THE INTERNATIONAL YOUNG PHYSICISTS' TOURNAMENT (IYPT)

by
Gunnar Tibell
Division of Nuclear and Particle Physics
Department of Physics and Astronomy
Uppsala University, Sweden

History and administration

In this paper a team competition called the International Young Physicists' Tournament (IYPT) will be described, in particular with respect to the skills one hopes to develop among participating students. The history of IYPT dates back to 1988 but in the beginning the event was always organized inside the Soviet Union or, from 1992, in Russia. However, already from the year 1979 there was a precursor organized at Moscow State University for secondary school students from the Moscow region. In 1994, for the first time, it was arranged in a different country, namely The Netherlands. Since then sixteen countries have organized IYPT with a fluctuating number of countries participating. In 2004, for the 17th IYPT, Brisbane, Australia, was the host for 26 teams from 24 countries, representing six continents; in 2005 Winterthur, Switzerland, in 2006 Bratislava, Slovakia, in 2007 Seoul, Korea, in 2008 Trogir, Croatia, in 2009 Tian Jin, China, and in 2010, Vienna, Austria hosted the IYPT event. Austria became the first country to arrange an IYPT event for the second time

The details of the competition structure are strictly prescribed in Regulations, whereas the organization itself is ruled by Statutes, adopted in June 2004. The governing body is an International Organizing Committee (IOC) which meets at least once annually, during an IYPT event. The event itself is arranged by a Local Organizing Committee (LOC). Between IOC meetings an Executive Committee handles the issues as decided by IOC. It consists of eight members: President, Secretary General, Treasurer, two members elected by the IOC and the three LOC chairpersons from "last year, this year and next year". The fiscal year of IYPT runs from November 1 to October 31.

IYPT structure

The structure of the competition has been developed through the years from the start, but the changes introduced have normally been slight. In each of the five qualifying rounds, called Physics Fights, three, or sometimes four, teams meet and present their solutions to one of the 17 problems on the list. A team consists of five members, representing one country. However, up to the year 2007 the host country could have two teams participating. As a remnant from history the Russian language was allowed in the discussion; today everything is conducted in English.

Which problem a certain team has to tackle is decided by a so called challenge from one of the other teams present in the qualifying round. There are three roles possible in a round: reporter, opponent and reviewer. The opponent challenges the reporter for one of the problems. The reporter can refuse to accept the challenge, but after a total of three refusals during the five rounds the grading of the jury will be

lowered. After the report of the solution the opponent will scrutinize the solution and point out merits as well as possible weaknesses. The reviewer comments both the solution of the reporter and the remarks of the opponent. All items on the agenda are strictly timed. The report, for instance, can take no more than 12 minutes, whereas the opposition and the following discussion with the reporting team are allowed a maximum of 15 minutes.

After this first part of a particular qualifying round the roles are changed, and at the end of a full round all teams have had each of the three roles. If four teams are present the members of the fourth are called observers, and they remain passive. Also this role is adopted by each of the four teams in turn.

The performance of the teams is graded by an international jury, composed of normally 5 to 8 members who are either independent or connected to a team not participating in that particular round. In most cases jury members come from different countries and none of them comes from the same country as a participating team. The grading of the jury is recorded and forms the basis for a decision, after the five qualifying rounds, to select the best three teams who compete in the final round. The rules are different in the final in the sense that the three teams choose themselves which problem they want to handle. The choice is made according to the ranking after the first five rounds, the team with the highest ranking chooses first, etc.

IYPT problems, selection and examples

The 17 problems to be solved by participating teams are decided by IOC on suggestions from an international group of physicists, consisting of both school teachers and researchers from various institutions, mostly universities. They are nowadays published on the Internet, typically ten months before the competition takes place. The IOC normally has well over 100 problems to choose from. Care is taken to spread the problems over as many subfields of physics as possible. Additional criteria involve the need for problems which require some experimental research and which are by their nature "open", i.e., they should not have a unique solution but rather be possible to handle from different aspects and thus to give alternative solutions. Physics subfields which are quite frequent among the selected problems are mechanics, electricity/magnetism and optics. In these cases it is relatively easy for the students to find equipment, to construct models and develop strategies for discussing their solutions.

However, it has been shown difficult to list problems from certain areas like "modern" physics. Partly this is due to the assumption that many school curricula do not include this subfield, partly also to restrictions in handling radioactive substances, for instance. In general it could be added that the selected problems often favour schools with modern laboratory equipment. However, in judging the presented solutions the jury can take into account the ingenuity and creativity of the participants and thus compensate for the lack of equipment.

Some examples of problems will be given below, in order to show the character of typical IYPT problems.

The city of Odessa in Ukraine hosted the 15th IYPT in 2002. In that event the following problem was chosen in the final by the winning Polish team:

Spinning ball
A steel ball of diameter 2-3 cm is put on a horizontal plate. Invent and construct a device, which allows you to spin the ball at high angular velocity around a vertical axis. The device should have no mechanical contact with the ball.

