# International Physicists' Tournament—the team competition in physics for university students

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# International Physicists' Tournament—the team competition in physics for university students

**Vladimir Vanovskiy**[1,2]

[1] Moscow Institute of Physics and Technology, 141701 Dolgoprudny, Institutskiy Per. 9 Russia
[2] Institute for Problems in Mechanics of the Russian Academy of Sciences, 119526 Moscow, Pr Vernadskogo 101-1 Russia

E-mail: vovici@gmail.com and ipt.inbox@gmail.com

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**Abstract**

This paper is about one of the most fascinating competitions between university students: the International Physicists' Tournament (IPT). The IPT is a team competition. The most interesting and challenging problems for the IPT are selected by vote long before the contest. The competition is meant to be close to real scientific life: the solution of the problem is presented, and then opposed and reviewed; the solution usually contains self-made and profound theoretical and experimental investigations. The tournament promotes science among the students and helps them establish international scientific relations.

Keywords: student competition, IPT, tournament, physicists' tournament, physics tournament, physics competition, physics contest

## Why it is so unique?

Most talented students are well accustomed to school Olympiads [1]. The Olympiads are very interesting and always contain some problems that are hard to solve in time. However, this format does not allow new and particularly challenging university level tasks, as they usually require more than five hours to solve. The solutions for typical Olympic problems are usually well determined and provided before the competition starts. At the tournament-like competitions, the students should work hard for months before the completion in order to prepare theoretical and experimental solutions for new—and often unsolved—problems. This process provides them with lots of fun and pleasure when they finish the work, and it even offers them the possibility to conduct good laboratory research in the future [2] or to publish their results in scientific journals [3–5].

  

The tournament-type competitions develop real scientific skills, such as:

1. Problem formulation and the selection of frames in which each problem can be solved.
2. The combined use of theory and experiments.
3. Teamwork and the ability to look at problems from different angles.
4. The ability to prepare a short and comprehensive presentation of the results.
5. The ability to defend the solution and to discuss it with Opponent and Reviewer sides.

These reasons are why the International Physicists' Tournament is so unique and why most of the students who have played it once continue to play it for as long as they can (usually until the end of their study).

## History and statistics of the tournament

The tournament movement began in the Soviet Union in Moscow in 1979. It was created by Moscow State University professor, Evgeny Yunosov. In 1988, it was transformed into the International Young Physicists' Tournament, the well-known international competition for secondary school students that was attended by students from 26 countries in 2013.

The same competition between university students appeared as a result of the Russian –Ukrainian friendship in 2008. The Russian team from the Moscow University of Physics and Technology traditionally participated in the All-Ukrainian tournament, held by the Taras Shevchenko National University of Kiev. For the first two years, the tournament was held in Kiev, but it could not gather more than two teams (Ukraine and Russia). Eventually, the organizers from both parties decided that the tournament would be better if held in Moscow, and the tournaments that followed proved this was the right decision. Over the next two years, six countries participated in the 3rd and 4th IPT. This year's tournament gathered teams together from nine countries, namely Denmark, France, Poland, Russia, Singapore, Sweden, Switzerland, Ukraine and the United Kingdom. In the last five years, the team from Switzerland has won the competition once, and Ukraine and Russia have been declared the winners twice. The winner of this year's IPT was France; the other two finalists were the Ukraine and Denmark teams. It is interesting to note that the two teams, namely Russia and Switzerland, who won two of last year's IPTs occupied the last places this year.

The Tournament has a deep web of preliminary stages. In three countries, namely Russia, Ukraine and France, preliminary national stages are used to select one team who will represent the country at the final. In some universities that have a higher number of participants, a university stage helps to select the national stage representative.

## Brief introduction of the rules

The complete set of rules can be easily found by the link in [6]. The rules are very similar to the ones listed in the IYPT competition [7], except for different timing, the existence of discussions between all three of the playing teams and some other minor differences. Here, I will briefly summarize the main points of the play competition.

