International Mathematical Olympiad

The International Mathematical Olympiad (IMO) is an annual six @-@ problem mathematical olympiad for pre @-@ college students , and is the oldest of the International Science Olympiads . The first IMO was held in Romania in 1959 . It has since been held annually , except in 1980 . About 100 countries send teams of up to six students , plus one team leader , one deputy leader , and observers .

The content ranges from extremely difficult algebra and pre @-@ calculus problems to problems on branches of mathematics not conventionally covered at school and often not at university level either , such as projective and complex geometry , functional equations and well @-@ grounded number theory , of which extensive knowledge of theorems is required . Calculus , though allowed in solutions , is never required , as there is a principle that anyone with a basic understanding of mathematics should understand the problems , even if the solutions require a great deal more knowledge . Supporters of this principle claim that this allows more universality and creates an incentive to find elegant , deceptively simple @-@ looking problems which nevertheless require a certain level of ingenuity .

The selection process differs by country , but it often consists of a series of tests which admit fewer students at each progressing test . Awards are given to the lowest percentage of the individual contestants . Teams are not officially recognized ? all scores are given only to individual contestants , but team scoring is unofficially compared more than individual scores . Contestants must be under the age of 20 and must not be registered at any tertiary institution . Subject to these conditions , an individual may participate any number of times in the IMO .

History

The first IMO was held in Romania in 1959 . Since then it has been held every year except in 1980 . That year , it was cancelled due to internal strife in Mongolia . It was initially founded for eastern European member countries of the Warsaw Pact , under the Soviet bloc of influence , but later other countries participated as well . Because of this eastern origin , the IMOs were first hosted only in eastern European countries , and gradually spread to other nations .

Sources differ about the cities hosting some of the early IMOs . This may be partly because leaders are generally housed well away from the students , and partly because after the competition the students did not always stay based in one city for the rest of the IMO . The exact dates cited may also differ , because of leaders arriving before the students , and at more recent IMOs the IMO Advisory Board arriving before the leaders .

Several students , such as Zhuoqun Alex Song , Teodor von Burg , Lisa Sauermann , and Christian Reiher , have performed exceptionally well in the IMO , winning multiple gold medals . Others , such as Grigory Margulis , Jean @-@ Christophe Yoccoz , Laurent Lafforgue , Stanislav Smirnov , Terence Tao , Sucharit Sarkar , Grigori Perelman , Ngô B?o Châu and Maryam Mirzakhani have gone on to become notable mathematicians . Several former participants have won awards such as the Fields Medal .

In January 2011 , Google gave ? 1 million to the International Mathematical Olympiad organization . The donation helped the organization cover the costs of the next five global events (2011 ? 2015) .

Scoring and format

The examination consists of six problems . Each problem is worth seven points , so the maximum total score is 42 points . No calculators are allowed . The examination is held over two consecutive days ; each day the contestants have four @-@ and @-@ a @-@ half hours to solve three problems . The problems chosen are from various areas of secondary school mathematics , broadly classifiable as geometry , number theory , algebra , and combinatorics . They require no knowledge of higher mathematics such as calculus and analysis , and solutions are often short and elementary . However , they are usually disguised so as to make the solutions difficult . Prominently featured are

algebraic inequalities , complex numbers , and construction @-@ oriented geometrical problems , though in recent years the latter has not been as popular as before .

Each participating country , other than the host country , may submit suggested problems to a Problem Selection Committee provided by the host country , which reduces the submitted problems to a shortlist . The team leaders arrive at the IMO a few days in advance of the contestants and form the IMO Jury which is responsible for all the formal decisions relating to the contest , starting with selecting the six problems from the shortlist . The Jury aims to order the problems so that the order in increasing difficulty is Q1 , Q4 , Q2 , Q5 , Q3 and Q6 . As the leaders know the problems in advance of the contestants , they are kept strictly separated and observed .

Each country 's marks are agreed between that country 's leader and deputy leader and coordinators provided by the host country (the leader of the team whose country submitted the problem in the case of the marks of the host country) , subject to the decisions of the chief coordinator and ultimately a jury if any disputes cannot be resolved .

