

# 2021 KCATM High School Math Contest

Name: \_\_\_\_\_

Grade: \_\_\_\_\_

High School: \_\_\_\_\_

e-mail address: \_\_\_\_\_

phone number: \_\_\_\_\_

## INSTRUCTIONS

The following test consists of 20 questions. Use whatever resources you like to solve these problems. Each question is worth 5 points. Partial credit will be given for making progress. However, you must show your work to get any credit. **PLEASE PRINT THIS DOCUMENT OFF IN LANDSCAPE MODE!**

## THE CONTEST and REGISTRATION

- There is no cost for this contest.
- There are two grade categories: 9<sup>th</sup> and 10<sup>th</sup> graders will be graded in one category, while 11<sup>th</sup> and 12<sup>th</sup> graders will be graded in a second.
- All students will be informed of their score approximately one week after the date below, and the top-3 in each category will be officially recognized.

## SUBMIT YOUR TEST AND ANSWERS EITHER ...

### BY MAIL

Mike Round  
13234 Long Street  
Overland Park, KS 66213

*Entries must be post-marked  
no later than April 10<sup>th</sup>.*

### BY EMAIL

[round12345@aol.com](mailto:round12345@aol.com)  
*Entries must be received  
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## QUESTIONS

High School Test Coordinator: Mike Round  
(913) 515-3911      [round12345@aol.com](mailto:round12345@aol.com)

1

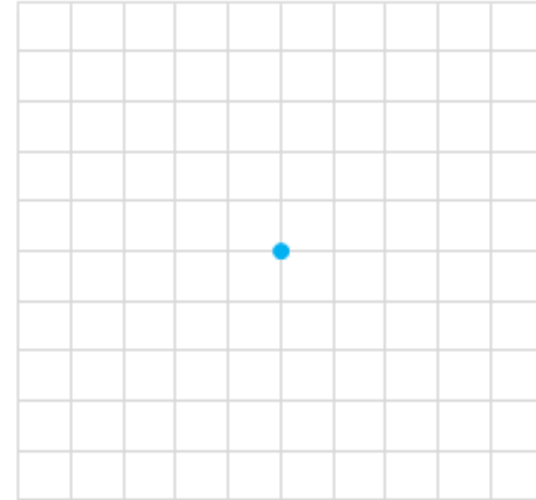
I drove 600 miles from Kansas City to Denver, and the trip took 8 hours. What was my average speed for the trip?

**2**

On the 600 mile drive home from Denver to Kansas City, I drove  $70\text{mph}$  for the first 300 miles, and  $80\text{mph}$  for the second 300 miles. What was my average speed for the trip home? (hint: the answer is NOT the same as #1).

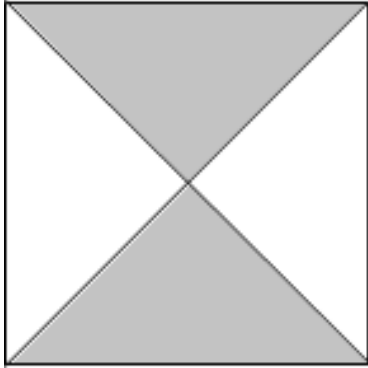
**3**

Starting at the point, head left and move one unit, tracing your route as you go. Turn left and move two units, and then turn left again and move three units. Continue repeating the process, always turning left before moving, and always moving 1, 2, and 3 units, respectively. How much area is fully enclosed by this “spiralateral” walking algorithm?



**4**

The square below has sides of length 12". What is the total area of the shaded region?



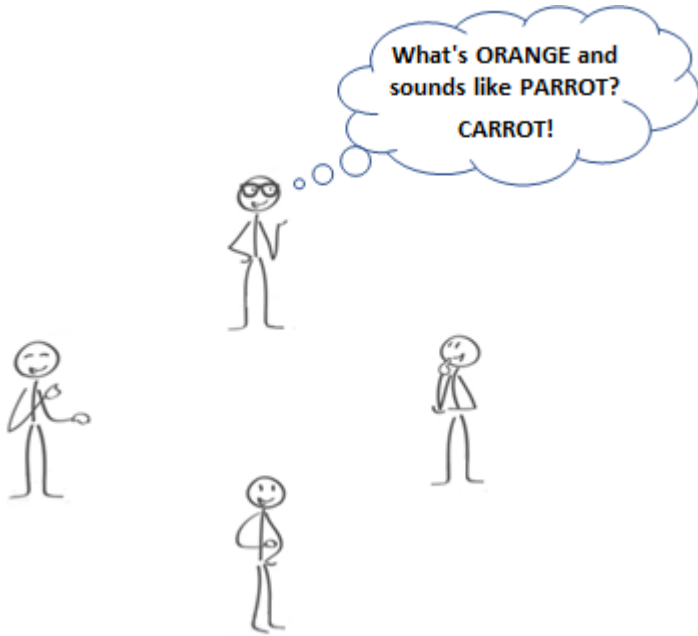
**5**

Built in the 1960s, the SR71 Blackbird could fly at high altitudes (90,000 feet) and at fast speeds (Mach 3.5). If the speed of sound at this altitude is approximately 979 feet / second, how fast could the plane fly in miles / hour?

