Girls in Math
2025 Guts Round

1. [5] Georgia and Carolina begin at the point $(1, 0)$ on a circular path with radius 1 centered at the origin. Georgia runs on the path for 2025 degrees counterclockwise, while Carolina runs for 2025 degrees clockwise. When they finally stop, what is the minimum number of degrees that Georgia must run to meet Carolina?

2. [5] Given a right triangle with side lengths 4 and 5, what's the difference between the maximum and minimum area?

3. [5] There is a set of real numbers, S, where if x is in S, then $\frac{1}{1-x}$ is in S. If 2024 is in S, what is the closest integer to the sum of the elements in S?

1. ____________ Answer

2. ____________ Answer

3. ____________ Answer

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4. [5] The n-color theorem is a theorem that states that no more than n colors are required to color the regions of any map so that no two adjacent regions have the same color. This theorem was famously proved by use of a computer. What is n?

5. [5] The Online Encyclopedia of Integer Sequences (OEIS) is an online database of integer sequences. As of February 2025, there are n sequences in the database. What is the largest integer x such that $10^x < n$?

6. [5] The Millennium Prize Problems are a set of well-known mathematical problems selected in 2000. Each has a prize of $1 million for a correct solution. How many Millennium problems are unsolved?

4. ____________ Answer

5. ____________ Answer

6. ____________ Answer

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7. [7] Evelyn is home, located at (0, 0), and is on her way to school at (6, 8) on the coordinate plane. Along the way, her mom wants her to buy groceries at (2, 3) and wash the car at (4, 5). Assuming Evelyn takes a random path from home to school (in increments of one unit and only driving in the positive-x and positive-y directions), what is the probability she will make her mom happy by passing by the grocery store and the car wash?

8. [7] Poppy's favorite number has three digits. It is a multiple of 7 and divisible by at least 3 square numbers. The sum of the digits is divisible by 9, and the digits are strictly increasing. What is Poppy's favorite number?

9. [7] In convex quadrilateral $ABCD$, $AB = AC = AD = 2025$, and $BC = CD = 2024$. If AC and BD intersect at X, and Y is the midpoint of CX, find $\sqrt{CY}$.

7. ____________ Answer

8. ____________ Answer

9. ____________ Answer

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10. [9] Alice is rolling k-sided dice. On her first turn, she rolls one of these dice. At each subsequent turn, she rolls a number of k-sided dice equivalent to the sum of her dice on the previous turn. For example, if she rolls a 3 on her first turn, she rolls three k-sided dice on her second turn. Let $E_{n,k}$ denote the expected number of dice Alice rolls on her nth turn, using k-sided dice. What is $\frac{E_{10,13}}{E_{10,6}}$?

11. [9] How many non-negative integers n less than 2025 are there such that $n^2 \cong 1 \bmod 2024$?

12. [9] Let P be the number of points your team will get in total during the entire Guts round, excluding this question. Write down $\sqrt{P}$, rounded to the nearest integer. If your answer to this question is x, and the answer ends up being y, you will get $\max\{0, 9 - 4|x - y|\}$ points.

10. ____________ Answer

11. ____________ Answer

12. ____________ Answer

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13. [12] Let C be the answer to Problem 15. Sarah the penguin is tiling a CxC grid with knights. What is the most number of knights that she can put on the grid such that no knight attacks each other? (A knight in chess moves in an "L" shape, meaning it moves two squares in one direction (either vertically or horizontally) and then one square perpendicular to that direction)

14. [12] Let A be the answer to Problem 13. How many ways are there to permute the set $\{1, 2, 3, \ldots, A\}$ such that the odd numbers are in increasing order and the even numbers are in increasing order?

15. [12] Let B be the answer to Problem 14. n is an integer such that $n^3 + 8n^2 - 9n + 6 = B$. Find $n/2$.

