A Guide to Math Competitions

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1 Introduction

If you're a middle school-er just getting into Competition Math, all this may seem daunting at first. So many competitions, what do all the acronyms mean? This guide is meant to introduce some of the biggest competitions that we (the authors) participate in, and is no means comprehensive.

For the first time middle school competitive mathlete, read through sections 2-4, with sections 4 and higher being optional (but highly reccomended!) MATHCOUNTS is the primary competition for middle schoolers, and the AMC 8 helps get them ready for high school math competitions.

For high schoolers and high performing middle schoolers who want to practice competition math, sections 5-9 are for you.

2 MATHCOUNTS Rounds

MATHCOUNTS is the premier middle school contest. There are 4 rounds: Sprint, Target, Team, and Countdown, as shown from the MATHCOUNTS Coach Handbook:

WHAT DOES THE TEST LOOK LIKE? Every MATHCOUNTS competition consists of 4 rounds—Sprint, Target, Team and Countdown Round. Altogether the rounds are designed to take about 3 hours to complete. Here's what each round looks like.

Sprint Round
40 minutes
30 problems total
no calculators used
focus on speed and
accuracy

Target Round
Approx. 30 minutes
8 problems total
calculators used
focus on problem-
solving and
mathematical reasoning

*The problems are given
to students in 4 pairs.
Students have 6 minutes
to complete each pair.*

Team Round
20 minutes
10 problems total
calculators used
focus on problem-
solving and
collaboration

*Only the 4 students on
a school's team can take
this round officially.*

Countdown Round
Maximum of 45
seconds per problem
no calculators used
focus on speed and
accuracy

*Students with highest
scores on Sprint and
Target Rounds com-
pete head-to-head. This
round is optional at the
school, chapter and
state level.*

The individual score is calculated as Sprint Score[1] $+ \, 2 \cdot$ Target Score. This makes the maximum

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[1]Score = # of Correct Answers

individual score 46.

The team score is calculated as the average of the individual scores of the team members plus twice the Team Round Score. Countdown Round is unofficial in South Dakota.

3 MATHCOUNTS Competitions

There are 4 levels of the MATHCOUNTS Competition Series. The **School Round** is held at MMS the week before winter break. In this round, everyone competes individually in the Sprint and Target rounds, although we often do a Countdown Round[2] for fun. From the School round, the top four individuals become the MMS school team, while the next four students do not form a team.

The **Chapter Round** is located at SDSU in even numbered years, and NSU every odd numbered year. This competition is held in mid-February. The top 2 teams and the top 4 individuals not on those teams represent NE South Dakota at the state competition.

The **State Round** is held in Pierre, South Dakota every year in March. Here, the top teams and students from around the state compete to see who goes to the National Competition. The top 4 students[3] and the winning team's coach represent the great state of South Dakota in the National Competition.

The **National Competition** is held in a different location every year. For the 2017-18 school year, it will be held in Boston, MA. This competition is an extremely fun event where students meet other well performing competitors from around the country. There are 224 competitors from 56 teams[4]. The national participants get pins, t-shirts, and a yearbook for being in the top 224 in the nation.

More detailed information and lots of practice problems can be found in the MATHCOUNTS Handbook[5].

4 AMC 8

The AMC 8 is a 25-question, 40-minute, multiple choice examination in middle school mathematics designed to promote the development of problem-solving skills.

The AMC 8 provides an opportunity for middle school students to develop positive attitudes towards analytical thinking and mathematics that can assist in future careers. Students apply classroom learned skills to unique problem-solving challenges in a low-stress and friendly environment.

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[2]It is also used for tiebreaks. However, the only ties that are broken are for the top 8.

[3]Not necessarily on the same team

[4]Including the 50 states, Washington, DC, the State Department, The US Department of Defense, Guam, Puerto Rico, and the Virgin Islands.

[5]https://www.mathcounts.org/sites/default/files/u1706/NF1718PartialHBNoSolutions%28FINAL%29.pdf

MMS hosts the AMC 8 each November. Each question on the AMC 8 is worth 1 point. There is no penalty for guessing.

5 High School – MAA Circuit

5.1 AMC 10/12

The high school AMCs come in 4 different varieties: AMC 10 A, AMC 10 B, AMC 12 A, and AMC 12 B. The A and B varieties signify different times and tests that are taken. All the A tests are taken in early February, and all the B tests are held 15 days after the A test date.

In Brookings, SD, SDSU only offers the B test, so only the AMC 10 B XOR[6] the AMC 12 B may be taken. However, some years the high school offers the A test – talk to a high school math teacher if you would like to compete in the A test before the B. It is allowed to participate in one A test AND one B test.

The AMC 10 and AMC 12 are both 25-question, 75-minute, multiple choice examinations in high school mathematics designed to promote the development and enhancement of problem-solving skills. The AMC 10/12 provides an opportunity for high school students to develop positive attitudes towards analytical thinking and mathematics that can assist in future careers. The AMC 10/12 is the first in a series of competitions that eventually lead all the way to the International Mathematical Olympiad. This contest heavily favors problem solving skills over formula knowledge. **Many prestigious universities such as MIT and Carnegie Mellon ask for an AMC 10/12 score**. The score is calculated as follows:

$$6 * C + 1.5 * B + 0 * W$$

Since incorrect answers are worth less than a blank answer, a good idea is to not guess. The maximum score is 150.

