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Are You Smarter Than a Quant? Here Are 5 Questions from the MoMath Masters Contest

Two Sigma Investments co-founder John Overdeck competes in the 2016 MoMath Masters competition
PHOTO: NATIONAL MUSEUM OF MATHEMATICS

By BRADLEY HOPE
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The quants have been performing especially well in this year's choppy markets.

How do they do it? You won't hear any of the brainiacs at firms such as Renaissance Technologies and Two Sigma Investments giving away any secrets. Hedge funds that use largely quantitative strategies are notoriously secretive about their algorithms.

But a few times a year, the top quants get together to compete over math puzzles for the good of charity or the National Museum of Mathematics in Manhattan.

Last week, the museum held its 2016 MoMath Masters competition. The overall winner was Po-Shen Loh, a Carnegie Mellon math professor. In second place was Two Sigma's Daniel Stronger, a quantitative analyst with a Ph.D. in computer science, and in third was Ken Perlin, a computer science professor at New York University who invented something called "Perlin noise" that makes textures look realistic in computer games.

Winner of the Math Classics category – which has famous, old puzzles – was Geva Patz, co-founder of an automated options trading firm called Android Alpha Fund LLC (and a part-time "pyrotechnician" for Grucci fireworks, according to his Linkedin page). Patrick Huggins, a quantitative researcher at Citadel Investment Group, won the "Gardner Greats" category – named after the famous math puzzler Martin Gardner. And the winner of the Math Pulse category, which has math questions from popular culture, was Satish Ramakrishna, global head of prime finance risk and pricing at Deutsche Bank.

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Think you can compete with the quants? Here are five questions from the competition, followed by the answers. Scroll down even further to see detailed explanations of the answers, courtesy of Glen Whitney, founder and president of MoMath.

Question 1 (Math Pulse trivia category)

Fermat's Sandwich Theorem reveals what mathematical fact?

A) A function between two others that have the same limit has that limit as well.

B) 26 is the only number immediately between a square and a cube.

C) A bounded increasing sequence has a limit.

D) 152 is the largest number immediately between a prime and a triangular number.

E) Any sandwich can be cut so that both pieces have the same amount of bread and the same amount of filling.

Question 2 (Gardner Greats based on the work of Martin Gardner)

Which of the following must be true about the handshaking that occurred at a recent teachers' convention?

A) The number of teachers who shook hands an odd number of times is even.

B) The number of teachers who shook hands an even number of times is odd.

C) The number of teachers who shook hands an odd number of times is odd.

D) The number of teachers who shook hands an even number of times is even.

E) The number of times teachers shook hands is odd.

Question 3 (Math Classics, easier level)

Given any quadrilateral, connecting the midpoints of consecutive sides will always result in which of the following shapes?

A) square

B) rhombus

C) rectangle

D) parallelogram

E) kite

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Question 4 (Math Pulse pop culture)

Who among the following received a scholarship to study Chemical Engineering with Mathematics at Northwestern University?

A) Heidi Klum

B) Kate Moss

C) Brooke Shields

D) Naomi Campbell

E) Cindy Crawford

Question 5 (From the Finals Round)

Let m be the smallest positive integer such that $m^2+7m+89$ is divisible by 77. What is m?

A) 8

B) 18

C) 52

D) 73

E) 74

Answers

Question 1: B) 26 is the only number immediately between a square and a cube.

Question 2: A) The number of teachers who shook hands an odd number of times is even.

Question 3: D) Parallelogram

Question 4: E) Cindy Crawford

Question 5: B) 18

Full explanations

Question 1: First, the statement in option D is false; the next time it happens is 230, in that 229 is prime and 231 is triangular. All of the other four statements are true. Statement A is known as the "Squeeze Theorem," Statement C is called the "Monotone Convergence Theorem," and statement E, believe it or not, goes by the name "Ham Sandwich Theorem." That leaves option B as the correct answer. 26 is one more than the square 25, and one less than the cube 27. Another way of stating this theorem is to say that $(\pm 5,3)$ are the only solutions to $x^2 = y^3 - 2$. The famous Pierre de Fermat is believed to be the first person to have noticed this fact, and it is an interesting case in which he did have a proof of this statement, which he at first did not reveal and challenged others to find, stumping them. He in particular taunted the English

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mathematicians Wallis and Digby for their inability to find the answer. This pattern, of Fermat claiming the proof of an extraordinary statement and then backing up his claim even though no one else could reproduce the proof, for years reinforced the notion that "Fermat's Last Theorem," eventually proven by Andrew Wiles, must be true and that perhaps wily old Fermat really did have a proof.

Question 2: Every handshake that occurred involved two people. Therefore, the number of combinations of a person and a handshake involving that person must be even. But another way to get that same number is to add up for each person, how many times s/he shook hands. So we know you get an even number if you do that.

Now think about all of the people who shook hands an odd number of times. If there were an odd number of them, then all of their odd numbers of handshakes would add up to an odd number. Adding on all of the even numbers of handshakes from the other teachers would still leave an odd total. But we know the total is even, and so we conclude that it could not have been an odd number of teachers who shook hands an odd number of times. In other words, an even number of teachers shook hands an odd number of times, which is option A.

Question 3: It is not hard to see that if you connect the midpoints of the sides of a rectangle, you get a diamond shape with four equal sides called a rhombus, which rules out choices A (square) and C (rectangle). And if you try a trapezoid in which the sides are not parallel and one base is much longer than the other, you will find that you get a quadrilateral in which the sides are not the same, nor are adjacent sides the same, which rules out B (rhombus) and E (kite). Therefore the answer must be C, parallelogram. The reason that you always get a parallelogram is that it is not difficult to see, by similar triangles, that each side of this midpoint quadrilateral is parallel to the diagonal of the original quadrilateral that it does not intersect. Hence, the midpoint quadrilateral is a parallelogram.

Question 4: In 1984, Cindy Crawford graduated as valedictorian from De Kalb High School, and earned an academic scholarship to Northwestern University to study chemical engineering. She recalls her first calculus class thus: "For some reason, I caught the professor's eye. He was like, 'Honey, I think you have the wrong class.'"

Crawford was stunned. "That made me so mad," she remembers. "It was really the first time in my life that I felt judged by the way that I looked… It set me on a course of… I've got to prove to the world that I'm not [what he thought]."

Question 5: If $m^2+7m+89$ is divisible by 77, then 77 less will also be divisible by 77. That's $m^2+7m+12$. That factors as $(m+3)(m+4)$, which should be divisible by 77. Since $m+3$ and $m+4$ are consecutive numbers, we are looking for the smallest pair of consecutive numbers, one divisible by 7 and one by 11 (so that the product will be divisible by 7 times 11, which is 77.) That turns out to be 21 and 22, making m equal to 21 – 3 = 18, or option B.

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