A typical 'Physics Fight' consists of three rounds. In each round, the roles are changed, as shown in table 1. The Physics Fight begins with a small captains' competition, which determines the order in which the teams choose their place in the table. The round begins with the Opponent team challenging the Reporter team for a problem. After a certain number of refusals (a penalty is given if the number of refusals exceeds the number allowed), the problem is chosen and reported. After the report, the problem's solution is criticized. The


**Figure 1.** The jury marks 'Ladder', IPT 2011.

**Table 1.** The roles in the Physics Fight.

| Three teams PF | | | | Four teams PF | | | | |
|---|---|---|---|---|---|---|---|---|
| Team \Round | 1 | 2 | 3 | Team \Round | 1 | 2 | 3 | 4 |
| A | Rep. | Rev. | Opp. | A | Rep. | Obs. | Rev. | Opp. |
| B | Opp. | Rep. | Rev. | B | Opp. | Rep. | Obs. | Rev. |
| C | Rev. | Opp. | Rep. | C | Rev. | Opp. | Rep. | Obs. |
| | | | | D | Obs. | Rev. | Opp. | Rep. |

Opponent puts questions to the Reporter and points to possible inaccuracies and errors in the understanding of the problem and in the solution. The goal of the Opponent is to analyse the advantages and drawbacks of both the solution and the presentation of the Reporter. After the opposing speech and discussion, the Reviewer takes the floor, and then all three teams discuss the problems together. The main goal of the Reviewer is to summarize the work done by the Reporter and the Opponent in order to help the jury decide on their marks. Marks from 1 to 10 are given by the independent jury (figure 1).

If four teams fight, one team in each of the four rounds has the Observer role. Some of the lowest and highest marks are disregarded (depending on the number of jury members). The final Physics Fight is the most interesting because, in the final fight, the teams select their best problems to report on.

## Interesting problems and plays

The problems are selected by international vote. The participants and all interested people prepare the problems' conditions for the next competition and then sends them to the International Organizing Committee, who select the best 70–80 of them and organizes the vote between all of the participating countries. Every country that has participated in an IPT before has 100 points in the vote, but a new country has only 50. After the vote, the 17 best problems are selected for play at the next IPT. The problems archive from previous IPTs can be found on the official site [8].

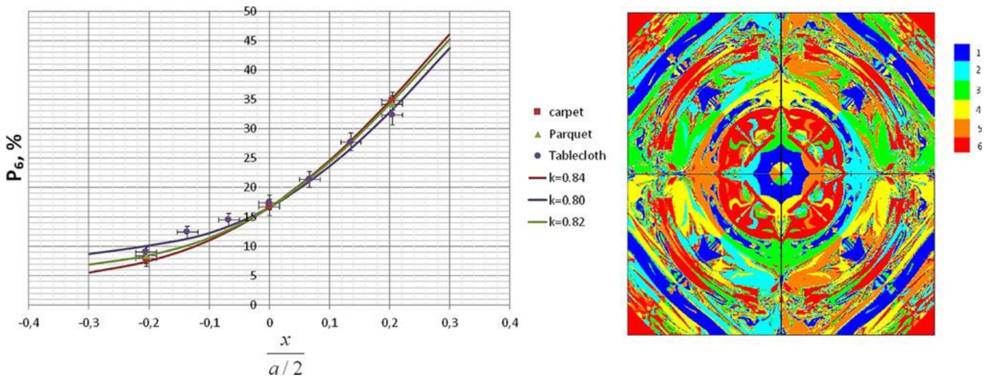


**Figure 2.** The left graph is a comparison between the experimental data and numerical simulation for a '6' throwing probability in dependence of the lead load relative position inside the dice. The lead ball of mass is slightly bigger than that of the dice that was used. The diagram on the right shows the final top face of the dice thrown with a certain initial velocity (the $x$ and $y$ coordinates on the diagram are the respective velocity components squared) from a small initial height. The diagram illustrates the transition from deterministic to chaotic dice behaviour at rather small initial velocities. Presented by Pavlo Bulanchuk and Dmytro Oliinychenko, members of the Russian team, 'The Legend' in 2012.

A good problem should consist of both theoretical and experimental parts. No official solution can be given for a problem (for many problems, the solution does not yet exist). Some examples of problems from previous IPTs are given below.