= = Selection process = =

The selection process for the IMO varies greatly by country . In some countries , especially those in east Asia , the selection process involves several tests of a difficulty comparable to the IMO itself . The Chinese contestants go through a camp . In others , such as the USA , possible participants go through a series of easier standalone competitions that gradually increase in difficulty . In the USA , the tests include the American Mathematics Competitions , the American Invitational Mathematics Examination , and the United States of America Mathematical Olympiad , each of which is a competition in its own right . For high scorers in the final competition for the team selection , there also is a summer camp , like that of China .

In countries of the former Soviet Union and other eastern European countries , a team has in the past been chosen several years beforehand , and they are given special training specifically for the event . However , such methods have been discontinued in some countries . In Ukraine , for instance , selection tests consist of four olympiads comparable to the IMO by difficulty and schedule . While identifying the winners , only the results of the current selection olympiads are considered .

= = Awards = =

The participants are ranked based on their individual scores . Medals are awarded to the highest ranked participants ; slightly fewer than half of them receive a medal . The cutoffs (minimum scores required to receive a gold , silver or bronze medal respectively) are then chosen so that the numbers of gold , silver and bronze medals awarded are approximately in the ratios 1 : 2 : 3 . Participants who do not win a medal but who score seven points on at least one problem receive an honorable mention .

Special prizes may be awarded for solutions of outstanding elegance or involving good generalisations of a problem . This last happened in 1995 (Nikolay Nikolov , Bulgaria) and 2005 (Iurie Boreico) , but was more frequent up to the early 1980s . The special prize in 2005 was awarded to Iurie Boreico , a student from Moldova , who came up with a brilliant solution to question 3 , which was an inequality involving three variables .

The rule that at most half the contestants win a medal is sometimes broken if it would cause the total number of medals to deviate too much from half the number of contestants . This last happened in 2010 (when the choice was to give either 226 (43 @.@ 71 %) or 266 (51 @.@ 45 %) of the 517 contestants (excluding the 6 from North Korea ? see below) a medal) , 2012 (when the choice was to give either 226 (46 @.@ 35 %) or 277 (50 @.@ 55 %) of the 548 contestants a medal) , and 2013 , when the choice was to give either 249 (47 @.@ 16 %) or 278 (52 @.@ 65 %) of the 528 contestants a medal .

= = Penalties = =

North Korea was disqualified for cheating at the 32nd IMO in 1991 and again at the 51st IMO in 2010 . It is the only country to have been accused of cheating . There is some debate as to whether North Korea was actually cheating , especially in the 51st IMO .

= = Recent and future IMOs = =

The 51st IMO was held in Astana , Kazakhstan , July 2 ? 15 , 2010 .
The 52nd IMO was held in Amsterdam , Netherlands , July 13 ? 24 , 2011 .
The 53rd IMO was held in Mar del Plata , Argentina , July 4 ? 16 , 2012 .
The 54th IMO was held in Santa Marta , Colombia , July 18 ? 28 , 2013 .
The 55th IMO was held in Cape Town , South Africa , July 3 ? 13 , 2014 .
The 56th IMO was held in Chiang Mai , Thailand in 2015 .
The 57th IMO was held in Hong Kong in 2016 .
The 58th IMO will be held in Brazil in 2017 .
The 59th IMO will be held in Romania in 2018 .
The 60th IMO will be held in UK in 2019 .
The 61st IMO will be held in St. Petersburg , Russia in 2020 .

= = Notable achievements = =

The following nations have achieved the highest team score in the respective competition :
China , 19 times (from the first participation in 1985 until 2014) : in every year from 1989 to 2014 except 1991 , 1994 , 1996 , 1998 , 2003 , 2007 ;
Soviet Union , 14 times : in 1963 , 1964 , 1965 , 1966 , 1967 , 1972 , 1973 , 1974 , 1976 , 1979 , 1984 , 1986 , 1988 , 1991 ;
Hungary , 6 times : in 1961 , 1962 , 1969 , 1970 , 1971 , 1975 ;
United States , 6 times : in 1977 , 1981 , 1986 , 1994 , 2015 , 2016 ;
Romania , 5 times : in 1959 , 1978 , 1985 , 1987 , 1996 ;
West Germany , 2 times : in 1982 and 1983 ;
Russia , 2 times : in 1999 and 2007 ;
Bulgaria , once : in 2003 ;
Iran , once : in 1998 ;
South Korea , once : in 2012 .
East Germany , once : in 1968
The following nations have achieved an all @-@ members @-@ gold IMO with a full team :
China , 11 times : in 1992 , 1993 , 1997 , 2000 , 2001 , 2002 , 2004 , 2006 , 2009 , 2010 and 2011 .

