B$_1$ Circle the largest number:

$$2^{2^{2^{2^{2^{2}}}}} \qquad 2^{2^{2^{2^{22}}}} \qquad 2^{2^{2^{222}}} \qquad 2^{2^{2222}} \qquad 2^{22222} \qquad 222222$$

B$_2$ Let x be the answer to this question. If x is written in English, how many letters are used?

B$_3$ What is the largest integer $a \leq 2019$ so that there exists an n so that $a = n^2$?

B$_4$ *(Contest 1)* Submit any real number. Every team that submits the most common number will get 20 bonus points. If there is a tie, this question has no effect. **Write your team name on this submission.**

B$_5$ *(Estimation 1)* Estimate the number of Adult Medium T-shirts we ordered for MBMT. This includes students, chaperones, and volunteers.

C$_1$ *(Memory 1)* Choose three bullets and fill in the proper numbers in those bullets:

- (Descartes Algebra #1) Haydn is thinking of a number. When he subtracts 20 from it and then adds 1, he gets $\boxed{}$. What is Haydn's number?
- (Leibniz Combo #6) Mr. Anderson rolls n fair six-sided dice, where $n \in \{1, 2, 3, 4, 5, 6\}$ is chosen uniformly at random. Given that the sum of the dice rolls is 6, find the probability that $n = \boxed{}$.
- (Leibniz Geo #5) Find the area of a triangle with side lengths $\sqrt{2}$, $\sqrt{58}$, and $\boxed{}\sqrt{17}$.
- (Descartes NT #1) Find the greatest common divisor of $\boxed{}^2 - \boxed{}^2$ and $2 + 0 + 1 + 9$.

C$_2$ *(Game 1)* Go to room 166 to play this game; winning gives you the sticker:

The proctor picks a positive integer N and places N tokens on the table. Then, you decide whether to go first or second. The players alternate; on each turn a player can remove either 1 or 4 tokens from the table. The first player to remove all the tokens wins.

C$_4$ *(Contest 2)* On the back of this paper, define the largest real number you can. The definition must be self-contained and well-defined; for example, "one more than the largest other submitted number" is not allowed. The team that submits the largest number will get 40 bonus points. **Write your team name on this submission.**

C_3 *(Game 2)* Go to the courtyard (area directly opposite the entrance, not the one enclosed by the building) to play this game; winning gives you the sticker:

You must throw a piece of paper at least 20 feet. You can do anything to the sheet of paper, but the paper must remain intact.

C_5 *(Trivia 1)* Last year a Blair teacher ran for elected office. How many vote did (s)he get?

C_6 *(Scavenger hunt 1)* Haydn is hidin'! Find Haydn to solve this question.

The MBMT website is perhaps useful.

C_7 *(Estimation 2)* Steven made a March Madness bracket. Estimate the number of games (not counting games played today) for which he correctly predicted both the two participating teams and the winner.

As of the morning of March 30, 56 games have been played.

C_8 *(Estimation 3)* Earlier, we timed Daniel walking around the outside of Blair. Estimate the number of minutes this took.

C_9 Find an 11-digit perfect square that has exactly 4 distinct digits.

C_{10} Find a solution x to the equation

$$2019^{x^{2019}} = x^{2019^x}.$$

D_1 *(Memory 2)* Choose two of the following bullets and fill in all blanks for those two bullets:

- (Team, Descartes #9, Leibniz #5) There are $\boxed{}$ dogs in the local animal shelter. Each dog is enemies with at least 2 other dogs. Steven wants to adopt as many dogs as possible, but he doesn't want to adopt any pair of enemies, since they will cause a ruckus. Considering all possible enemy networks among the dogs, find the maximum number of dogs that Steven can possibly adopt.
- (Guts, Descartes #10) Daniel has enough dough to make 8 12-inch pizzas and 12 8-inch pizzas. However, he only wants to make $\boxed{}$-inch pizzas. At most how many $\boxed{}$-inch pizzas can he make?
- (Guts, Leibniz #21) Steven is concerned about his artistic abilities. To make himself feel better, he creates a $\boxed{} \times \boxed{}$ square grid and randomly paints each square either white or black, each with probability $\frac{1}{2}$. Then, he divides the white squares into connected components, groups of white squares that are connected to each other, possibly using corners. (For example, there are three connected components in the following diagram.) What is the expected number of connected components with 1 square, to the nearest integer?

D2 *(Game 3)* Send four people to room 167 to play this game; you must win **twice in a row**:

All four team members close their eyes. The proctor will then put either a green or pink hat on each team member. Then, the players open their eyes. The players then simultaneously guess their hat color. To win a game, at least 2 people must guess correctly.

Note. No resources are allowed in this game.

D3 *(Game 4)* Go to room 168 to play this game; winning gives you the sticker:

The proctor randomly chooses 25 distinct integers from 1 to 50, inclusive. You have one minute to memorize them all. To win, your team must recall the 25 numbers perfectly.

Note. No resources are allowed in this game.

D5 *(Trivia 2)* Consider the last International Math Olympiad that a student from Blair attended. How many points did this student score?

D4 *(Contest 3)* Design next year's MBMT logo on the back of this page. The team that submits the best submission will get 50 bonus points. **Write your team name on this submission.**

D6 *(Scavenger hunt 2)* There are lots of flags in Blair Boulevard (the big three-story hallway). Of what country is the flag directly to the left of the flag of Somalia?

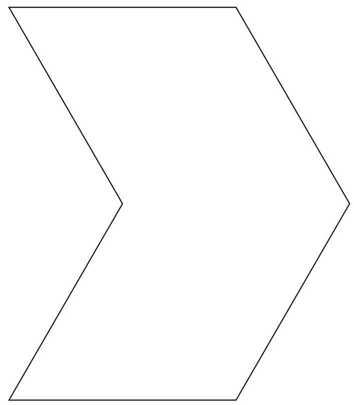
D7 *(Estimation 4)* Estimate the number of sheets of paper we used to print all the MBMT tests, **not** including the fun round. This includes answer sheets, but not solutions.

D8 *(Estimation 5)* Earlier today we picked 100 points randomly in a square. Estimate the number of triples (A, B, C), where A, B, and C are distinct points among the 100, satisfying the property that $\angle ABC < 10°$.

D$_9$ Consider a soccer ball. What is the minimum number of hexagons need to be colored black so that no two white hexagons are touching?

You may find a soccer ball around to aid you in computation.

D$_{10}$ Divide the following region into exactly 7 congruent pieces:



E$_1$ Let T be the answer to problem E$_5$. In a regular T-gon, how many different distances are there between any two of the vertices?

E$_2$ Let T be the answer to problem E$_1$. For how many integers $0 \leq a < T$ does there **not** exist an integer k so that $k^2 - a$ is divisible by T?

E$_3$ Let T be the answer to problem E$_2$. If S is a set with T elements, how many of its subsets have an even number of elements?

E$_4$ Let T be the answer to problem E$_3$. How many 6-tuples of nonnegative integers (a, b, c, d, e, f) are there so that $a + b + c = d + e + f = T$?

E$_5$ Let T be the answer to problem E$_4$. Assuming that the three lines $y = Sx - T$, $y = -x + 3$, and $y = x - 1$ intersect at a common point, find S.

F To complete this problem and the Fun Round, go to room 171.