5.2 AIME

High scorers (top 2.5% on the AMC 10 and top 5% on the AMC 12) are invited to take the AIME, the American Invitational Mathematics Exam. This is a challenging 15-question 3-hour exam.

The AIME is a 15 question, 3 hour examination, each answer is an integer number between 000 to 999. The questions on the AIME are much more difficult than those on the AMC 10 and AMC 12 competitions.

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[6]exclusive or

5.3   USA(J)MO

The United States of America Mathematical Olympiad (USAMO) and the United States of America Junior Mathematical Olympiad (USAJMO) are six question, two day, 9 hour total essay/proof examination taken at school. It is run in the exact same format as the IMO. In the USA(J)MO, a top score on any problem is a 7. The top 250 scoring AMC 12 participants (based off USAMO index[7]) are invited to take the USAMO. The top 250 scoring AMC 10 participants (based off USAJMO index[8]) are invited to take the USAJMO.

5.4   MOSP / MOP

The Mathematical Olympiad Summer Program (abbreviated MOSP) is a 3-week intensive problem solving camp held at the Carnegie Mellon University to help high school students prepare for math olympiads, especially the International Mathematical Olympiad. While the program is free to participants, invitations are limited to the top finishers on USA(J)MO.

One purpose of MOSP is to select and train the US team for the International Mathematical Olympiad. This is done at the end of MOSP via a team selection team selection test (TSTST). The top 18 students or so then take two team selection tests (TSTs) in their schools in the winter after MOP. The 18 who "pass" the TSTSTs also take the Romanian TST and the Asian Pasific Math Olympiad to see who the top 6 students are. The results of next year's USAMO, TST are weighted equally when selecting the US IMO team to mitigate "bad days".

The other important purpose of MOSP is to train younger students in Olympiad-level problem solving and broaden their mathematical horizons.

Students, participants, and alumni nearly universally call the program MOP, although the abbreviation MOSP is used in formal documents.

5.5   International Math Olympiad

The International Mathematical Olympiad is the pinnacle of all high school mathematics competitions and the oldest of all international scientific competitions. Each year, countries from around the world send a team of 6 students to compete in a grueling competition. Like the USA(J)MO, the competition takes place over 2 consecutive days. Each day 3 problems are given to the students to work on for 4.5 hours.

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[7]Fancy name for the number calculated by AMC 12 + 10 · AIME Score
[8]Fancy name for the number calculated by AMC 10 + 10 · AIME Score

6   USA Mathematical Talent Search

The USA Mathematical Talent Search (USAMTS) is a free mathematics competition open to all United States middle and high school students. There are 3 rounds with 5 questions each worth a possible 5 points.

The USAMTS allows students a full month to work out their solutions. Carefully written justifications are required for each problem. The problems range in difficulty from being within the reach of most high school students to challenging the best students in the nation. Students may use any materials - books, calculators, computers - but all the work must be their own.[9]

Student solutions to the USAMTS problems are graded by mathematicians and comments are returned to the students. The goal is to help all students develop problem solving skills, improve their technical writing abilities, and mature mathematically.

The USAMTS is one of the ways to qualify for the American Invitational Mathematics Examination (AIME). However, it is much more difficult to qualify for the AIME through USAMTS than the AMCs. A very high score is needed[10] and few people qualify. Most likely, those people who qualified for the AIME through USAMTS also qualified for the AIME through the AMC 10/12.

With permission, USAMTS participant's names and addresses are provided to colleges, universities, and employers for recruitment purposes.

7   Online Math Open

Students may compete in teams of up to four people, but no student can belong to more than one team. There are two OMO contests yearly: a Spring Contest and a Fall Contest. Each contest consists of 30 questions ranging from early AMC level to late IMO level. Teams have 10 days to solve as many problems as possible. The designated team leader submits numerical answers to each of the problems. Only the team leader needs an account for a team to participate.

8   National Internet Math Olympiad

Monthly contests will usually have 40 minutes to solve 8 problems. The problems increase in difficulty and are roughly AIME difficulty. Each problem has a given weight (announced before the contest), and a contestant's score is the sum of the weights of the problems he/she scores correctly. At most 3 submissions are allowed per problem per contestant. Only the latest submission for a given problem will be graded. To participate in NIMO, an account must be made on the website.

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[9]Anything is allowed, except live chat, forums, and other things that allow you to chat with another person.

[10]This year it was 68/75

9 Parting Thoughts

We encourage you to participate in as many math contests as possible. It is also a good idea to make a list of (realistic) goals to achieve on each contest. That way you have at least one thing to work towards, if not other math goals.

We recommend AoPS books for contest preparation and subject learning. The (specifically) contest preparation books are CMMS, Volume I, and Volume II. The book Competition Math for Middle School is a good book to begin with, as it covers all five MATHCOUNTS and AMC 8 topics: Algebra, Counting, Probability, Number Theory, and Geometry. Volume I covers the difficulty of the AMC 10/12. Volume II covers the difficulty of advanced high school contests like the AMC 12 and AIME. The Introductory and Intermediate Series cover Prealgebra, Algebra, Counting & Probability, Number Theory, Geometry, Precalculus, and Calculus extremely thoroughly. More about AoPS books can be found at `artofproblemsolving.com/store`.

Finally, the only way to improve is to do more problems! Buy a math book, print out online handouts, or do practice tests. Also know that a lifetime mathematics journey is not a sprint, or any kind of race. Work on it at your own pace, be resilient especially when it is difficult, and eventually you will get more than contest results: you will have mastered the beautiful art of problem solving.

Keep calm and do the math!