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If $X = \text{Fedora}$, Solve for X

All of the eighth-graders lined up to enter the room.

Inside would be problems that would surely keep each of us biting our nails and wiping our brows, measuring our strengths and judging our peers, as this room could mean the difference between glory and defeat.

We were the smart ones. We were the gifted. We were the types of kids you would expect to see at an event called “Math Field Day.”

We represented twenty-eight junior high schools across seven counties, and we looked like it. Awkward and gangly, we were the best of our schools, best of our counties, and now we competed to be the best in the region, with state championships awaiting the people who emerged unscathed from the other side of this room.

There had been other rooms all morning. First came the testing room—an hour of filling in the bubbles and how fast did the second train get to Cleveland and solve for X .

Next came the puzzle room—an hour of putting together complex puzzle pieces, some made of blocks, some made of sticks, some actual pictures of historic paintings, and one that was like a Rubik’s Cube but with letters on each square instead of colors. The room was like a kindergarten play room for smart kids.

Those were the two rooms that we had been told would be part of this day, the two rooms we could prepare to tackle.

Lastly, came this room, with its possibilities, perhaps estimation or intricate problem solving.

The buzzer sounded, the door swung open, and the mustached instructor with the suede jacket motioned us all to come in, handing us each a small pad of paper as we entered.

There were fourteen stations around the room, and the first fourteen of us walked in with heavy steps mingled with nervous giggles. Mr. Suede, who bore the serious look of a man planning a tactical maneuver in a war, held a clipboard from which he read our names aloud, and when we heard our names and timidly raised our hands, he instructed us each to go to an appointed station. I happened to be placed at Station #1.

The mustache spoke. “You may begin,” and he paused, looking at his stopwatch; the room was completely silent as fourteen pubescent mathematicians held their collective breath.

“Now.”

My station contained a blue cylinder housing colored marbles:

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blues, reds, yellows, greens, purples, oranges, blacks, and whites—all of which seemed to be about the same size—filling the cylinder from the bottom to just below the rim at the top. A white envelope lay in front of the cylinder, and I opened it to read the instructions for this station, fully aware that I had a total of sixty seconds to complete whatever conundrum may lie within.

“Estimate the number of marbles within the cylinder. Write your estimation on the answer pad you were given as you entered.”

Putting the instructions back in the envelope, I stuck my arm up against the cylinder, and saw that its height was from my elbow to my wrist, which was precisely thirteen inches. Laying my hand across the top of the circular opening, with my wrist resting on the edge, the tip of my middle finger fell just short of the opposite side of the cylinder. This meant the structure was approximately six inches across, as the length from my wrist to the end of my middle finger was just under six inches. That meant that the radius would be about three inches. Lastly, I held the end of my finger next to one of the marbles at the bottom of the cylinder. One inch exactly. Just to be sure, I scanned the cylinder to see if the marbles appeared to be of different sizes, or if each one was the same. With the clock ticking, I had to make a snap judgment that each marble appeared to be the same.

The equation for solving the volume of a cylinder is $V = \pi r^2 h$, where V is volume, r is radius, and h is height. A stack of pieces of scrap paper lay next to the cylinder, and I quickly did my calculations before entering my answer of the pad I had been given. The volume is approximately 367, so my estimate, allowing for the air and space around each marble, is 350. The buzzer sounded, and we all moved on to the next station.

Keys to Math Field Day Success #1: Know the length and height of your bodily appendages

The end knuckle on my pointer finger is exactly one inch long, a fortuitous happenstance of my own personal evolution, which allows me to measure in inches quickly and effectively. My elbow to my wrist is thirteen inches, my wrist to the end of my middle finger is about six inches, so my elbow to the tip of my middle finger is nineteen inches, give or take a hair. My dad and I did not measure my hair. “If you know these things going in, you can use your body the same way you’d use a yard stick or a ruler,” my father had told me the night before when we turned my body into inches and feet. He was kneeling before me with a tape measure by his side. “I bet you’re the only one whose dad thinks of this.” He paused as he finished measuring my foot, which was not a foot

but was only ten inches long. He looked up at me and asked as casually as you would ask the time, "Ever measured your dick?" When I just stared back at him with my mouth open, he winked and laughed, then stood and turned to walk out of the room.

