

**MINNESOTA STATE
HIGH SCHOOL
MATHEMATICS
LEAGUE**

**LEAGUE MANUAL
2022 -2023**

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I. Introduction to the Minnesota State High School Math League

The Minnesota State High School Mathematics League was founded in 1980-81 by Macalester professor Wayne Roberts and was modeled after leagues that have flourished along the U.S. eastern seaboard since the mid-1940s. During the first year, four schools participated, followed by sixteen schools in the second year. The number of participating schools has grown over the years, with 167 schools in the League in 2021 – 2022.

The League exists to identify students with exceptional interest and/or mathematical ability, give them recognition and encouragement, bring them together with similarly motivated students, and introduce them to topics not commonly taught in the high school curriculum.

Although the League's focus and related activities tend to draw the attention of students with exceptional ability and interest in mathematics, they are inextricably relevant to educational practices for students at all levels of mathematical aptitude. The League has always believed that a program for gifted students is shortsighted if it is not developed in a way that strengthens mathematics education for all students.

Currently, the Minnesota State High School Mathematics League administers the original annual state-wide math competition (known as the Math League or Math Team) open to all qualified students attending schools in Minnesota and schools on the border of Minnesota. Also, as part of the All-State Math Team, the League invites high-performing students to participate in the American Regions Mathematics League (ARML), the Berkely Competition, the Harvard-MIT Math Tournament (HMMT), and the Carnegie-Mellon Math Tournament. During the summer, the League sponsors residential math programs (Summer Math Institute) for 7th – 12th grade students. All of these programs are outlined below.

II. Executive Summary of fall Board meeting decisions. New information for 2022 - 2023

Three, hold meets 1 – 4 in a hybrid manner, where some schools meet separately in their own school and grade the “new” way and other schools meet together and grade the “old” way

Four, hold meets 1 – 4 at a common site but use the “New” way

NOTE: the format for Meet 5 will be where all schools in a Division meet at a common site and administer the meet the “old” way.

The state tournament will be in person at South St. Paul on March 13th, 2023.

All individual events A – D will be NO Calculator for the year. Team events will also be NO Calculator. ***All answers will be integers.*** New wording, to help students arrive at the same integer answer, has been incorporated into the problem description. The new wording, information regarding releases of solutions, and challenges are in Appendix F.

A. Communication

Our website, www.mnmathleague.org, is updated on a regular basis. Important announcements will be posted. Check the website regularly. Email is also used regularly for communication. If necessary, coaches should alert the associate director of updated email addresses.

B. Schedules

The next three years of schedules were approved.

Competition Schedule	2022-2023	2023 - 2024	2024 - 2025
Meet 1	November 7, 2022	November 6, 2023	November 4, 2024
Meet 2	November 28, 2022	November 27, 2023	November 25, 2024
Meet 3	December 19, 2022	December 18, 2023	December 16 , 2024
Meet 4	January 23, 2023	January 22, 2024	January 27, 2025
Meet 5	February 13, 2023	February 12, 2024	February 10, 2025
Tournament	March 13, 2023	March 11, 2024	March 10, 2025

C. Math League Sponsored Summer Coaches’ Conference

Every year, the summer conference gives coaches the opportunity to renew friendships, learn new coaching techniques, discuss League rules, explore new mathematical ideas, and establish a sense of collegiality. The dates and location for the 2023 Summer Conference are to be determined.

D. The following is a summary of the actions of the Board of Directors at the fall meeting. Full unofficial minutes of the meeting are available from the League office.

1. Stacy Paleen, Reid Froiland, and Jenna Innes, were elected to new three-year terms as President, Secretary, and Treasurer , respectively, of the league.
2. Changes were approved as to how we allocate plaques to division winners and section winners. Also changes to the awards given to individual winners at the state tournament were approved. Going forward, division winners will receive a plaque and second place in the division will receive a certificate. Section winners will receive a plaque. Regular season trophies to the top three schools will not be awarded. Trophies to the overall individual winners for the season will be discontinued.
3. If a school does not meet during the December 19th week, that school can administer Meet 3 on Thursday the 15th or Friday the 16th. Exceptions like this reinforce the importance of the Code of Conduct that students need to adhere to.
4. The Board of Directors approved another way of administering a meet. Divisions can decide which of the **four** ways to administer a meet. The method chosen may vary from meet to meet. Schools are required to gather together at Meet 5. The four ways to administer a meet are:
 - A. Gather as a division at a common site and administer the tests the “old” way. The “old” way is defined as giving students a paper copy of the tests, correcting them at the site, and coaches entering the scores via the scoring website.
 - B. Gather at individual schools and administer the test the “new” way. The “new” way is defined as giving students a paper copy of the tests, allowing them to enter their answers online via the scoring website, and coaches verify the scores after the events are finished.
 - C. Gather some of the schools at a common site and allow the other schools in the division to gather at their own school and use a “hybrid” method to deliver the meet. Schools gathered at the common site will use the “old” way while the schools gathering at their own school will use the “new” way.
 - D. (approved at the fall board meeting) Gather schools at a common site and allow the schools to use the “new” way to administer the meet. This can be done if the division is confident that the site has sufficient Internet capability and the students have the device capability to do the meet online the “new” way.
5. Given that schools will be doing meets in different ways and at different times, coaches should stress the importance of not discussing the problems until all schools are finished. Coaches should not release solutions until all schools are finished. When all schools are finished, coaches will be sent an email allowing them to release solutions. Said email shall include a timeline and process for challenges.

6. The board approved the motion that all events A through D **and the team event** will be NO calculator for the 2022–2023 season. Also, all answers will be integers. Coaches should stress this with their students. An integer is defined as a number from the set $\{\dots -3, -2, -1, 0, 1, 2, 3\dots\}$. Answers written in the form of a fraction will not be correct. For example, $6/2$ will not be considered correct nor will $3/1$.
7. The league will be implementing a beta version of proof-based problems to be sent to coaches three weeks prior to a meet. Solutions to these proof-based problems will be sent to coaches one week prior to the meet. These problems will be voluntary but could be instructive and help students understand the topics for the meet.
8. Given that schools may be added in the following two weeks, the Board approved a motion to finalize division and section placement by October 14th.
9. A sample meet 0 will be available for practice purposes on October 24 and October 31.
10. The Board approved some minor wording changes to the Manual

III. Math League Competition Rules

A. Eligible Individuals and Teams/Registering a team

Math League/ Math Team is a competition for both individuals and teams. Math League/Math Team has two components: the regular season and the State Tournament. Members are U.S. high schools in or bordering on the State of Minnesota. Member teams are placed in a Division and Section based on criteria outlined below.

Each year, schools need to notify the League of their intent to participate by completing the Letter of Intent Google Form by September 1st. Each school team is required to pay a fee of \$600 to participate in the League. Payment of the registration fee must be received by October 15. Schools with math team rosters of fewer than 5 students may petition the League by October 15 to request a reduced registration fee.

Individual contestants must be regularly enrolled students in a participating Senior High School or a Junior High School/Middle School in the district of the Senior High School. The number of students that can participate from a school is unlimited.

Students with disabilities may fully participate in the League. Coaches of these students should contact the League office to discuss arrangements for accommodations.

Individual Participation for any student without a Math team

Home-schooled students or students who attend schools having no official Math Team may fully participate with another school's math team unless school policy prohibits such participation. Students can also register directly with the League as individuals and will be assigned to the appropriate geographical Division. Students are eligible for all individual awards and honors within that Division and at the state level. Individual students must be accompanied by an adult chaperone at all meets. The cost for an individual student is \$100.

B. Division, Class, and Section Structure

See Appendix B for a list of current Divisions. See the Math League website, www.mnmathleague.org, for Class and Section assignments.

Division Creation History and Current Maintenance

As of fall 2022, there are 26 divisions in the League. These divisions were formed many years ago. The 26 divisions are from all corners of the state. Divisions are composed of schools that are geographically close. This has several advantages:

1. expedition of in-person meets
2. representation across the state in Board discussions. Division coordinators are automatically Board members
3. representation across the state at the state tournament as division winners automatically qualify for the state tournament
4. Recognition of students from all corners of the state since the high scoring students in a division receive awards

It is desirable to have Divisions of at least 5 teams. Typically, the league would prefer divisions to have between five and eight teams. Smaller Divisions can give rise to a feeling of inequity.

The League will do what it can to maintain the 26 divisions. If a division falls below five members, the league will work with the division coordinator and the surrounding schools to find more schools to join the math league. If those efforts are unsuccessful, the league may start a process of moving schools to another division.

Division Alignment Policy

New schools, merging of existing schools, schools dropping out of or joining the League, the forming of new athletic conferences: these and other changes require that each fall we do some reorganizing of our divisional structure. In setting up Divisions, the office staff should observe the following guidelines:

- Member schools should, insofar as possible, be put in a division with schools where they are most comfortable.
- Unless prompted by external requests, we should attempt to keep intact the same Divisions from year to year.
- When an existing Division is to be changed slightly by addition or deletion of a team or two, this should be done with the cooperation of the Division Coordinator.
- Great effort should be made to have Divisions consist of at least 5 teams.
- When major realignments are undertaken, coaches of all teams affected should be invited to a meeting to discuss implementation issues. In all cases, alignment of Divisions worked out through negotiations between the office staff and the affected teams must be approved by the League's Executive Committee.