6

I'm thinking of pursuing a career in comedy and want to try my jokes on some friends. I gathered three friends I know have a sense of humor (half the time they hear a joke they laugh). Assuming I always laugh at my own jokes, and I tell all three the joke at the same time:

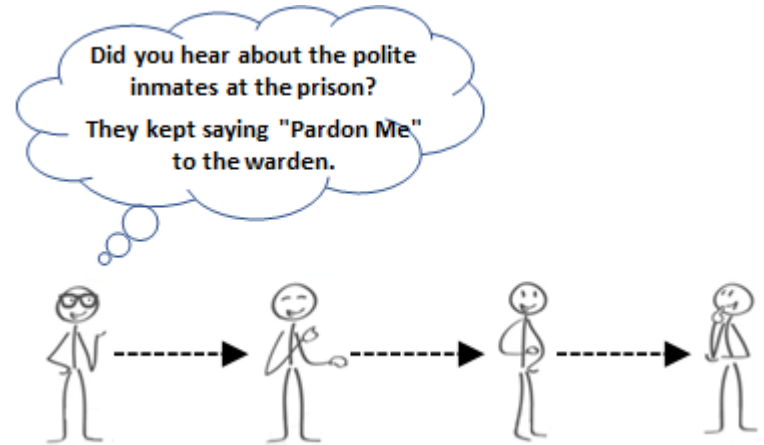
- a. What is the expected number of people in the room who will be laughing?
- b. If I repeated this with other groups of three friends, what is the most likely number of people who will be laughing?



7

While continuing to tell wonderful jokes, I find it's easier to tell one friend the joke, and tell them to tell the joke to someone else – *but only if they thought the joke was funny*.

- a. What is the expected number of people in the room who will be laughing because of this joke?
- b. If I repeated this with other groups of three friends, what is the most likely number of people who will be laughing?



8

I make four stops on a bus route (with scheduled departures at 8:00, 8:10, 8:20, and 8:30). After the last stop, it then takes 10 minutes to drive to school. On Monday, I arrived at my first stop right on time. The driving time between subsequent stops was 5, 15, 10, and 10 minutes. If the bus cannot leave before any scheduled departure time, what time did I arrive at school?



<u>Stop #1</u>	<u>Stop #2</u>	<u>Stop #3</u>	<u>Stop #4</u>	<u>School</u>
8:00	8:10	8:20	8:30	

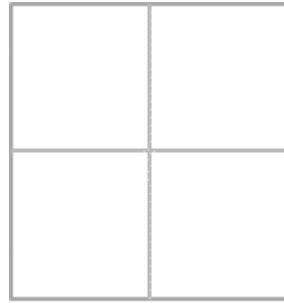
9

On Tuesday, I again arrived at my first stop right on time. The driving time between subsequent stops was 15, 5, 10, and 10 minutes. If the bus cannot leave before any scheduled departure time, what time did I arrive at school? (Hint: this is not the same as #8).

**10**

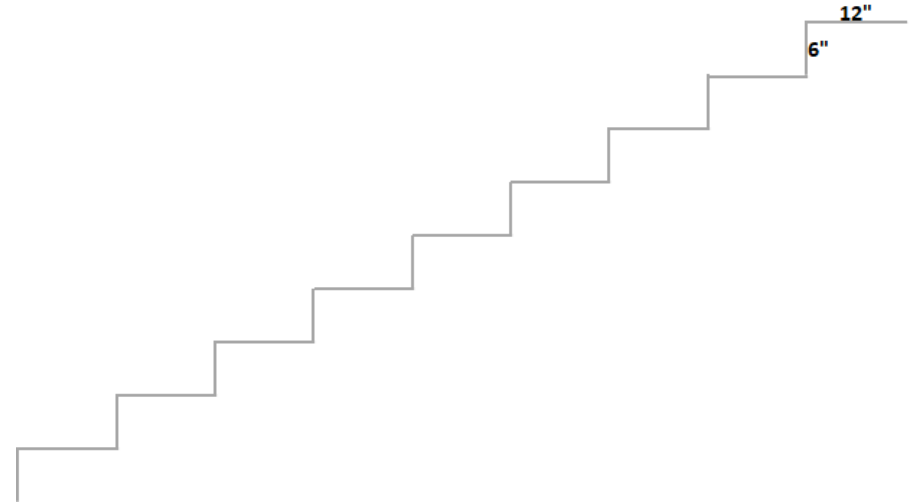
Imagine a 2x2 game of Tic-Tac-Toe, where "Winning" means two moves in either the same row or the same column.