Moving quickly to my second station, there are no props or gizmos or anything to measure, but I see that the previous student failed to put the instructions back in the envelope. It is a small gift of probably three to five seconds that he saved me by leaving it out, but when you are competing with twenty-seven supposed fellow geniuses for only three spots in the state championship, seconds matter.

"Estimate to the nearest million the answer to the following: $187,596 \times 2,998$. Write your estimation on the answer pad you were given as you entered."

There is no scrap paper at this station, but that doesn't bother me. I close my eyes, imagining a chalkboard in front of me. I pick up the piece of imaginary chalk and begin to write out the equation, making sure to leave plenty of space underneath the bottom number so that I could show my work.

The funny thing about multiplication estimations is that, when given a number like 2,998, which is oh-so-very tantalizingly close to 3,000, and with only sixty seconds to do the math no less, you will be tempted to just use 3,000 to make the math quicker and arrive at an answer. After all, they want you to estimate to the nearest MILLION, so just adding two isn't going to make a big difference.

If you do the math on your imaginary chalkboard, with a stick of pink chalk in your hand, because pink stands out so clearly against the dark forest green of the chalkboard, you have time to do the real math. Time seems to stand still, the numbers clearly illuminating on the board, your hand whizzing around writing each number with effortless ease. You don't have to think, you simply do what you've done since you were in third grade and write down what you already know from memorization. Eight times six is forty-eight, nine times eight is fifty-six, and so on. The fluidity of your hand across the chalkboard does not surprise you—you have been training for this like an Olympian trains for the marathon.

The answer is 562,412,808. That means to estimate to the nearest million would mean the answer is 562 million. I set the chalk down, picked up the imaginary eraser, and erased all of my work. Around me, I heard a couple of snickers, and one quite clear "humph." But I did not want them to "see" my work, for what I knew that I hoped some of them did not, was that if you had used 3,000 to make the math easier, you would've put down 563 million, which is one million wrong. Two can make a huge difference.

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I opened my eyes, put the equation back in the envelope, closed it up and wrote my answer on my paper. The buzzer sounded.

Keys to Math Field Day Success #2: Ignore the competition

Like bullies on the playground trying to intimidate their classmates, math geeks will use trash talk, or the nerd world equivalent, in Math Field Day (MFD) competitions. You can listen to it for motivation if you want, but the fact remains that usually, everybody in the MFD rooms has been the victim of verbal abuse in one form or another, so we don't usually find trash talk motivating. Instead, we cower at the least sound of it. But if we are amongst our fellow MFDers, some of us suddenly get brave enough, arrogant enough, and cocky enough to feel like we can use the trash talk element of intimidation. So some MFDers try to use it to show they are the smartest kid in the room, like a bully does to prove he's the toughest. The difference between our trash talk and bully trash talk is the difference between Star Wars and Star Trek: They are alike in name only. MFDers may snicker at your work, or may outright laugh as you draw your equations in the air, or they may say things like, "I bet he doesn't even know how gravity works. Hey, Leonard, in 10 seconds or less tell me how gravity works. See, I told you he didn't know! Ha!" When well-meaning parents or teachers tell you to ignore bullies, they mean the playground kick-your-ass ones. The funny thing is, ignoring doesn't work on the playground, but it does in MFD. Show them it doesn't bother you, and they will start to second-guess themselves about who the smartest person in the room really is.

Out of the corner of my eye, I caught a glimpse of my friend David walking away from Station #14, which would've been his second station but would end up being my last. David was currently our class's valedictorian. He had come in first in our county competition and I had come in second, which had given each of us a spot in this regional battle. He was my friend, but he was also my biggest competition, and in that brief moment I saw a look on his face that could be described only as bewilderment. He saw me and quickly smiled, but he was paler than usual and beads of sweat were on his forehead. Whatever Station #14 was, it had stumped the smartest kid I knew.

My third station asked us to solve a math riddle, and it took me a second to focus, as the look on David's face had given me pause. I knew that it would be awhile before I got to Station #14, and I had

plenty of math to do in the interim, but it still took me a couple of precious seconds to gather myself for the task at hand.