In 2003 IYPT was organized in Uppsala, Sweden. The winning German team had chosen the following problem:

Heat engine
Construct a heat engine from a U-tube partially filled with water (or another liquid), where one arm of the tube is connected to a heated gas reservoir by a length of tubing, and the other arm is left open. Subsequently bringing the liquid out of equilibrium may cause it to oscillate. On what does the frequency of the oscillation depend? Determine the pV diagram of he working gas.

The following problem was given in Brisbane in 2004:

Didgeridoo
The 'didgeridoo' is a simple wind instrument traditionally made by the Australian aborigines from a hollowed-out log. It is, however, a remarkable instrument because of the wide variety of timbres that it produces. Investigate the nature of the sounds that can be produced and how they are formed.

It was chosen by the Polish team in the final and the solution presented live performances as well as theoretical descriptions of how the sound was produced. The solution of this problem made the Polish team winners.

The winning Croatian team in Bratislava in 2006 chose a problem with the following wording:

Electrostatics
Propose and make a device for measuring the charge density on a plastic ruler after it has been rubbed with a cloth.

A final example is taken from Vienna in 2010. There the winning team from Singapore had chosen the following problem:

Magnetic spring
Two magnets are arranged on top of each other such that one of them is fixed and the other one can move vertically. Investigate oscillations of the magnet.

***What skills are developed*?**

For participants in the IYPT competition it is evident that certain skills are needed for success. Some of these are essential also for success later in life, especially if a student chooses to continue to a career in physics research or in teaching.

In the preparation for the competition some experimental research as well as a study of the theoretical basis for a solution to the problem are needed. This work would normally be done in a team, sometimes inside the team that appears in the competition. In addition, search in the literature is normally performed, and the participants have the liberty to quote suggestions from elsewhere, also from teachers or professional researchers. Already it is clear that to be prepared for the event itself the following skills have to be developed:

Experimental research,
Theoretical study,
Correct references to other results quoted, and
Team work.

The reports are given in English and the time assigned is quite limited. For the vast majority of teams English is a foreign language; some years back no team in fact had English as their mother tongue. It is thus essential to learn to present a solution in a clear, convincing and logical way and to be disciplined regarding the time to be used. In addition, the use of modern visual means of presenting a report becomes increasingly important for the outcome. The corresponding skills would be:

To present as clearly as possible the solution suggested,
Using modern means of communication, and
To plan the report within the time given.

In the discussion periods, between opponent and reporter as well as when the reviewer makes comments, great emphasis has traditionally been put on the way possible criticism is formulated. Unnecessarily aggressive behaviour will be punished by the jury. Remarks like "Obviously you have not understood the physics behind your reported solution" do not open for an efficient discussion and must be excluded. Adding the fact that an IYPT event, when hundreds of young students from all over the world meet and associate for a week, calls for some behavioural attitudes, one might add to the list the need for and development of

Social skills in a broad sense.

The selection of national teams

Just as is the case for the better known International Physics Olympiad different countries have adopted quite different strategies for selecting their national teams. Quite a few organize their own national qualifying competitions in order to find the best team for representing their country. In some cases the selected students are also invited to prepare for their performance in IYPT at a university. Other countries depend on a few enthusiastic physics teachers who trim and encourage pupils from their own classes.

The school curricula in different countries also differ substantially, making it more or less difficult to fit in the rather extensive preparation needed for students of the final year in upper secondary schools.

It is clear that if only the resulting ranking would be important for participating teams such different preparation possibilities could appear unjust. However, like in most other instances it is only fair that those who have the best preparation also reach the best ranking. In addition there are certainly many other positive features of participating which compensate for a less successful ranking.

Since in many countries girl students show less interest in physics than boys it is encouraging that a considerable number of girls do participate in IYPT. Recent years have even seen teams of only girls among the competitors, once from Poland and once from Australia. It is possible that the cross-disciplinary nature of some of the problems is a contributing cause.

The future of IYPT

After a period of difficulties to find willing hosts for the next IYPT events the situation is now encouraging in the sense that we seem to have a "line" of candidates for the next few years. In 2011 Iran will be the host and the Czech Republic is already committed for 2012.

An international organization, the World Federation of Physics Competitions ((WFPC) was recently set up. It held its fourth Congress in Baske Ostarije, Croatia, in July 2010. In the first issue of Vol. 12, their journal Physics Competitions gives a full account of the agenda of this meeting. Both national and international competitions are presented. In previous issues of their journal the impact of events like IYPT on the physics curriculum is discussed by experienced teachers who have also been organizers of different competitions.

In closing I should like to express my gratitude to the IYPT organizers and participants for providing an outstanding platform for social and professional contacts. In particular my period of presidency between 1998 and 2008 will be vividly remembered as a source of constant encouragement in the mission of transferring to colleagues and young people the enthusiasm for the cause of physics education in its broad sense.

I should like to thank A. Nadolny, former Secretary General of IYPT, for providing important details, especially concerning the history of IYPT