Division Coordinator

Each Division should, as its last act of business at the conclusion of a season, appoint a Division Coordinator for the following season. It is permissible, even advisable, to have the same person serve as Division Coordinator for several successive years.

The Division Coordinator becomes a member of the League's Board of Directors and represents the Division at the Annual Fall Board Meeting and at any special meetings of the Board. A Division Coordinator who cannot

attend a meeting of the Board should appoint another coach from the Division who then becomes a voting member for that meeting. An annual meeting will normally be scheduled in late September. At this meeting, any pending questions about League rules will be settled, alignment of teams into Divisions will be tentatively settled, and host schools in each Division should be designated for the coming season. Division Coordinators should contact schools in their Division before this meeting and come to the meeting with a list of host schools to give to the League Associate Director, if the Division is meeting together.

Class and Section Structure for State Tournament Qualification

For the purpose of qualifying for the State Tournament, the schools in the League will be organized into three Classes as outlined below. Each Class is composed of 8 Sections with schools placed in a Section based on similar geographic location.

Class Assignment

Placement of teams into Classes shall be based on enrollment numbers from the Minnesota State High School League for the upcoming two-year cycle. Class assignments will be for two-year cycles. The current two-year cycle ends in 2023. After a two-year cycle is completed, adjustments in Classes are made based on the averages of the previous two years of performances. Class AA and A teams who average in the top 15 overall in the regular season in the previous two years would be moved to Class AAA for the following two years. Class A teams who average in the top 50 in the regular season in the previous two years would be moved to Class AA for the following two years.

Teams that have been moved to a higher Class will be returned to the Class dictated by the most recently available enrollment numbers if the 2-year review dictates it. The teams will be moved if, during the two years they were moved to a higher Class, they did not maintain the standard by which they were moved up. For instance, if a Class AA or Class A team had been moved to Class AAA due to being in the top 15 based on their two-year average, but did not maintain that top 15 average, the team would be placed in the appropriate Class for their performance. This could be Class AA, if a Class A team met the performance criteria for placement in Class AA, or moved back to Class A. If a Class A team was moved to Class AA due to being in the top fifty, but did not maintain the top fifty status for the two years they were moved up, the team would be moved back to Class A.

Any school will have the option to “play up” to a higher Class by declaring their intent to do so prior to October 1 of the beginning of the two-year period. Teams will be notified of approval of their request to opt up by October 15.

Class placement for schools added to the League in the middle of a Class assignment cycle shall be at the discretion of the Executive Committee or its designee.

C. Regular Season Procedures

Overview of Season Structure and Competition

The regular season of the League consists of 5 meets as noted in the schedules. Teams and individuals compete in Divisions; the teams either meet all together, apart online, or some hybrid of the two. The number of students that can attend a meet is unlimited and each student’s score is recorded for individual honors. However, only 8 pre-selected student scores are counted toward the total team score (see further explanation below). Individual and team scores are kept for all meets and cumulative scores for individuals and teams are used to determine

invitations to the State Tournament. The League recognizes team accomplishments by awarding trophies in each Division and in each Class.

Meet Rules

Each meet is organized into two parts, “Individual Competition” and “Team Competition,” as follows:

Individual Competition

Each student can only compete in two of the four events during any single meet. The events are labeled A, B, C, and D but are essentially Algebra I topics (event A), Geometry topics (event B), Trigonometry/Pre-calculus topics (event C) and Algebra II/Analysis topics (event D). Each event has four questions. The first question is worth 1 point while the other three questions are each worth 2 points for a total of 7 points per event. Questions typically increase in difficulty within each event.

In each event, the students are given 15 minutes (exception: Event 5A is a 20 minute event) to solve as many of the four questions as they can. Students are not allowed to communicate with each other during the individual events. Topics for these events vary by meet and are outlined in the appendices. Students may, but are not required to, compete in a different pair of events from one meet to the next. Participants’ scores in individual events count towards their cumulative season individual scoring totals, regardless of whether or not they are one of the pre-selected scoring students (see Team Competition below).

Team Competition

Since the number of participants is unlimited, larger schools would have an advantage if all student scores were counted for the total team score. To mitigate this advantage, coaches must identify 8 students prior to each meet to be the official scorers for the team for that meet. These 8 scoring students must each be entered in two events, with 4 students per event. Students therefore still compete in two events to keep individual scores comparable.

The 8 scoring students can vary from meet to meet, but for any given meet, those 8 students representing their school shall be clearly indicated in the Math League Online Scoring and Reporting System roster before the meet begins. Under no circumstances shall a team be allowed to identify its scoring students for a particular meet after grading of the first event at that meet has begun. It is important to note that the 8 scoring students’ individual scores not only count towards their cumulative season individual scoring total, but also towards the Division-wide, Class, Section and Statewide ranking of their team.

After the individual events are completed, the 8 scoring students (but none of the others who have participated as individuals) compete in a final team event consisting of 6 questions. They are given 30 minutes for this event during which they can cooperate with one another in order to produce and submit a single set of answers. Teams are sequestered in different rooms with the intention that they cannot hear other teams’ discussions. Each question on the team event is worth 4 points, for a total of 24 points. The team event score plus the sums of individual event scores of the 8 team members determines the official team score for the meet.

Team Composition, Scoring, and other Rules

1) *Age Restrictions on scoring team members*

No more than 6 of the 8 scoring team members shall be beyond the 10th grade.

Penalties for Age Restriction Violations

If all 8 of the scoring team members are beyond the 10th grade then the two students with the highest scores will have their totals removed from the team score. There will be no penalty for the team event.

If 7 of the 8 scoring team members are beyond the 10th grade then the one student in grades 11 or 12 with the highest score will have their totals removed from the team score. The score for the eligible student in grades 9 or 10 still counts, even if it is the top score. There will be no penalty for the team event.

2) *Distribution of Team Members across events A - D*

Important: A school with 8 scoring team members cannot allocate its 8 team members unevenly – e.g. have 5 students in event A and 3 students in event B. Teams with 8 scoring team members may only have 4 team members in any one event A, B, C, or D.

Exception: Some teams may not have a full complement of 8 participants and therefore may not be able to get a full slate of 4 students per event. These teams can have uneven allocations but still cannot have more than 4 students per event.

3) *Errors in event participation*

More than 4 scoring team members in an event: No more than 4 scoring team members may participate in an individual event. If more than 4 participate, *the 4 lowest scores are used*. The individual points are not taken away from the student; only the team score is affected.

More than 2 tests taken by a student: A student (team member or non-team member) **may not** participate in more than (2) events (A, B, C, or D) at a meet. If an individual takes more than 2 tests at a meet, the two lowest scores are used for that student. If the student is on the scoring team, the team score will be updated to reflect the individual's revised score, regardless of the student's score on the events they were pre-selected to take.

4) *Tabulation of Points for Individuals*

Individuals (team scorers or not) can earn up to 14 points in any one meet for a possible total of 70 for the five-meet season. The scores of scoring team members will be weighted using the following formula:

$$(\text{Event Score}) = (\text{Base Score}) + \ln \frac{1 + (\text{number of students attempting the question})}{1 + (\text{number of students correctly answering the question})}$$

The weighted scores will be used to rank individuals statewide and within their division.

Points are tabulated and the top 50 individuals and ties are posted on the League web page. Cumulative weighted scores are used to determine divisional honors and individual invitations to the State Tournament.

5) *Tabulation of Points for Teams*

The maximum team score for a meet is 136 points and is based on the raw scores of the scoring team members (14 perfect score for each of the 8 individual scoring team members and a perfect 24 team event score) for a possible 680 points for the five-meet season. Cumulative points are tabulated and reported to the League. The top 50 teams (and also those teams tied for 50th place) are posted on the League web page.

6) *Ranking of Teams within Divisions and Sections*

For the sake of ranking within Divisions and Sections, teams are awarded ordinal ranking points at each meet as follows. If n is the number of schools in the Division or Section, then:

The 1st place team earns $n + 1$ ordinal points

The 2nd place team earns $n - 1$ ordinal points

The 3rd place team earns $n - 2$ ordinal points

The pattern continues until the last place team at the meet earns a minimum of one ordinal point.

A team that does not participate in a meet will not receive any points. In case of a tie at a meet, the ordinal points normally awarded for each place are averaged and awarded to each tied team. For example, if there is a 3-way tie for second place, the second, third and fourth place ordinal points are averaged and awarded to each team.

Teams are ranked in their Division and Section by cumulative ordinal points, not overall total season points. If there is a tie in ordinal points after five meets, the Division or Section winner will be the team with the most season points.