13. ____________ Answer

14. ____________ Answer

15. ____________ Answer

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16. [14] Patricia, Penelope, Piper, Prudence, Pam, and Peggy the penguins are standing in the shape of a regular hexagon. They can all either waddle to the spot one of their immediate neighbors is currently standing on, or they can waddle to the center of the hexagon. Assuming each penguin picks a destination randomly out of their three possible destinations, find the expected number of penguins that will waddle to their destination without bumping into another penguin at the destination nor on the way to the destination.

17. [14] $ABCD$ is a parallelogram. Circle ω is tangent to BC at X, CD at Y, and AB at A, and it intersects AD again at Z. Given that $AZ = 16$ and $CX = 5$, if the area of circle ω is $k\pi$, find k.

18. [14] Write 1 or 2 for this problem. If you write 1, you get 7 points. If you write 2 and under half of the teams write 2, you get 14 points. If at least half the teams choose 2 and you write 2, you instead lose 7 points. If you write any other answer, you get 0 points.

16. ____________ Answer

17. ____________ Answer

18. ____________ Answer

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19. ______
Answer

20. ______
Answer

21. ______
Answer

19. [16] Let $n = p_1^{e_1} p_2^{e_2} \dots p_k^{e_k} = \prod_{i=1}^{k} p_i^{e_i}$, where $p_1 < p_2 < \dots < p_k$ are primes and $e_1, e_2, \dots, e_k$ are positive integers, and let $f(n) = p_1^{e_k} \prod_{i=2}^{k} p_i^{e_{i-1}}$. Let N be the maximum value of $f(n)$, where n is an integer, $1 \le n \le 1000$. Find the remainder when N is divided by 100.

20. [16] Deirdre and Demi are playing a game involving continuous coin-flipping with a fair coin. They each pick one of the 16 length 4 strings consisting of only "T" and "H", with Demi picking first (Demi will announce her choice out loud, and then Deirdre will choose). A player wins, if, at some point, the past four flips have been precisely the string that they chose. Assuming both Deirdre and Demi choose optimally, what is the probability that Deirdre wins?

21. [16] You are playing on an 8×8 chess board with a new piece called a super pawn. A super pawn can only move to a square that is exactly two total horizontal or vertical jumps away (this includes one horizontal, one vertical move). Super pawns can jump over other pieces. What is the most amount of super pawns you can place on your chess board such that no super pawn is attacking another?

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22. ______
Answer

23. ______
Answer

24. ______
Answer

22. [19] Let x and y be integers satisfying the equation $(xy-1)^2 = 13\sqrt{(x^2+y^2)}$. What is the minimum value of x+y?

23. [19] Points A, B, and C exist on a parabola with focus F, directrix ℓ, and vertex B. Let D be the foot of the altitude from F to AB and E the foot of the altitude from F to BC. Denote the intersection between $\overline{FD}$ and ℓ as X and the intersection between $\overline{FE}$ and ℓ as Y. If $FA = 33, FB = 26, FC = 46, AB = 25$, and $BC = 52$, find the area of $\triangle FXY$.

24. [19] Write an integer from 1 to 100, inclusive. Let $x = \frac{2}{3}$rds of the average answer submitted rounded to the nearest integer, and y be the answer you write for this question. You will get $\max\{0, 19 - 2(y-x)^2\}$ points.

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25. ______
Answer

26. ______
Answer

27. ______
Answer

25. [25] Given $x^7 + 2x(2(x^4 - x^3 + 9x^2 - x + 1) + 9x(x^2 - x + 1))(1 + x) = 3y - 3x(x+1)(x^2+x+1)(x^2-x+1)$, and $x = 3^{1/7} - 1$, find y^2.

26. [25] Let ABC be a triangle with $AB > AC$ and circumcircle Γ. Let the tangent to Γ at A intersect BC at D. Let O, X, and Y be the circumcenters of $\triangle ABC$, $\triangle ABD$, and $\triangle ACD$, respectively. If $\triangle OXY$ has area 1, find the maximum possible area of $\triangle ABC$.

27. [25] How many different names were mentioned in this contest? (include the Individual and Team Rounds as well). If the correct answer is x and your answer is y, you will get $\max\{0, \lfloor 25e^{-\frac{(x-y)^2}{3}} \rfloor\}$ points.