Luckily, the riddle was one I had seen before: “*Part 1: What digit appears the most frequently between and including the numbers 0 and 1,000? Part 2: Within the same parameters, what digit occurs least frequently? Write your answers on the pad you were given as you entered.*”

This is a riddle designed to test your ability to quickly recognize patterns, an important skill set in mathematics. If you think about just the numbers 0-30, you’ll figure out the answer in seconds, and as I had seen this riddle before, I had plenty of time to write my answers on my paper and then look around the room. My eyes were drawn to David first, who was back at the station where I began. He was staring at the cylinder with his pencil in his mouth, his finger drumming on the side of the table, and though I couldn’t know for sure what he was thinking, I would’ve bet money that he was actually counting the marbles.

Keys to Math Field Day Success #3: Never let them see you sweat

If you don’t know the answer to something, and you let your opposition see you struggle, see you get frustrated, see you fight back tears or even (God forbid) let them flow, you are toast. It doesn’t really matter from that point forward how good you are at math or how smart you are in general because you are simply going to lose. It is kind of like the power of positive thinking in reverse—let the universe know that you just can’t solve this problem to save your life and the universe will respond by making you begin to doubt your ability to solve any problem anywhere for the remainder of the day. It does not matter about your prep work. The night before MFD, my dad was like a drill sergeant. “How do you solve for the area of a triangle?” $A=1/2 bh$ “What is the equation for the volume of a sphere?” $V=4/3 \pi r^3$ “How many faces on a dodecahedron?” Twelve. In the heat of battle, it is good to have these things memorized, but you are not going to remember them all. Don’t know the answer or even how to solve it? Fake it. Put down anything, and then forget it and move on. You will not get every single problem right at an MFD no matter how brilliant you are or how many quizzes your dad gave you the week leading up to it. You will simply not know what the hell some equation means, and if you let the rest of the world see it, you will be done. Fake it, fuck it, forget it. Write down X. Move on.

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The answers to the last riddle, by the way, are one and zero respectively, and Dad had told me that one many times. The stations that followed were all things with which I was at least moderately comfortable. Some more estimations, like the surface area of a ball or the volume of a cube, and a few more riddles, most of which my dad had shown me before. For some of them, I required every second of the sixty to complete the task, but for a few of them, I had a little spare time. Each time I was gifted with these extra seconds, I would take a peek at the person at Station #14.

Without exception, every single student who stood before this station, from the tall blond girl who wore cowboy boots to the short fat kid that smelled like cheese, every one of them looked dumbfounded. Every single one of them walked away shaking their heads or scratching their cheeks. Some rubbed their pencils on the tops of their skulls like they wanted to erase whatever they had just seen.

Finishing the puzzle at Station #13, the butterflies in my stomach fluttered more than they had all day, and as the penultimate buzzer sounded, I moved to Station #14.

The last person who had been at this station had clearly gotten pissed off and just shoved the paper back into the envelope, wrinkling them both. My hands were sweaty and a little shaky, and it took me a second to pry the wrinkled question from the envelope.

When I read it, all the butterflies flew away, and a smile spread across my face.

*“If $N=X$, $R=Y$, and $F=Z$, what is $X=Y_ * Z_ p X_ e Z_ l Z_ i Z_ c L$? Write your answer on the pad you were given as you entered.”*

I almost laughed out loud. Now I knew two things, and I knew them with as much certainty as I had ever known anything in my life: 1. I knew the answer to this problem, and 2. I knew I was the only one in the room who did.

Keys to Math Field Day Success #4: Be my dad’s son

Green Bank, West Virginia, is home to the world’s first large satellite used for scanning the universe and viewing the stars, built in the 1950s in the mountains of Appalachia and hundreds of miles from any major city. It houses the world’s largest moving telescope. The site at Green Bank is the original home of the National Radio Astronomy Observatory, which now also has satellites in New Mexico and Washington state, and it is the place where SETI was born. The Search for Extra-Terrestrial Intelligence conducted their first scans of the galaxy right here, their search for little green men beginning among the bright green mountains of my home state. It is a two-hour drive from my

hometown, and they offer tours of the satellite during the summer.

Two years ago, my dad drove the five of us to Green Bank, in the heat and humidity of a West Virginia July, in our brown station wagon with the camping trailer bumping along behind us, precariously attached by a frayed towing cable. In the woods of a Pocahontas County campsite, we popped up the camper and settled ourselves in, sweat pouring from every part of our bodies the moment we stepped out of the car. After setting up camp and begging for some water, we climbed back in the wagon, now unhitched from the trailer, and drove over to see the satellite.