7) *Calculator Usage*

Per Board action in September 2022, the current policy states that **NO calculator** can be used for any event. We allow 2nd language translators, pencil and eraser - AND NOTHING ELSE - especially CELL PHONES. Cell phones used as a 2nd language translator need prior approval of the Division Coordinator and the League Associate Director. Scratch paper is to be supplied by the host school.

Topics for Events

Below is a broad overview of the topic areas of each event. See Appendix C for a complete list of topics covered per event per meet. Keep in mind that topics from previous events can occur in subsequent events.

Event A - Algebra I topics

Event B - Geometry topics

Event C - Trigonometry/Pre-calculus topics

Event D - Algebra II/Analysis topics

Given the choice Divisions can make as to how they run a meet, there are 2 sets of instructions

INSTRUCTION ONE: Schools meet online

See videos at scoringmnmathleague/help for videos describing how to run a meet and coaches' responsibilities or view Power Point at Coaches Corner.

Here are steps outlined for each coach

D. Steps Prior to Meet 1

- Edit team roster adding and removing students
- Student Accounts
 - Each student will have their own account. Go to Team Admin Student Accounts to generate and retrieve their user names and passwords.
- Team Communication
 - If you are not able to be physically present with some or all of your students, you will want to determine a method such as zoom or google meets for you to communicate with them as well as for the scoring team members to communicate with each other.
- At least once, run through the practice meet with your students so everyone understands the process.

E. Steps For Every Online Meet

- Meet Setup
 - Go to Team Admin Team Meet Setup
 - Select the students on your scoring team and what events they will be in
 - CHANGE: Previously optional to preselect events for alternates but now that must be done or they will not be able to compete
- Control Competition
 - Go to Meet Op Online Comp Control
 - Select who the recorder will be for the scoring team and optionally alternates recorder.
 - Activate Individual Events (single time block during which students will do both their events.)
 - Activate Team Event
- Verify Grades
 - Go to Meet Op Grade Online Taken Events
 - May be started as soon as some students have finished their first event
 - Individual Events
 - Select each student and verify auto-scoring was correct.
 - Mark team done with event
 - Team Event
 - Select scoring team and alternates and verify auto-scoring
 - Mark team done with meet

INSTRUCTION TWO: Schools meet in a common place

Structure of a Meet

Divisions run meets somewhat differently but often employ a structure resembling the following:

- i. Convene all students in a central gathering space

- ii. Welcome students, serve refreshments, and remind students of the rules
- iii. Gather graders in a separate room and review problems and solutions
- iv. Announce Event A and direct Event A participants to designated room(s)
- v. Administer Event A and set up Event B
- vi. Bring Event A student answers to graders
- vii. Post Event A answers so students can learn solutions or challenge scoring
- viii. Repeat previous four steps (iv. – vii.) for Events B,C, and D
- ix. Allow students time to review all solutions to Events A, B, C, and D or challenge scoring
- x. Announce team event and move teams to separate rooms
- xi. Administer team event
- xii. Bring answers to graders
- xiii. Post team solutions and allow challenges
- xiv. Disallow challenges after 15 minutes; finalize and report scores

Proctoring Individual Events

It is suggested that in Individual Events, tests and scratch paper be laid on desks, face down, before contestants enter the room. It is also suggested that contestants from the same school should not sit next to each other. In some Divisions, contestants write their names and schools on the backs of the exams before turning them over on the signal to start. The proctor should give a two-minute warning before the end of the event. Contestants should lay their pencils down and turn their papers over when time is called. The proctor collects papers off the desks after contestants leave.

Team Event:

Each team participating the team event requires a proctor. An individual proctor may be assigned more than one team to proctor.

Coaches' Duties

Before the day of the meet, the Host Coach shall prepare an assignment sheet to be given to each visiting coach upon arrival. This sheet should assign coaches (and perhaps extra people as needed from the host school) to:

- Serve as proctors of Events A, C
- Serve as proctors of Events B, D (This allows proctors for Event B to set up the room for Event B while A is underway, etc.)
- Serve as graders (2, preferably 3 or more)
- Serve as a proctors of teams during team event.
- Monitor waiting areas, supervise distribution of refreshments (if any)

These assignments should leave the host coach free to respond to unexpected requests and generally oversee the meet. The assignment sheet should also give locations for the various events.

Rooms Needed

At each meet a number of rooms are needed as indicated by the following suggestions.

- Large meeting area for students (initial announcements, announcing of events, holding area, posting of solutions and scores, etc.)
- One room or set of rooms for Events A and C; similarly for Events B and D.
- A room for each team (and for alternate teams if your Division allows them) for use during the team event.
- A room, preferably isolated from areas of activity, for grading. Keep exam materials here during the meet; proctors pick them up as needed. Materials should be turned over so they cannot be read while the meet is in progress.

Displaying Scores

Before the meet, prepare a scoreboard large enough to be seen at some distance. The scoreboard should list team total points accumulated during the season so far. A large chalkboard will do, but many Divisions use poster board which can then be awarded to the team winning that day's meet so they can display it the next day at their school. Some Divisions use other technology (overheads, monitors) for displaying results.

Copying Materials

Try to have access during the meet to a duplicating machine just in case you run short of materials.

Grading

Graders receive a League provided answer key with which to grade student tests. Graders should mark questions correct if the student answer matches the provided answer. Answers that do not meet this criteria should be marked incorrect.

Once the tests are graded, the scores are then entered into the Math League Online Scoring and Reporting System at <http://scoringmnmathleague.org>

Students may challenge an answer marked as incorrect, using the Challenge Procedure described in Uniform Grading Procedures (Appendix F).

Refreshments

Some Divisions serve refreshments to participants at each meet; some do not. Such a practice does, of course, appeal greatly to the participants, and can often be funded either by school funds, the PTA, etc. The League does not provide funds for meet refreshments. Host coaches should follow practices established within their Division.

Scheduling and Postponement of Meets

All meets are scheduled on Mondays and Tuesdays. Meet dates are selected by the Board of Directors and schools are encouraged to place meets on their calendars as soon as they are published. Postponement or cancellation of a meet because of weather conditions is a decision made at the divisional level, typically by the designated Division Coordinator, working within any guidelines the Division has established. The League Office shall be notified as soon as possible of any postponement, and the Executive Committee shall, in exercising its

right to extend special State Tournament invitations to top-scoring individuals, weigh any possible effects of postponed meets.

SPECIAL CIRCUMSTANCES: The League acknowledges that special circumstances, other than weather conditions, may arise that may affect team or individual participation at a meet. Any variation from the standard meet procedures that have been set forth in this manual must obtain prior approval by the Executive Committee or its designee.

End of Season Honors and Awards

Division Coordinators, working with guidelines developed by Division Coaches, should plan a suitable awards ceremony at the conclusion of the regular season. This most often takes the form of a dinner (or a pizza party) paid for by an area industry (or by assessing each school in the Division). Division Coordinators may forward bills for their recognition event of up to \$70 per team to the League office. Most award ceremonies have been held in conjunction with Meet 5, and include all students who have participated. This format may be changed by any Division wishing to do so, but it should be remembered that one goal of the League is to recognize effort and achievement in mathematics, to give increased visibility to activities available to those with interest and ability in mathematics, and to encourage students with mathematical talent to pursue further training in the discipline. The recognition event should be consistent with that goal. Media coverage is of course desirable. To assist the schools in recognizing teams and students at the end of the year, the Board of Directors has approved the following program of awards for participants in the Minnesota State High School Mathematics League:

Team Awards

- The League will award plaques to the first-place team in each Division based on the cumulative ordinal scoring. Two plaques will be awarded in Divisions of 9-12 teams, 3 plaques in Divisions of over 12 teams. In addition to an engraved statement of achievement (identifying the League, the Division, and the year), each plaque will have room for a photo and the names of the coach and each school participant who (1) participated as a team member or as an extra in at least three of the five regular meets, and (2) was selected at least once during the season as a member of the school's team.
- Should there be a tie for first place between teams in a Division based on cumulative ordinal scoring, each team will receive a First Place Division award
- The League will (as of 2022-2023) not be awarding regular season trophies to the top 3 schools in the regular season
- The League will (as of 2022-2023) be awarding Section Winner plaques similar to the Division winner plaques

Individual Awards

- The League will award a certificate suitable for framing and a pin to the individual on each team who has over the season accumulated the most points.
- The League will provide awards to students in each Division who accumulate the most points. The top three awards will be desktop accessories (a pen holder, a marble paper weight, a mug) with a suitably inscribed plate. All Top Division Students according to the schedule below will receive pins and certificates. The desktop awards will change from year to year in anticipation that some students may win in successive years, and the number awarded in a Division will vary with the size of the Division as follows:

Teams in Division	Desktop Award	Division Pins	Team Pin	Team Plaques
1-8	3	10	1 per school	1
9-12	4	15	1 per school	2
Over 12	5	16	1 per school	3

(Unless the League Associate Director is otherwise instructed by the Division Coordinator, the awards will be sent to the Division Coordinator who should check them beforehand to see that all is in order.)

- The League will award trophies to the individuals that finish first, second, and third in individual scoring (overall across the state) during the League's regular five-meet season. These awards will be presented at the State Tournament.
- Also, by Board action in 2022, students who score a perfect 70 will receive a certificate honoring that achievement.