If **X** goes first, what is the total number of moves **O** can make in all possible games of 2x2 Tic-Tac-Toe?



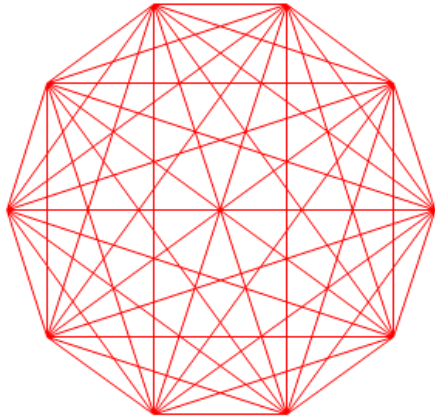
**11**

The staircase below needs carpeting. If each step is 6" high and 12" deep, and if the stairwell is 36" wide, and carpet sells for \$30 per square yard, how much will it cost to carpet my stairs?



**12**

10 points are evenly spread around a circle, and diagonals drawn so every point is connected to every other point. How many diagonals are there?



**13**

What are the  $(x, y)$  coordinates of the two points where  $y = x^2 - 2x + 1$  and  $x + y = 3$  intersect?

**14**

On one side of a teeter totter there are two 10-pound weights. One is six feet from the fulcrum; the other is eight feet.

Where should I put a 20 pound weight so the teeter totter is perfectly balanced?



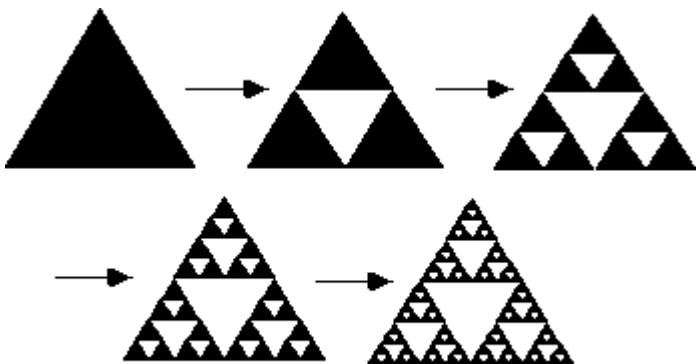
**15**

What is the area of a triangle with vertices  $(1, 3)$ ,  $(8, 0)$ , and  $(2, -4)$ ?



16

I have an equilateral triangle with area 1 square unit. I then remove an equilateral triangle with vertices touching the sides of the original triangle. I repeat the process three more times, each time removing an inner equilateral triangle from every shaded triangle. What is the area of the shaded region in the fifth image below?



17

The Richter Scale defines the magnitude ( $M$ ) of an earthquake in terms of its intensity ( $I$ ), and is given by:

$$M = \log \frac{I}{S}$$

where  $S$  is the intensity of a standard earthquake. Earthquake 1 has magnitude 7.0, while Earthquake 2 has magnitude 8.5. How many times more intense is Earthquake 2 relative to Earthquake 1?

**18**

Suppose there is a population of 10,000 people and a good estimate of how many of them who have a disease is 1%. If I've invented a test that correctly diagnoses those people who actually have the disease 95% of the time, how many people who actually have the disease did my test say "Positive"?

**19**

Using the same assumptions as #18, in addition to my test correctly identifying (with a "Positive") those who have the disease 95% of the time, it also correctly identifies (with a "Negative") those who do NOT have the disease.

Suppose a friend says they took my lab test and their results were positive. What is the likelihood they actually have the disease?

		<i>Does the person have the disease?</i>		
		YES	NO	TOTAL
<i>What were the test results?</i>	POSITIVE			
	NEGATIVE			
	TOTAL			

**20**

During the first 50 games of the basketball season, Player #1 averages 28 points per game. During this same time, Player #2 has only played in 45 games and is averaging 24 points per game. Each player eventually plays 82 games. If Player #1 continues scoring at their same average while Player #2 averages 32 points per game over the next 36 games, how many points does Player #2 have to score in the last game in order *to win* the scoring title?

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