IYPT problems teach students about teamwork and the scientific method

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What is the IYPT?

- The International Young Physicists´ Tournament (IYPT) is a team-based Physics competition for 16 and 17-year-old students.
- Each year, the IYPT publishes seventeen open-ended problems. The problems are accessible to students with high-school physics education and household materials.
- IYPT students tackle the problems in teams of five. For each problem, the team must read relevant literature; formulate a research question and a hypothesis; design and carry out experiments; and present their results in a ´physics fight´.
- To enter the international tournament, teams must prepare solutions to fourteen problems.

Why should you participate?
The IYPT gives high school students the opportunity to develop their own research projects. Students gain science knowledge, learn to work in teams, and practice their rhetorical skills.

How can you participate?
Individual IYPT problems can inspire a laboratory class or an extracurricular project.

Or, you can send a team to the US YPT, which will be held in March at the University of Michigan, Ann Arbor. The winning team will attend the 2016 IYPT in Ekaterinburg, Russia. Contact us!

Creating a Young Physicists´ Tournament

What we did: Our team of seven physics and engineering students organized the first Chilean Young Physicists´ Tournament. We worked at two high schools in Santiago: Liceo Numero Uno and Instituto Nacional, where we taught for three hours per day for six weeks. During this time, we mentored six teams of three to six students. Each team chose two IYPT problems. Three of the projects are showcased on the right. The projects culminated in an IYPT-style tournament supervised by local scientists.

Educational objectives and outcomes: Our first aim was to **give students a realistic a taste of scientific research** and ownership over their own projects. Our role was not to lead the projects, but to encourage the students to test the limits of their abilities. We required that each team chose their own IYPT problem (which they were happy to do) and formulated their own research question (which was a slow process and required many hints). For the first projects, we helped them refine their questions into testable hypotheses. In the second projects most groups did this independently.

Our second aim was to **help students develop practical science and engineering skills**. Most teams needed new skill sets to complete their projects. We introduced the ´ugar and salt water´ team to fluid dynamics; showed the ´whistling grass´ team how to interpret frequency spectra; and taught the ´magnus glider´ team to solder. All students gained experience with group work, data analysis, and scientific presentation skills. Most students enjoyed learning new science, and had difficulty giving presentations. Several discovered new interests in topics like electronics or photography.

What do you need for an IYPT program?
Teachers: Our project had a 6:1 student:teacher ratio. We think that an optimal ratio would be two teams per teacher. Since this is a project-based program, teachers need solid science backgrounds but do not need to prepare many lectures.

Students: The IYPT is aimed at high-achieving pre-university students.

Time: Our teams completed two projects each in 120 class hours.

Space and materials: We had access to two high school physics laboratories and spent an additional $300 on materials across twelve projects.

Final tournament: Our final tournament was held in the local Museo de Ciencia y Tecnologia. We recreuited ten local scientists as volunteer judges and spent $900 on brochures, catering and cleaning.

Community support: This project would not have been successful without the support of both high schools and the Museo de Ciencia y Tecnologia.

Acknowledgements

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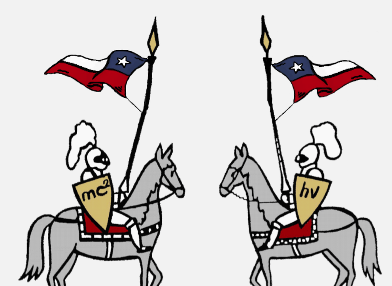


This summer, teams of young physicists:

Whistled with blades of grass

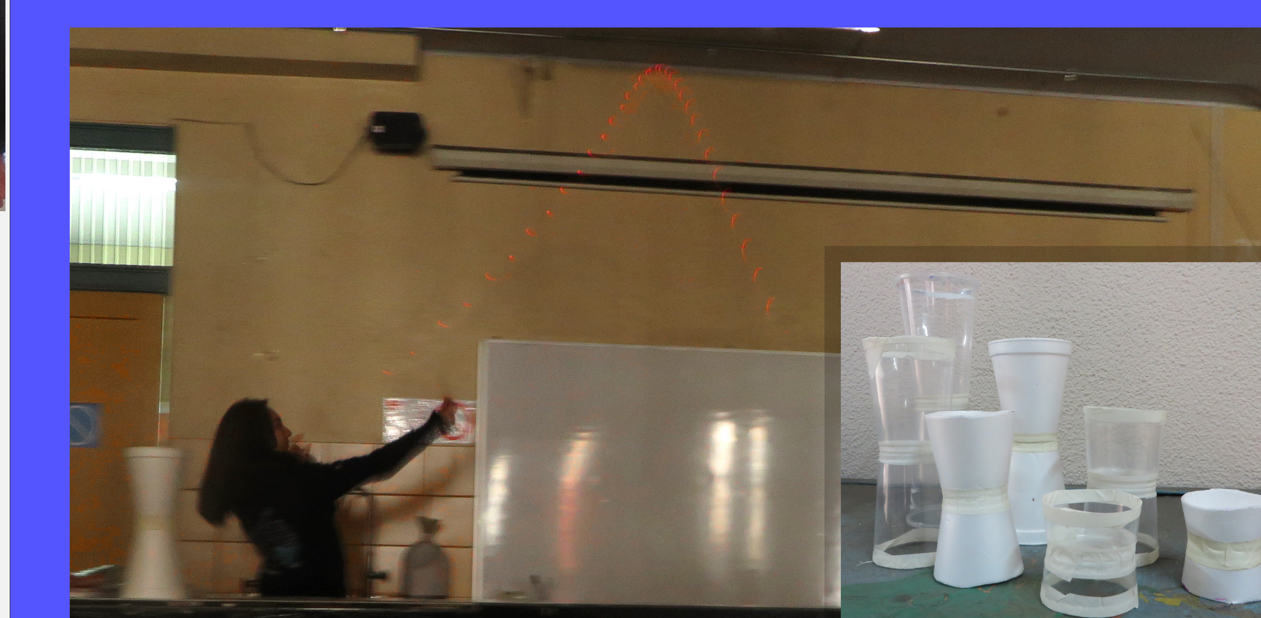
¨It is possible to produce a sound by blowing across a blade of grass, a paper strip or similar. Investigate this effect (IYPT, 2015, Q.10)