Schools are also encouraged to recognize individuals who participate on their mathematics team. The awards (a school letter, a pin of some kind) and the method of representation should give recognition to the student and increase school awareness of the activity. These awards (cost, decision as to who receives them) are completely the responsibility of the local school.

League Comments on Building a Team, Level of Difficulty

League policy requires that no more than 6 members of a school's 8-member team can be beyond 10th grade. The general expectation is that 2 members will be 10th graders, and 6 members will be 11th or 12th graders. Schools may include 9th or even 8th graders from their system, but to compete effectively, such students would have to be familiar with mathematical topics not usually taught at their grade level. A coach wishing to build for the future might encourage a 9th grader to come to meets and compete as an extra, particularly in Event A.

Event A is generally restricted to topics covered in traditional Algebra I and II courses. To emphasize the importance of geometry and to guarantee a second event in which a 10th grader has a good chance of scoring points, Event B always covers topics in geometry.

It must be understood that the topics listed for a particular event are intended as an indication of the primary emphasis, not as a complete list of everything a participant must know. An effort is made to draw upon material generally covered prior to the topics listed, but varying order of presentation from school to school makes this difficult, and certain topics (the theorem of Pythagoras, proportions, solving simple equations) are likely to crop up everywhere. Event A of a meet may use all topics of previous Event A's; similarly for events B, C, and D. By keeping the same topics for corresponding events from one year to the next, it is intended that a file of exams from previous years will help participants anticipate the kind of questions to be expected.

Review is, in fact, to be encouraged at every level. Team Events always emphasize topics drawn from Individual Events of the meet, sometimes using a question that is only a slight variation of one used in an Individual Event earlier in the meet. Also watch in Team Events for variations of some of the more difficult questions that were used in meets earlier in the season. NOTE that to prepare questions for event 5D, it is necessary for the problem writer to read through the previous year's AMC 12 (contest A and B) very carefully. The influence of this reading may be detected throughout the season, and the AMC contest materials can always be recommended as a source of sample questions.

Event A of Meet 5 focuses on puzzle problems. This is because media coverage, if we get it, commonly reports on the final meet. Puzzle problems are the problems most easily worked into an article intended for the general public. At the same time, such problems frequently require more careful reading and more time to do some experimenting and guessing; and since we do want to legitimately claim that our students do solve such problems, the time limit for this Individual Event is 20 minutes.

F. State Tournament Procedures

Overview of State Tournament Structure and Competition

The Math league culminates its season with an end-of-the-year State Tournament. There are three components to the State Tournament: an Invitational Event in which top scoring individuals from the regular season compete directly with each other, a Math Bowl competition staged as a public quick-response event between top scorers in the Invitational, and finally, a Tournament Team Contest that follows the regular season meet rules (with minor time adjustments). Individuals are invited to the State Tournament on the basis of their standing in their Division or their overall standing in the state (see further explanation below) Teams are invited to the State Tournament on the basis of their standing in their Section or their overall standing in their Class or in the state (see further explanation below). Awards are given at the end of the meet for outstanding performances. Costs of this tournament, including the cost of the recognition dinner, are paid from League funds. Those who drive more than 50 miles to the tournament site may elect to be housed overnight by the League.

Tournament Invitational Event and Math Bowl

Tournament Invitational Event participants

Invitations to individuals to participate in the Tournament Invitational Event will be extended according to the following procedures.

- i. The top-scoring individual from each Division shall be invited. If the top-scoring individual cannot attend, the second-place individual will be invited.
- ii. From the list of top-scoring individuals in the League, ranked on a statewide basis in order of weighted scores earned during the regular season, the top 50 students shall be invited.
- iii. The Executive Committee or its designee may invite other students who because of individual circumstances may not be selected in steps 1 and 2 but who have compiled outstanding individual records.

The Tournament Invitational Event

The Invitational Event is a 30-minute test with a maximum score of 24 points. The event consists of eight quickie questions (one point each), four questions intended to be equivalent in difficulty to the three 2-point questions that normally appear on regular season Individual Events (two points each), and two multiple part challenge questions (four points each).

The top ten scorers in the Invitational Event then compete in the Math Bowl.

The Math Bowl

The Math Bowl is a quick-response elimination competition that operates under the following rules and procedures.

- i. The top ten students from the Invitational Event will be selected to participate. Seasonal scores will be used to break ties.
- ii. The names of the participants will be announced at the time of the event. The participants will be asked to come to the stage and proceed to an assigned seat at a table on stage. They will be asked to print their name and school at the top of a name placard and will be given a small whiteboard on which to write their answers. A dry-erase marker and eraser will be provided.
- iii. Each student will be given a written problem (one problem at a time) with enough space under the problem to do their work. A time limit is imposed on each problem and when time is called, participants hold up their answers. A point is awarded to each student displaying a correct answer.
- iv. At the end of eight (8) problems the participant(s) with the top number of correct answers (including ties, if any) will continue and the rest of the competitors will leave the stage.
- v. After each additional question, those who had wrong answers will be asked to leave the stage. This will continue for as many as 7 more questions. If at the end there are still ties, the Invitational scores will be used to break the ties.
- vi. One winner is declared (if possible). The winner receives a trophy.

Tournament Team Contest

Modifications from Regular Season

Teams compete against each other at the State Tournament just as they did during each meet in the regular season. The usual rules that govern all meets (including the rule that a team includes two students not beyond 10th grade) will be followed, with the following modifications:

- i. Event A will cover any topic listed in any A event during the regular season; similarly for events B, C, and D.

- ii. Challenges to answers must be submitted no later than 30 minutes after the team event has concluded.

Any ties occurring between teams will be settled on the basis of which of the tied teams scored the most points during the regular season.

Tournament Team Participants

Invitations to teams will be extended according to the following procedure:

- i. The team with the best ordinal score from each Section is invited to the State Tournament. In addition, 2 wild card teams per Class are invited to the State Tournament. The wild card teams are the two highest raw scoring teams in the Class that didn't win a Section.
- ii. Therefore, 10 teams from each Class receive automatic invitations. At this point, thirty teams are thusly invited to the State Tournament. The rest of the State Tournament field is filled out by choosing the next 6 to 10 highest raw scoring teams from across the state, regardless of Class, for a full State Tournament complement of 38 teams.

Number of students per school at Tournament Team Contest

Invited teams are to bring eight team members to represent their school in the tournament. Teams wishing to bring 1 alternate may do so, but will be asked to pay a fee for the alternate to cover the costs of room and board. Alternates will be formed into one or more teams to compete as Alternates Team 1, Alternates Team 2, etc. in the tournament, but these teams will not be eligible for awards.

Teams requesting extra facilities (a practice room) or awards for Assistant Coaches will be asked to pay for extra costs incurred.

Recognition of Individual Scoring Leaders

The League will award trophies to the individuals that finish first, second, and third in individual scoring at the State Tournament. Those students who reach the Invitational Event at the tournament will receive certificates. The scores received at the Invitational together with the scores received at the tournament will determine the first, second, and third place for Tournament Scoring Leaders. In order to be considered for an Individual Award for individual scoring honors, a student must be involved in at least one of Events C or D during the State Tournament.

When donors provide scholarship funds, these scholarships shall be awarded to individuals ranked highest on the basis of the sum of the season total score and the tournament total score. Such awards will be deferred until after high school graduation and sent directly to the student upon League receipt of a letter indicating how the student plans to use the money to further his/her education. If said letter is not received within 3 years of graduation, the student forfeits the scholarship and the monies are returned to the scholarship fund.

Recognition of Top Scoring Teams at the Tournament

At the tournament, awards will be given for the top scoring teams in each of the Classes. In addition, an award for the team that 1) does not earn an award within any of the Classes and 2) demonstrates the most improvement from their average regular season score compared to their State Tournament score

will be also be presented at the State Tournament. This award is known as the Quantum Leap award and is a distinction of significant team improvement.

Tournament Weather Procedures

Owing to scheduling commitments made for hotel rooms, for the auditorium, cafeteria and classroom space at the host school, our policy is to hold our tournament on the scheduled day if it is at all possible. This recognizes the fact that our tournament, once cancelled, would be extremely difficult to reschedule.

If severe weather conditions seem to threaten our ability to proceed with the tournament, information shall be available via the following instruments:

- i. on our web site: www.mnmathleague.org
- ii. on Metro radio/TV channels
- iii. via email message

The executive committee will try to make any determination on the cancelling of the tournament by 7 AM on the day of the tournament. Travel conditions typically vary across the state, as do intended modes of travel (bus, van, private automobile). It is expected that participants in the tournament will in all cases follow the rules and directives of responsible officials of their school in deciding whether to attempt the trip to the tournament.

If participants from a school can assemble themselves locally but cannot make the trip to the tournament, they may, if arrangements are approved ahead of time by the League's Executive Committee, participate electronically. Scores obtained in this way by people taking the exams at the same time in another location shall be posted with the scores of teams at the meet, and shall qualify for awards as if they were present.