United States , 3 times : in 1994 , 2011 , and 2016 .
Russia , 2 times : in 2002 and 2008 .
South Korea , once : in 2012 .
Bulgaria , once : in 2003 .
The only countries to have their entire team score perfectly in the IMO were the United States in 1994 (they were coached by Paul Zeitz) ; and Luxembourg , whose 1 @-@ member team had a perfect score in 1981 . The US 's success earned a mention in TIME Magazine . Hungary won IMO 1975 in an unorthodox way when none of the eight team members received a gold medal (five silver , three bronze) . Second place team East Germany also did not have a single gold medal winner (four silver , four bronze) .
Several individuals have consistently scored highly and / or earned medals on the IMO : As of July 2015 , Zhuoqun Alex Song (Canada) is the most successful participant with five gold medals (including one perfect score in 2015) and one bronze medal . Reid Barton (United States) was the first participant to win a gold medal four times (1998 @-@ 2001) . Barton is also one of only eight four @-@ time Putnam Fellow (2001 ? 04) . Christian Reiher (Germany) , Lisa Sauermann (Germany) , Teodor von Burg (Serbia) , and Nipun Pitimanaaree (Thailand) are the only other

participants to have won four gold medals (2000 ? 03 , 2008 ? 11 , 2009 ? 12 , 2010 ? 13 , and 2011 ? 14 respectively) ; Reiher also received a bronze medal (1999) , Sauermann a silver medal (2007) , von Burg a silver medal (2008) and a bronze medal (2007) , and Pitimanaaree a silver medal (2009) . Wolfgang Burmeister (East Germany) , Martin Härterich (West Germany) , Iurie Boreico (Moldova) , and Jeck Lim (Singapore) are the only other participants besides Reiher , Sauermann , von Burg , and Pitimanaaree to win five medals with at least three of them gold . Ciprian Manolescu (Romania) managed to write a perfect paper (42 points) for gold medal more times than anybody else in the history of the competition , doing it all three times he participated in the IMO (1995 , 1996 , 1997) . Manolescu is also a three @-@ time Putnam Fellow (1997 , 1998 , 2000) . Evgenia Malinnikova (Soviet Union) is the highest @-@ scoring female contestant in IMO history . She has 3 gold medals in IMO 1989 (41 points) , IMO 1990 (42) and IMO 1991 (42) , missing only 1 point in 1989 to precede Manolescu 's achievement .

Terence Tao (Australia) participated in IMO 1986 , 1987 and 1988 , winning bronze , silver and gold medals respectively . He won a gold medal when he just turned thirteen in IMO 1988 , becoming the youngest person at that time to receive a gold medal (a feat matched in 2011 by Zhuoqun Alex Song of Canada) . Tao also holds the distinction of being the youngest medalist with his 1986 bronze medal , alongside 2009 bronze medalist Raúl Chávez Sarmiento (Peru) , at the age of 10 and 11 respectively . Representing the United States , Noam Elkies won a gold medal with a perfect paper at the age of 14 in 1981 . Note that both Elkies and Tao could have participated in the IMO multiple times following their success , but entered university and therefore became ineligible .

The top 10 countries with the best all @-@ time results are as follows :

= = Media coverage = =

A documentary , " Hard Problems : The Road To The World 's Toughest Math Contest " was made about the United States 2006 IMO team .
A BBC documentary titled Beautiful Young Minds aired July 2007 about the IMO .
A BBC fictional film titled X + Y released in September 2014 tells the story of an autistic boy who took part in the Olympiad .

= = = Official = = =

Official IMO web site
Old central IMO web site

= = = Resources = = =

MathLinks Olympiad resources - IMO problems and solutions , IMO Shortlists , IMO Longlists and one of the largest collection of Olympiad problems in the world .