Hypothesis: The greater the tension on the grass, the higher the frequency.
Experiment: Students held pieces of grass, paper, aluminum foil and cellophane in front of a focused fan (above). They recorded the sound, and created digital frequency spectra.
Result: Without any material, the fan produces frequencies from 100Hz to 15kHz (white noise). Cellophane produces a peak frequency at 1242Hz and stiffer plastic produces a peak at 2110Hz. When students increased the tension on the materials, the frequency increased. We were unable to measure tension quantitatively, which limited the reproducibility of our results.
Explanation: The fan produces a range of frequencies. The materials amplify their resonant frequencies, producing clear, single-tone sounds.

Mixed sugar and salt water

¨When a container with a layer of sugar water placed above a layer of salt water is illuminated, a distinctive finger pattern may be seen in the projected shadow. Investigate the phenomenon and its dependence on the relevant parameters.¨ (IYPT 2015, Q.8)

Hypothesis: The type of mixing (´fingers´, convection, or nothing) depends on the densities of the solutions.
Experiment: Students made sugar solutions with densities from 1.03-1.27g/ml and placed them over salt solutions with densities of 1.08 and 1.16g/ml.
Result: The fluid convects if the sugar solution is denser than the underlying salt. However, ´fingers´ (right) form whenever sugar is above salt, regardless of density.
Explanation: The fingers form by double-diffusive convection, which depends not on density but on diffusivity.



Optimized gliders

¨Glue the bottoms of two light cups together to make a glider. Wind an elastic band around the centre and hold the free end that remains. While holding the glider, stretch the free end of the elastic band and then release the glider. Investigate its motion.¨ (IYPT 2015, Q.6)

Aim: To create ¨a glider you could sell in La Plaza Italia after Chile won the Copa Americana¨. Specifically, to build a glider that could carry an LED light to 2 metres high and stay in the air for 2 seconds.
Experiment: Students chose to vary the glider materials (plastic and styrofoam) and glider lengths (6-9cm). Their seven gliders are shown above. Students threw each glider nine times and measured height and flight times.
Results: Only three reached 2m more than half the time. Of those three, the 6cm plastic glider remained in the air for the longest, 1.78 +/- 0.02s.
Glider mechanics: after we soldered LEDs onto our glider, students used long-exposure photography (above) to capture the gliders´ non-parabolic trajectories, which are the result of the Magnus effect.

Presented their results

What is a physics fight? Each fight involves three teams. One team is the ´reporter´. This team gives a twelve-minute presentation explaining their project aim, their experiments, and their conclusions. A second team, the ´adversary´, questions the reporter and explores the limitations of the results in a sixteen-minute debate. Finally, a third team, the ´reviewer´, summarizes the debate for the audience. Then the jury assigns points to each team based on the content and clarity of their presentations, and the teams rotate roles until everyone has presented.

Our final tournament consisted of two rounds, or six fights, so that every team had a chance to present two projects. To prepare, the students spent several days making figures and preparing presentations. Many students were nervous about public speaking, but the tournament gave them a good opportunity to organize and summarize their work.

Outcomes in Chile

Chilean students are now preparing for the second Chilean Young Physicists Tournament, which will be held in March. The winning team will go on to represent Chile at the 2016 IYPT.

In our exit survey (response rate: 18/28) 93% of students agreed that the program had increased their understanding of research and the scientific method. 93% of students plan to go on to careers in physical science or engineering. All of these said the program had reinforced that decision.

Four female students have gone on to enter a scientific entrepreneurship competition, and eleven are preparing for a national Physics olympiad.

IYPT resources

International Young Physicists´ Tournament : **iypt.org**
Archive of problems : **archive.iypt.org/problems**
Reference kits for problems : **kit.ilyam.org**
IYPT Chile website (Spanish) : **iyptchile.wordpress.com**
The 2015 USA team website : **www.iypt.us**
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