For teams and individuals unable to be present at the tournament to accept awards they have earned, the League Director shall make a good-faith effort to personally present such awards in an appropriate venue (school awards night, honors banquet, etc.). In cases where several invited schools from the same area of the state cannot get to the tournament, the League shall cooperate with said schools in setting up a suitable recognition event in their area later in the spring.

IV. Other League-Sponsored Activities

A. Minnesota All-State Math Team

American Regions Mathematics League Competition (ARML)

Each spring approximately 80-100 students are invited to be participants on the Minnesota All-State Math Team, representing Minnesota at the national American Regions Mathematics League (ARML) competition. In addition, approximately ten to fifteen students from grades nine and ten are invited to be ARML “students in training.” Selection for the All-State Math Team and students in training is based on a combination of a student’s individual performance during the regular League season, his or her score on the AMC 12 (or AMC 10), and his or her individual score at the State Tournament. The top ten scorers in each of these three categories are each guaranteed an All-State Math Team invitation.

A student who accepts an invitation to be a member of the Minnesota All-State Math Team has the following responsibilities:

- i. Attend three mandatory all-day practices held in the Twin Cities on the first three Saturdays in May. (Exceptions are granted on a case-by-case basis.)
- ii. Participate at the ARML Competition held at the University of Iowa on the last weekend in May or the first weekend in June.
- iii. Raise \$350 to cover the cost of travel to ARML

Letters of invitation should be sent to the students via their coaches within the week following the State Tournament. A letter will also be sent to the principal of the school attended by each invitee recognizing the honored student and asking for help in raising the necessary funds.

A student who accepts an invitation to be a student in training has the following responsibilities:

- i. Attend three mandatory all-day practices held in the Twin Cities on the first three Saturdays in May. (Again exceptions are granted on a case-by-case basis.)
- ii. Be willing to participate at the ARML Competition held at the University of Iowa on the last weekend in May or the first weekend in June if selected to be a member of the All-State Math Team.
- iii. Raise \$350 to cover cost of travel to ARML, if selected as member of the All-State Math Team and going to the ARML contest

After one or more of the practice sessions, the coaches may decide to invite one or more of the students in training to be members of the All-State Math Team. At that time, a letter will also be sent to the principal of the school attended by each invitee recognizing the honored student and asking for help in raising the necessary funds.

A total of sixty students, four teams of fifteen, will ultimately be selected for the All-State Math Team and travel to Iowa for the competition.

The head coach of the Minnesota All-State Math Team and three or more additional coaches will be selected by the executive board. A small compensation will be given to each coach.

Harvard-MIT Mathematics Tournament (HMMT)

Students who competed the previous year at the ARML competition may also be invited to compete at the Harvard-MIT Mathematics Tournament (HMMT). The League brings 2 teams of 8 students to this competition. This competition occurs in February in Boston, MA and is an overnight trip. Each student is responsible for paying the costs of transportation, hotel, and food to attend this tournament. More information about this competition can be found at the HMMT website: <http://web.mit.edu/hmmt/www/>.

Berkeley Mathematics Tournament (BMT)

Students who competed the previous year at the ARML competition may also be invited to compete at the Berkeley Mathematics Tournament (BMT). The League brings 3 teams of 5 students to this competition. This competition occurs in November in California and is an overnight trip. Each student is responsible for paying the costs of transportation, hotel, and food to attend this tournament. More information about this competition can be found at <https://www.ocf.berkeley.edu/~bmt/bmt-2022/>

Carnegie Mellon Mathematics Tournament (CMIMC)

Students who competed the previous year at the ARML competition may also be invited to compete at the Carnegie Mellon Mathematics Tournament (CMIMC). The League brings 2 teams of 5 students to this competition. This competition occurs in February in Pittsburgh and is an overnight trip. Each student is responsible for paying the costs of transportation, hotel, and food to attend this tournament. More information about this competition can be found at <https://cmimc.math.cmu.edu/>

Summer Mathematics Institute (SMI)

Beginning in 2012, the League began offering a week-long summer residential program for students entering grades 7-12 called the Summer Mathematics Institute. In 2023, the SMI will have its 11th incarnation as there was no SMI during the 2020. The Institute provides an opportunity for students to experience a residential math program on a college campus where they can learn mathematical topics that are beyond the typical high school curriculum. The curriculum enables them to prepare for success in math competitions at the high school level

V. Other Associated Competitions

A. American Mathematics Competitions (AMC)

While the American Mathematics Competitions (AMC) are not an official part of our League activities, they provide an additional opportunity for our most gifted students, and we encourage League members to participate. Our regular season builds towards the AMC 10 and AMC 12. We also encourage participation in other members of the AMC family of tests: AMC 8, the Junior High School version of AMC 10 and AMC 12, AIME (the American Invitational Mathematics Examination), USAMO (the United States of America Mathematical Olympiad), and the IMO (the International Mathematics Olympiad).

VI. Resources for Coaching

A. Math League Sponsored Summer Coaches' Conference

Each summer, we invite coaches and their significant others to a two-day conference, free of charge, on the Augsburg University campus. These conferences were originally supported by a grant from the Blandin Foundation to whom we had proposed that the conferences should have the following goals:

- Give specific help to coaches in some aspect of working with mathematically gifted students.
- Create an esprit de corps among the coaches/teachers by coming together in a congenial setting to discuss the season just past, possible changes to strengthen our League, and ways that we work with our teams.
- Make it clear, both to coaches and to their significant others, that the extra time required for League activities is recognized and appreciated by a state increasingly dependent on people able to provide leadership in mathematics and technology.

The Summer Conference is a day and a half event with work sessions during the day followed by dinner and social activities for coaches and their significant others. The second day continues with work sessions designed to help coaches with the tasks of attracting students gifted in mathematics and with all the aspects of preparing them for competition. We have brought some of the country's best-known mathematics coaches and problem solvers to the conference to present to our coaches.

Some participants from outside of the Twin Cities metropolitan area have accepted the invitation to be overnight guests of Augsburg University so as to fully participate in conference activities. Housing is free for the conference.

B. Past Exams

Coaches are encouraged to use tests from previous years for student practice. *Past exams are available for download in the Math League Online Scoring and Reporting System at scoringmnmathleague.org.* In addition, various online sites often have good problems for practice.

C. How to Start a Team and other related links

Coaches who are just starting a team are encouraged to go to the League website (www.mnmathleague.org) and visit the FOR COACHES link.

VII. Governance

Having begun in 1980-81 as a group of four schools, and having grown to a group of 156 schools in 1986-87, we were, on September 10, 1987, officially incorporated under the laws of Minnesota Corporate Charter Number 18-388 with the name MINNESOTA STATE HIGH SCHOOL MATHEMATICS LEAGUE.

We include below a summary of the League Bylaws. A complete copy is available from the League Office.

MEMBERSHIP: Members are high schools in, or bordering on, the State of Minnesota. Membership is granted for an academic year and must be renewed annually. Member schools must affiliate with an existing Division of the Corporation or be assigned to a new Division by the Board of Directors. It is the intention of the board that each Division be composed of at least five teams. The Board of Directors sets dues that member schools must pay before the date of the first fall meet.

Following the State Tournament, each Division shall appoint a Division Coordinator for the following year. This Division Coordinator is a member of the Board of Directors.

DIRECTORS: The Board of Directors consists of

1. One Division Coordinator to be chosen by each Division of the Corporation, each of whom shall serve for a one (1) year term that commences with the summer conference in the year of appointment.
2. Up to five (5) members elected at large by the Board, each to serve for a three-year term
3. The League Director, elected for a five-year term, serving as an ex officio voting member.
4. The All-State Math Team Coach, the Head of the Problem Writing Team, and the Tournament Director, if not already on the board.

Directors may succeed themselves, and there are provisions for removal of any director.

MEETINGS: The annual meeting of the Board of Directors shall be held in the fall at a time agreeable to the members. Other meetings may be scheduled as needed, and the Executive Committee may call special meetings.

DECISIONS: A majority of the Directors constitute a quorum, and decisions at meetings having a quorum present shall be made by a majority of those present, unless a greater number is required by an applicable law or Robert's Rules of Order.

EXECUTIVE COMMITTEE: The President, Secretary and Treasurer of the Corporation and four (4) additional Directors shall constitute an Executive Committee of the Board. In addition, the League Director and Associate Director shall serve as nonvoting members of the Executive Committee. The Executive Committee exercises the power of the Board of Directors between meetings of the Board.

COMPENSATION: The League Director and such staff as the Board of Directors shall approve from time to time shall be compensated on an annual basis at rates to be set by the Board of Directors. Other members of the Board receive no compensation for services as Directors, but may be compensated for services rendered in a capacity other than that of a member of the Board.

LEAGUE MANUAL: The League Director shall prepare, or cause to be prepared, a League Manual for each academic year, which shall consist of a compilation of the rules adopted by the Board of Directors from time to time and then in effect, and which shall be subject to the approval of the Board of Directors. The Coach's Manual

shall include all rules for meets, information regarding League business and affairs, and topics to be included in the tests for the year.