### *Cheating dice, IPT 2012*

Consider the possibility of fraud in a casino with the help of dice with a displaced centre of mass or with ferromagnetic marking of the faces. Estimate the displacement for the centre of mass or the magnitude of the magnetic field of the magnet embedded in the table needed to provide a double probability of getting the required face in each of the methods.

This problem was reported by the Russian team in the final and brought them to first place in 2012. 'The Legend' team conducted a big scientific experiment for different shifts of the lead load inside of the dice, throwing the 'charged' dice over the different surfaces. The experiment was confirmed by numerical simulation, with more than 1000 h of machine time used. The magnetic part of the problem was solved too. Some of the results obtained are shown in figure 2

### *Incandescent data transfer, IPT 2012*

Achieve a maximum data transfer rate using an incandescent bulb as a transmitter to modulate the optical signal and a photo sensor as a receiver.

The transfer rate achieved in this problem by different teams was of the order of 10 kbps. Juries could see live demonstrations of such devices transferring an MP3-track to a 10 m distance. The limiting factor for the transmission speed was the bulb inertia on being heated and cooled and the photo sensor sensitivity to small changes of light intensity. The participants used sophisticated optical schemes to eliminate the ambient noise.

**Figure 3.** Illustration for the problem 'Water shield'. The photo was taken by Pavlo Bulanchuk.

*Water shield, IPT 2012*

When washing dishes, one can easily see that if one puts a spoon under a stream of water, the water will not scatter in the form of droplets but in the form of a thin film with a pretty large radius (the faster and thicker the water jet is, the greater the radius). Describe this phenomenon both qualitatively and quantitatively. The phenomenon is illustrated in figure 3.

*Battery cry, IPT 2013*

Fabricate an AA battery-powered sound source (i.e., continuously converting electric energy, stored in the battery, into sound) which is as loud as possible.

*Spirit of Africa, IPT 2013*

Many native tribes (as well as Japanese ninjas and some others) use blowguns to shoot poisoned needles in war or for hunting. Suggest the optimal construction for achieving the maximal shooting range and estimate the shooting range (the air pressure is created by human lungs).

*Dangerous flash, IPT 2014*

In many museums, taking photos with a flash is prohibited. Explain the mechanisms by which a flash can destroy materials. How many flashes does it take to spoil (a) a medieval icon, (b) metal armour, and (c) papyrus from ancient Egypt? How does the effect depend on flash power?

In this problem, some teams managed to give the 20 years museum flash dose to an oil painting and even to get close to a famous experiment that David Sounders carried out in 1995 in the National Gallery in London.

**Figure 4.** Illustration of the problem 'Priceless vitrages'.

*Priceless vitrages, IPT 2014*

The vitrages (stained glass windows, figure 4) in churches are often coloured by a colloidal solution of gold particles. What size and form should these particles be in order to obtain the bright red colour of a vitrage at minimum cost (minimal gold expenses)?

## Guidelines for future participants

Any new team willing to participate in the IPT is warmly welcome. Many of the countries that did not take part in last year's competition gathered a team and started the preparations. You may ask why they cancelled their participation. The answer is very simple: barring any financial problems experienced by the teams, most of the teams had not solved many of the problems before the beginning of the tournament.

The list of 17 problems selected for the play usually contains 2–4 rather simple problems, 7–10 problems that are rather challenging and need thorough experimental and theoretical description and 3–7 tough nuts. If the team does not work together and help each other with new ideas and manage experiments in their groups, and if work on the problems does not begin months before the IPT, the team has little chance of gathering enough solved problems.

A fresh participating team should know that it is not necessary to solve all of the problems before the tournament. It is stated in the rules that when you are challenged for a problem you may refuse, and a certain number of refusals can be taken without penalty. Usually, 8–12 solved problems is enough to play. Of course, if you have 10 well-solved problems, it is better to have some work done on all of the other problems in order to make good opposition and review these tasks.

If you are a student willing to participate, or if you know of any willing students, you are welcome to gather a team and contact the IPT organizing committee as soon as possible. We will be very happy to invite you to the final stage and give you any advice you need. If too many teams want to participate (usually the maximum number of teams allowed at the final stage is 12–15) or if more than one team from a country applies, an online preselection will be organized.

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