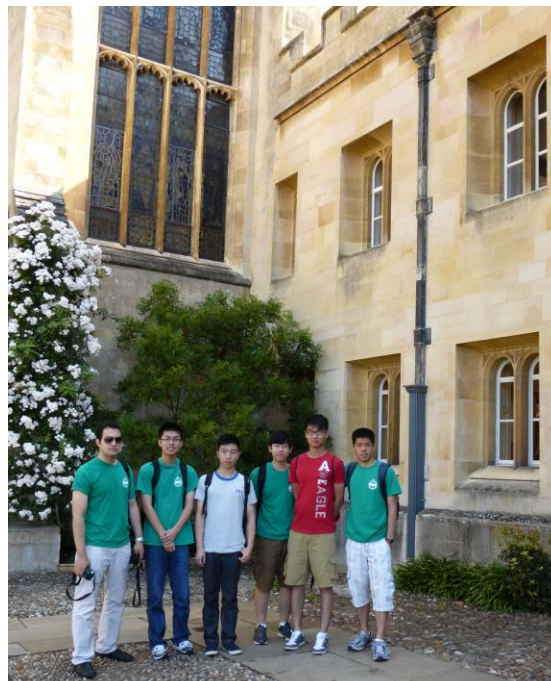


Fig. 1. The team under the windows of Newton's old rooms!

The Technical University of Denmark and the University of Copenhagen hosted this year's Olympiad. The opening and closing ceremonies were held at the Technical University of Denmark, and showcased wonderful Danish entertainers. Eighty-three countries participated in this year's Olympiad, competing for physics glory. According to the IPHO's statutes, roughly 67% of the participants are awarded Olympic medals or honorable mentions.

As usual, the competition had both theoretical and experimental parts that challenged students at a level more advanced than the high school exams. The experimental and the theoretical exams are both five hours long and consist of two and three parts, respectively. Compared to the last year's competition, this year's theoretical exam was more straightforward but longer. Problems were very well posed and they tested the students in different areas of physics.

The first theoretical problem was about a meteorite (a small particle from a comet or an asteroid) that hit the earth somewhere near southern Denmark. The problem asked for different physical processes associated with this phenomenon. Students were mainly tested in classical mechanics and thermodynamics. They had to find the velocity of the meteorite when hitting earth, consider the melting process of the meteorite, determine the age of the meteorite and analyze the impact of the meteorite on the earth.

The second theoretical problem concerned nanoparticles that can produce steam by absorbing light through a process that involves collective electron oscillations of the metallic nanoparticles. This problem was the longest part of the 30-point theoretical exam and was worth 12 points. Nanoparticles were modeled with two interpenetrating uniformly charged spheres. Students were asked to find different characteristics of the nanoparticles, such as capacitance and inductance. Then, by modeling the nanoparticles with LC-circuits, they could find the resonance frequency of the nanoparticles. The nanoparticles illuminated with light at this frequency were examined to find the rate of steam generation.

As the birthplace of Niels Bohr, Denmark is proud of its role in the development of quantum mechanics, and many observers predicted that the final theoretical question would concern quantum mechanics. Instead, it was about the Greenlandic ice sheet. This problem studied the profile of the glacier, ice flow and the sea level rise from the melting of the Greenlandic ice sheet.

The first experimental problem was a very simple and beautiful experiment for finding the speed of light. Students used laser distance meters to measure optical path lengths and had to calculate the refraction index of water and of the core of an optical fiber.

The second experimental problem was longer and was about solar cells. The problem asked for the theoretical characteristic of solar cells and the maximum power they could produce. It also studied the solar cell coupling and the effect of an optical vessel on the solar cell current.

To ensure the fairness and consistency of the marking, the grading was moderated.

Overall, marking was very reasonable and consistent. However, a very few disagreements, normal for the marking process, were resolved in a friendly and reasonable manner.

Our team did well in the competition. Everyone received a prize: Henry Wu won a silver medal. Bailey Gu and Hao Zhe Sheng won bronze medals. Jannis Mei and Shun Da Suo won honorable mentions.

When the students were not busy with the exams, they experienced the rich cultural, social and scientific programs that are perhaps the most memorable part of the IPHO competitions. They visited the Niels Bohr institute and had a tour around the technical university of Denmark followed by a science show and a midterm party. They also visited some famous museums and a cathedral in Copenhagen. Prior to the closing ceremony, students took a canal tour in Copenhagen. They also had a chance to visit the fortress of Kronborg in Helsingor, known by many also as "Elsinore," the setting of William Shakespeare's famous tragedy Hamlet, Prince of Denmark. They finished this trip with a farewell party after the closing ceremony.

Next year, Kazakhstan will host the next Olympiad in the city of Astana. At the official closing ceremony of the Olympiad, the ministry of education and science of Kazakhstan held a presentation and invited all the countries to the next international physics Olympiad. Canada looks forward to participating in 2014.



Fig. 2. The team after the closing ceremony.



Figure 3. Henry Wu on the podium after receiving his silver medal.



Figure 4. In Kronborg