AMENDMENTS: The Board of Directors may amend the Articles of Incorporation or the Bylaws at a meeting of the Board of Directors for which proper notice, stating the purpose thereof including the proposed amendment, has been given at least five (5) days in advance of the meeting. If notice required by this Article has been given, the proposed amendment or a duly modified version thereof, may be adopted at any meeting of the Board of Directors by a two-thirds (2/3) vote of the Directors present at the meeting and entitled to vote.

A. Officers, At-Large Board Members and Executive Committee

Officers

Stacy Paleen President, Division Coordinator, Suburban East Division (elected 2022 for a 3-year term)

Jenna Innes Treasurer (elected 2022 for a 3-year term)

Reid Froiland, Secretary, Thief River Falls Coach (elected 2022 for a 3-year term)

At-Large Board Members

Executive Committee Members (1 yr term)

Colin Gardner-Springer

Luke Olson

Matt Eggert

Gary Kannel

Stacy Paleen

Jenna Innes

Reid Froiland

VIII. Hall of Fame

In 2005, in celebration of its 25th anniversary, the Math League instituted a Hall of Fame. The following individuals were inducted into the inaugural class:

Bill Boulger	Roger Sadlowsky	Stan Vee
Marlys Henke	Roy Schuman	Judy Cogna
Jerome Holicky	Kay Shager	Kathy Grundhoefer
Wayne Hysjulien	Bill Shimek	Stan Hill
Tom Kilkelly	Jack Sorteberg	Brant Klepel
John Kunz	Kathy Trier	Wayne Roberts

Also, to celebrate the 25th anniversary, Wayne Roberts wrote a book looking at the history of the Math League. The book is filled with anecdotes about instrumental people who helped form the League, students who have left a big impression during their tenure, and statistics from all the years the League has been in existence. That book is available by contacting the League office.

In the fall of 2005, the Board voted to select more members for the hall of fame during 2010, and every 5 years thereafter, in conjunction with the League's anniversaries. Please submit nominations to the League Office during the appropriate selection year.

The 2010 Inductees were:

Mick (Robert) Boatz	Shari Colvin	Larry Luck
Don Nitti	Tom Young	John Walther

The 2015 Inductees were:

Mike Reiners	Martha Knutson	Terry Hewitt
Karl Oleson	Ed Anderson	

The 2020 Inductees, inducted in 2022 were

Curt Michener	Tracy Bibelnicks	David McMayer
Gary Kannel	Dana Koletar	Daryl Anderson
Mary Rueter	Dan Butler	Mike Huberty
Jerry Shouts		

Appendix B: Divisions for 2022 – 2023

Name	Division Coordinator
Big 9	Wendy Wilcox
Canterbury	Gary Kannel
Central Gopher	Ben Thell
Classic Suburban	Carraig Hegi
Dynamic South	Dave Schimming
Hiawatha	Mike Lacine
Iron Range	Matthew Erickson
Metro Alliance	Daniel Honigs
Minneapolis	David McMayer
Minnesota Valley	Jerry Brooks
Mississippi	Curt Michener
Northern Lights	Reid Froiland
North Suburban	Rebecca Young
Polar	David Duesler
Prairie	Shari Colvin
Rum River	Stephen Larson
St Louis River	Matt Solberg
St Paul City	
South Suburban	Chuck Croatt
Southwest Suburban	Kristin Johnson
Suburban East	Stacy Paleen
Three Rivers	Allison Kaatz
Tri Metro	
TC Suburban West	Ernie Johnson
Wasioja	Jodi Flynn
West Central	Nicole Severance

Appendix C: Event Topics per Meet

Meet 1

1A Pre-algebra Topics

- Fractions to add and express as the quotient of two relatively prime integers
- Complex fractions and continued fractions
- Decimals, repeating decimals
- Percentage, interest, and discount
- Least common multiple, greatest common divisor
- Number bases; change of base

1B Angles and Special Triangles

- The Theorem of Pythagoras; familiar Pythagorean triples
- Complementary, supplementary, and vertical angles
- Interior and exterior angles for triangles and polygons
- Angles formed by transversals cutting parallel lines
- Properties of isosceles and equilateral triangles
- Relationships in 30° - 60° - 90° and 45° - 45° - 90° triangles

1C Elementary Trigonometry

- Definitions and solution of right triangles
- Elementary identities
- Radian measure and graphs of elementary functions
- Trigonometric functions of multiples of $\frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}$

1D Roots of Quadratic and Polynomial Equations

- Solution of quadratic equations by factoring, by completing the square, by formula
- Complex roots of quadratic equations; the discriminant and the character of the roots
- Relations between roots and coefficients
- Synthetic Division
- Function notation

Meet 2

Can include topics from meet 1

2A Linear Equations in One Unknown

- Solving numeric equations (perhaps involving a second degree term which drops out)
- Solving literal equations
- Story problems leading to linear equations in one variable
- Linear inequalities
- Absolute value equations and inequalities

2B Triangular figures and solids

- Medians, angle bisectors, and altitudes
- Ceva's and Stewart's Theorems
- Area of a triangle (including Hero's Formula)
- Triangular prisms & pyramids (including volume and surface area)

2C Trigonometry

- Functions of sums of angles and sums of functions of angles
- Half and double angle formulas
- Reduction formulas

(Not required: formulas for $\sin A + \sin B$, etc.)

2D Analytic Geometry of Straight Lines and Circles

- Slope, families of parallel, perpendicular, or coincident lines
- Point-slope, slope-intercept, intercept, normal forms of the straight line
- Intersections (solution of simultaneous systems)

Meet 3

Can include topics from meets 1 and 2

3A Systems of Linear Equations in Two (or on occasion three) Variables

- Numeric and literal systems
- Relation to graphical procedures
- Word problems leading to such systems
- Systems of inequalities used to define a region in the plane
- Determinants

3B Polygonal figures and solids

- Special quadrilaterals and regular polygons (including area formulas)
- Intersecting diagonals
- Circumscribed polygons and Ptolemy's Theorem
- Polygonal prisms & pyramids (including volume and surface area)

3C Trigonometry

- Law of sines, law of cosines
- Inverse functions and their graphs
- Solving trigonometric equations
- Complex numbers in the complex plane
 $(a, b) = a + bi$ $(r, \theta) = r(\cos \theta + i \sin \theta) = r \operatorname{cis} \theta$
- De Moivre's Theorem and the roots of unity

3D Exponents and Logarithms

- Use of fractional, negative exponents
- Simplifying expressions involving radicals
- Solving equations involving radicals
- Use of logarithms; identities involving logarithms
- Solving logarithmic equations
- Relationships between logarithms to different bases

Meet 4

Can include topics from meets 1-3

4A Algebraic Manipulation

- Factoring (including $x^3 + y^3$, $x^3 - y^3$)
- Sums, products, quotients of rational expressions
- Solving equations (including radical equations) involving these skills, but ultimately solvable by factoring or the quadratic formula (but no complex roots)
- Rational exponents
- Simplifying radical expressions
- Function notation and variational dependencies

4B Circular figures and solids

- Central, inscribed, tangential, and exterior angles
- Power of a point (chords, secants, tangents)
- Interior and exterior tangents of two circles
- Intercepted arcs
- Area of circles, sectors, circular segments
- Cylinders, cones, & spheres (including volume and surface area)

4C Miscellaneous Topics

- Sequences: patterns and recursion formulas, arithmetic and geometric sequences
- Series: partial sums, formulas for sums of consecutive integers $1 + 2 + \dots + n$, consecutive squares $1^2 + 2^2 + \dots + n^2$, and consecutive cubes $1^3 + 2^3 + \dots + n^3$
- Function notation
- Factorial notation and the Binomial Theorem

4D Analytic Geometry of the Conic Sections

- Using the standard forms of equations of the conic sections
- Graphs, including the location of foci, directrices, and asymptotes
- Use of properties of conics to solve applied problems, including max-min for parabolas

Meet 5

Can include topics from meets 1-4

5A Puzzle Problems (20 minutes)

- Word problems, one or more variables
- Max-min problems not requiring calculus
- Problems found in "brain-teaser" type books
- Logic puzzles, including the use of Venn Diagrams

5B Congruence and Similarity

- Ratio and proportion
- Segments intercepted by parallel lines
- Identification of similar/congruent figures
- Ratios of areas and volumes
- Elementary trigonometric ratios

5C Counting and Probability

- Permutations, with and without replacement
- Combinations, with and without replacement
- Using the principle of inclusion, exclusion
- Using the binomial and multinomial expansions
- Nonnegative integer solutions to $x_1 + x_2 + \cdots + x_n = b$
- Definition, simple applications of probability (when to multiply, when to add, etc.)

5D Variations of Problems appearing on the previous year's AMC 12 (contest A and B)

Appendix D: Regular Season Meet Topic Quick Reference

Each meet can contain topics from the previous meets.

1A Prealgebra Topics

- Fractions to add and express as the quotient of two relatively prime integers
- Complex fractions and continued fractions
- Decimals, repeating decimals
- Percentage, interest, and discount
- Least common multiple, greatest common divisor
- Number bases; change of base

1B Angles and Special Triangles

- The Theorem of Pythagoras; familiar Pythagorean triples
- Complementary, supplementary, and vertical angles
- Interior and exterior angles for triangles and polygons
- Angles formed by transversals cutting parallel lines
- Properties of isosceles and equilateral triangles
- Relationships in 30° - 60° - 90° and 45° - 45° - 90° triangles

1C Elementary Trigonometry

- Definitions and solution of right triangles
- Elementary identities
- Radian measure and graphs of elementary functions
- Trigonometric functions of multiples of $\pi/6$, $\pi/4$, $\pi/3$, $\pi/2$.

1D Roots of Quadratic and Polynomial Equations

- Solution of quadratic equations by factoring, by completing the square, by formula
- Complex roots of quadratic equations; the discriminant and the character of the roots
- Relations between roots and coefficients
- Synthetic Division
- Function notation

2A Linear Equations in One Unknown

- Solving numeric equations (perhaps involving a second degree term which drops out)
- Solving literal equations
- Story problems leading to linear equations in one variable
- Linear inequalities
- Absolute value equations and inequalities

2B Triangular figures and solids

- Medians, angle bisectors, and altitudes
- Ceva's and Stewart's Theorems
- Area of a triangle (including Hero's Formula)
- Triangular prisms & pyramids (including volume and surface area)

2C Trigonometry

- Functions of sums of angles and sums of functions of angles
- Half and double angle formulas
- Reduction formulas

2D Analytic Geometry of Straight Lines and Circles

- Slope, families of parallel, perpendicular, or coincident lines
- Point-slope, slope-intercept, intercept, normal forms of the straight line
- Intersections (solution of simultaneous systems)

3A Systems of Linear Equations in Two (or on occasion three)

Variables

- Numeric and literal systems
- Relation to graphical procedures
- Word problems leading to such systems
- Systems of inequalities used to define a region in the plane
- Determinants

3B Polygonal figures and solids

- Special quadrilaterals and regular polygons (including area formulas) 12
- Intersecting diagonals
- Circumscribed polygons and Ptolemy's Theorem
- Polygonal prisms & pyramids (including volume and surface area)

3C Trigonometry

- Law of sines, law of cosines
- Inverse functions and their graphs
- Solving trigonometric equations
- De Moivre's Theorem and the roots of unity
- Complex numbers in the complex plane

3D Exponents and Logarithms

- Use of fractional, negative exponents
- Simplifying expressions involving radicals
- Solving equations involving radicals
- Use of logarithms; identities involving logarithms
- Solving logarithmic equations
- Relationships between logarithms to different bases

4A Algebraic Manipulation

- Factoring (including $x^3 + y^3$ and $x^3 - y^3$)
- Sums, products, quotients of rational expressions
- Solving equations (including radical equations) involving these skills, but ultimately solvable by factoring or the quadratic formula (but no complex roots)
- Rational exponents
- Simplifying radical expressions
- Function notation and variational dependencies (inverse and direct variation)

4B Circular figures and solids

- Central, inscribed, tangential, and exterior angles
- Power of a point (chords, secants, tangents) x Interior and exterior tangents of two circles x Intercepted arcs
- Area of circles, sectors, circular segments
- Cylinders, cones, & spheres (including volume and surface area)

4C Miscellaneous Topics

- Sequences: patterns and recursion formulas, arithmetic and geometric sequences
- Series: partial sums, formulas for $1 + 2 + \dots + n$, $1^2 + 2^2 + \dots + n^2$, and $1^3 + 2^3 + \dots + n^3$
- Function notation; factorial notation and the Binomial Theorem

4D Analytic Geometry of the Conic Sections

- Using the standard forms of equations of the conic sections
- Graphs, including the location of foci, directrices, and asymptotes
- Use of properties of conics to solve applied problems, including max-min for parabolas

5A Puzzle Problems (20 minutes)

- Word problems, one or more variables
- Max-min problems not requiring calculus
- Problems found in "brain-teaser" type books
- Logic puzzles, including the use of Venn Diagrams

5B Congruence and Similarity

- Ratio and proportion
- Segments intercepted by parallel lines
- Identification of similar/congruent figures
- Ratios of areas and volumes
- Elementary trigonometric ratios

5C Counting and Probability

- Permutations, with and without replacement
- Combinations, with and without replacement
- Using the principle of inclusion, exclusion
- Using the binomial and multinomial expansions
- Nonnegative integer solutions to $x_1 + x_2 + \dots + x_n = b$.
- Definition, simple applications of probability (when to multiply, when to add)

5D Variations of the previous year's AMC 12 (contests A and B)

Appendix E: Past Conference Social Events

- 1985** Remmele Engineering and Sperry at a pop concert of the Minnesota Symphony, followed by dessert at the Roberts' home.
- 1986** The 3M Company at the Minnesota Club where we had dinner and entertainment by the 3M Music Makers.
- 1987** Cray Research hosted us for dinner at the St. Paul Hotel, followed by the musical *South Pacific* at the Ordway Theatre.
- 1988** Honeywell treated conference participants to a dinner cruise on the St. Croix River.
- 1989** Rosemont Inc. hosted the group at a Chanhassen Dinner performance of *Guys and Dolls*.
- 1990** Medtronic hosted us for dinner at Canterbury Downs, followed by an evening of horse racing.
- 1991** ADC Telecommunications hosted us for dinner and a play at the Old Log Theater.
- 1992** IDS Ins., Lutheran Brotherhood Ins., and MN Mutual Ins. hosted us to a dinner cruise on the St. Croix River.
- 1993** MTS hosted the group at a Chanhassen Dinner performance of *Fiddler on the Roof*.
- 1994** No sponsor, but the conference participants enjoyed dinner at Lee Ann Chin's followed by a play at the 7th Place Theater.
- 1995** ADC Telecommunications hosted us for dinner and a play at the Old Log Theater. They also hosted us at a tour of their plant in Minneapolis.
- 1996** MTS hosted the group at the Old Log Theater for dinner and a performance of *I Hate Hamlet*.
- 1997** Rosemount Inc. hosted us at the Chanhassen Theater for dinner and a performance of *State Fair*.
- 1998** We did not have a sponsor; therefore, the Conference was not held.
- 1999** MTS hosted the group at the Plymouth Playhouse for the performance of *How to Speak Minnesotan*.
- 2000** MN Mutual Foundation hosted us at the River Room at Dayton's St. Paul for dinner followed by a performance of *The Last Night of Ballyhoo* at the Park Square Theater.
- 2001** ADC Telecommunications hosted us for dinner and a performance of *South Pacific* at the Ordway Theater.
- 2002** ADC Telecommunications hosted us for dinner and a performance of *My Husband's Wild Desires Almost Drove Me Mad* at the Old Log Theater.
- 2003** ADC Telecommunications hosted us for dinner on the Jonathan Padelford and a performance of *Dracula* on the Centennial Showboat.
- 2004** ADC Telecommunications hosted us for dinner a performance of Agatha Christie's performance of *The Mousetrap* on the Centennial Showboat.
- 2005** ADC provided funds to take the group to see *Beauty and the Beast* at the Chanhassen.
- 2006** ADC provided funds to take the group to see *Singin' in the Rain* at the Chanhassen.
- 2007** ADC provided funds for the group to see *Les Miserables* at the Chanhassen
- 2008** ADC Foundation provided funds for dinner and a performance of *Forever Plaid* at the Old Log Theater.
- 2009** ADC Foundation provided funds for dinner and a performance of *Is There a Doctor in the House* on the Centennial Showboat.
- 2010** ADC Foundation provided funds for coaches and spouse to attend a Saint Paul Saints game and picnic.
- 2011** The League provided funds for a picnic and a performance of *The Demon Barber of Fleet Street* on the Minnesota Centennial Showboat.

- 2012** 3M provided funds for dinner and a performance of *The Vampire* on the Minnesota Centennial Showboat.
- 2013** Dinner at Downtowner Woodfire Grill and a performance of “Sherlock Holmes and the Adventure of the Suicide Club” at Park Square Theater
- 2014** Dinner at Axel’s Bonfire and a performance of “The Red Box” at Park Square Theater
- 2015** Hall of Fame Dinner and induction ceremony at Augsburg College. Entertainment from Comedy Sportz
- 2016** Dinner at Dixie’s on Grand and Trivia Contest
- 2017** Dinner at Downtowner Woodfire Grill and a performance of “Might as Well be Dead: A Nero Wolfe Mystery” at Park Square Theater
- 2018** Dinner at Augsburg University, table top escape room game from Trapped Puzzle Rooms
- 2019** Chanhassen Dinner Theater “Mamma Mia” sponsored by Casio
- 2020** the Summer Coaches conference was postponed
- 2021** Chanhassen Dinner Theater “The Music Man”
- 2022** Hall of Fame luncheon at Augsburg. Chanhassen Dinner Theater “Footloose”

Appendix F: Acceptable Answers and Challenge Process

All answer will be integers and the new wordings help students to arrive at those answers.

A. Exam Terms and Notation

Two expressions may be used in this years' problem sets.

“... can be written as $a\sqrt{b}$ where b is square-free. Determine the value of $a + b$ ”

For b to be “square-free”, it cannot have factors which are square numbers (other than 1). For example, as in the past, an answer of $\sqrt{12}$ would be unacceptable and students would have had to convert it to $2\sqrt{3}$ to receive credit. This year the student must still convert but the student must submit the answer 5 to receive credit. (N.B. If \sqrt{b} cannot be simplified, the problem would state “... can be written as \sqrt{b} , where b is square-free.” And the answer to submit would be b)

“... can be written as $\frac{p}{q}$, where p and q are relatively prime integers. Determine the value of $p + q$.”

For example, as in the past, an answer of $\frac{6}{8}$ would be unacceptable and students would need to simplify it to $\frac{3}{4}$ to receive credit. This year the student must submit the answer 7 to receive credit.

There is area of caution with this type of fraction formatting of which all students should be made fully aware:

Negative Rational Answers

Although we all know that $-\frac{p}{q} = \frac{-p}{q} = \frac{p}{-q}$ in order to create a unique answer, all students should be made aware that for this competition, the negative sign **MUST** be assigned to the numerator and **NOT** to the denominator.

So if the answer is $-\frac{3}{5}$ the student must submit the answer 2 to receive credit and if the answer is $-\frac{5}{3}$, the student must submit the answer -2 to receive credit.

B. Definitions of terms

Angles: Angle measurements written with the degree symbol ($^{\circ}$) will be in degrees. All other angle measurements will be assumed to be in radians. This applies to both printed exams and student solutions.

Note: All attempts will be made in problem writing involving trigonometric expressions to provide students with as much clarity as needed in the context of the problems with regard to range of expected solutions.

Area: The area of a region will be denoted by the use of the word “Area”, followed by the name of the figure in square brackets. For example: $Area[\Delta ABC]$ or $Area[\text{Circle } P]$

Bases: Number bases will be indicated by a subscript at the end of the number. For example, 632_4 indicates the number 632 in base 4, or $6(4^2) + 3(4^1) + 2(4^0)$.

Ceiling Function: Also known as the “least integer function,” this shall be denoted by $\lceil x \rceil$, defined as the least integer greater than or equal to x

Combinations: The number of combinations of r items chosen from a group of n items shall be denoted using binomial coefficient notation: $\binom{n}{r}$

Diagrams: ... are not necessarily drawn to scale. Only specifically given lengths, angle measurements (etc.) should be trusted

Digits: When some digits of a number are unknown, underlines will be used to denote individual digits. For example, $A\underline{13}B$ represents the four-digit number with A in the thousands place and B in the units place, *not* the product of A , 13, and B .

Floor function: Also known as the “greatest integer function,” this shall be denoted by $\lfloor x \rfloor$, defined as the greatest integer less than or equal to x

Integer: An integer will be defined as a member of the set of numbers $\{\dots -3, -2, -1, 0, 1, 2, 3, \dots\}$. All student answers shall be chosen from this set. Alternate representations will not be accepted. For instance, $6/2$ will not be acceptable as an alternate representation of the integer 3. Likewise, $3/1$ will also not be acceptable

Lattice points: Points whose coordinates are all integers.

Logarithms: The notation “log” shall denote a base-10 logarithm and “ln” shall denote the natural logarithm or base- e logarithm. Other logarithm bases will be indicated using subscripts.

Ordered pairs: When a problem calls for an ordered pair, such as (a, b) , the solution must be given in precisely that form, including the parentheses and the comma. The same applies for other ordered n -tuples.

Permutations: The number of permutations of r items chosen from a group of n items shall be denoted using subscripts: ${}_nP_r$

Polygons: If a polygon is named $MATH$, it is understood that the vertices M , A , T , and H occur in this adjacent order around the polygon, either clockwise or counterclockwise.

Triangles: If a triangle is named ABC , the sides opposite the vertices A , B , C (unless otherwise labeled in the problem) will have lengths denoted by a , b , and c respectively.

C. Grading Conventions:

It should always be remembered that the League desires to give credit to students on the basis of what they understand mathematically. The ideal would be to avoid withholding credit when a student has simply failed to observe some legalism. That being said, individual and team scores need to be compared across the League's many Divisions, with awards, scholarships, and appearances in the State Tournament dependent upon these comparisons. Therefore, it is essential that fundamental grading practices be as uniform as possible.

The following rules attempt to form a common grading foundation:

Partial credit: Unless specific instructions are given to the contrary in the official solutions, no partial credit should be given on any individual or team question.

Form of an answer: All answers for the 2022 – 2023 season will be integer. An integer will be defined as a member of the set of numbers {... -3, -2, -1, 0, 1, 2, 3,...}. All student answers shall be chosen from this set. Alternate representations will not be accepted. For instance, $\frac{6}{2}$ will not be acceptable as an alternate representation of the integer 3. Likewise, $\frac{3}{1}$ will also not be acceptable.

Units: Unless a problem obviously calls for attention to units (as when an answer requests both feet and inches, meters and centimeters, etc.), students should not be penalized for omitting units in their answers

D. Release of solutions and Challenges in 2022 – 2023 season

Since the divisions have the choice to meet in person (or online) the solutions shall be given to the coaches for the purposes of grading. Divisions and coaches should not publish the solutions at the time of the meet. This way, there will be less opportunity for sharing solutions with other students who have not taken the tests.

Solutions will be published for students once all divisions have reported their scores. Once solutions have been published, students should follow the challenge procedure for correcting errors. Given the extended timeframe for meets and the diverse methods for administering the meets, it should be noted that students are bound by a Code of Conduct.

Challenges:

If the official solutions contain an error, and it is discovered prior to the meet, all efforts will be made to alert the Division coordinators and coaches as to the correct answer. Coaches would then use the corrected answer to judge a response as acceptable or not.

If the official solutions contain an error, or if students believe their electronic submission has been graded incorrectly, or if the student had a unique interpretation of the question which resulted in a different answer, the students must submit a challenge to their coach as specified in the email releasing the solutions

Challenges submitted usually fall in these categories –challenges of grading mistake by the coach (the student actually got it right but the coach mistakenly marked it wrong), challenges of whether the response is an acceptable form of the answer, challenges due to problems with the scoring website or challenges caused by a unique interpretation of the question resulting in a different answer.

The challenges should be handled in this manner:

1. Challenges of mistakes made by the coach should be fixed by the coach.
2. Challenges of whether the response is an acceptable form of the answer should not occur as all answers are integers in the 2022 – 2023 season. No other answer should be deemed acceptable. However, the student can

challenge and the challenge should be sent to the League office.

3. Challenges due to problems with the scoring website should be sent to the League office.

4. Challenges as to a different answer due to a unique interpretation of the question should be sent to the League office.

Process for submitting a challenge to the League office:

All coaches in the Division should be made aware of the challenge. A short explanation as to the reason for the challenge, should be emailed to **mathleague@augsborg.edu** and to all schools in the Division by the time and date specified by the email releasing solutions.

The student should write the explanation but may need a coach's assistance.

The League will make every effort to rule on the challenge within 2 – 3 days. Schools in the Division will be notified as to the final ruling. Scores will be adjusted as necessary.

Only students who challenge a solution can be awarded points. If a student does not make a challenge, yet that student's answer is judged to be correct, that student who did not challenge will NOT be awarded the point(s) for a correct solution. Therefore, it is wiser to challenge than not.

Given this challenge process, and to insure the most uniformity, Coaches should mark answers correct only if the student answer matches the answer provided in the League answer key.

Appendix G

Procedures for holding Meets in 2022 - 2023

4. The Board of Directors approved another way of administering a meet. Divisions can decide which of the **four** ways to administer a meet. The method chosen may vary from meet to meet. Schools are required to gather together at Meet 5. The four ways to administer a meet are:
 - A. Gather as a division at a common site and administer the tests the “old” way. The “old” way is defined as giving students a paper copy of the tests, correcting them at the site, and coaches entering the scores via the scoring website.
 - B. Gather at individual schools and administer the test the “new” way. The “new” way is defined as giving students a paper copy of the tests, allowing them to enter their answers online via the scoring website, and coaches verify the scores after the events are finished.
 - C. Gather some of the schools at a common site and allow the other schools in the division to gather at their own school and use a “hybrid” method to deliver the meet. Schools gathered at the common site will use the “old” way while the schools gathering at their own school will use the “new” way.
 - D. (approved at the fall board meeting) Gather schools at a common site and allow the schools to use the “new” way to administer the meet. This can be done if the division is confident that the site has sufficient Internet capability and the students have the device capability to do the meet online the “new” way.
5. Given that schools will be doing meets in different ways and at different times, coaches should stress the importance of not discussing the problems until all schools are finished. Coaches should not release solutions until all schools are finished. When all schools are finished, coaches will be sent an email allowing them to release solutions. Said email shall include a timeline and process for challenges.