“They can see millions of miles into space with this thing, kids,” Dad was saying from behind the steering wheel. “Soon we’ll know for sure what other stars have planets and how to travel to them and things that we can’t even begin to imagine.” He was like a kid headed to Disney World and, for me, his enthusiasm was becoming contagious. “Maybe,” he continued, his voice rising with each second, “just maybe, they will hear the signal that means life exists on another planet, that we are not all alone after all.” That did it. I sat up straighter in my seat and began to peer out the window to try to be the first to catch a glimpse of the satellite.

As we rounded a curve and came out from a grouping of trees, I saw it. At once, I was in awe and terrified, as this gigantic machine loomed larger than anything I had ever seen. It made the 100-foot tall water tank in my neighborhood seem like a toy. Like something out of a science fiction movie, the satellite seemed to be a spaceship that had landed and deployed its contents, as dozens of lab-coated men and women could be seen walking around below it, ants under an enormous magnifying glass. It was beautiful and scary and I couldn’t take my eyes off of it. “Damn,” my dad uttered slowly from the front seat, with a deep intake of breath. We parked in the lot and walked up to the main entrance to the facility, and never once did my eyes or my dad’s move from the satellite. Once inside, Dad forked over \$20 to pay our entrance fee, and we walked around a museum dedicated to the scientific discoveries that had been made in Green Bank since the facility had opened some forty years prior. But what drew my dad’s attention, and subsequently mine, was a small room called “The Scientists’ Lounge.” We headed over to it while my mom took my brother and sister into the gift shop.

Dad approached the room as if he were a priest making a pilgrimage to the Vatican. As he reached the doors, he took off his fedora and held it tightly in his hands. His steps were slow and deliberate, and even though we could see the room was empty, he

moved as one who doesn't want to disturb the sleeping. My dad knew what had happened in this room, and he enlightened me in loud whispers as we walked slowly through the doors.

"Son, in the 1960s a group of scientists met in this room and changed the world forever," he said. "They included Carl Sagan, Melvin Calvin, and the one and only Frank Drake. They called themselves the Order of the Dolphin, and they were here to discuss an equation meant to determine if life on other planets could be found." The room just looked like any old meeting room to me, like you might find in some hotel lobby, but Dad took me to the far wall and showed me a golden plaque, with letters that shined with the reflection of the summer sun coming through the windows. "This is the Drake Equation," he said. "Memorize it, know it like you know your home phone number, because someday, someone will use it to know for certain just exactly where life in our galaxy exists." He stared at it, and so did I, and we didn't speak for several moments.

Later that day, when we finished our tour and went into the gift shop to get a couple of souvenirs, I bought a journal with the equation written on the front, and I stared at it in my room every night when I used that journal as the diary of my teenage years. It looks complicated, but once you memorize the terms, it is actually pretty straightforward. $N=R \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$. N is the number of civilizations in the Milky Way Galaxy with which we might be able to communicate. R is the rate of star formation in our galaxy, f_p = the fraction of those stars that have planets, n_e = the average number of those planets that can support life, f_l = the fraction of those planets that actually develop life on them, f_i = the fraction of those planets with life that actually become what we would call civilizations, f_c = the fraction of those civilizations that send signals of their existence into space, and L = the length of time they actually send out those signals before they all die off or blow themselves up or whatever. For two years after first seeing that equation, I had stared at it nightly when I went to write in my journal.

All the Math Field Day test creators had done was replace one letter for another, not as a math question, but merely as a question of how much the students knew about their own state's unique place in scientific history. I calmly placed the paper back in the envelope, wrote "The Drake Equation" on my answer sheet, and waited for the final buzzer.

As we sat in the auditorium awaiting the results, Dad's left leg

was shaking. He fidgeted with his belt buckle, twisted his shirt sleeve and put his fedora on his knee, then back on his head, then back on his knee. He reached over and patted my back a couple of times without looking at me.

Finally, Mr. Mustache approached the podium and the room of twenty-eight students and their extended families came to complete silence.

Without a smile, he began a lengthy speech, thanking the families for supporting “these bright young minds and leaders of the future,” and thanking their teachers for “instilling a love of math and science in these bright young minds,” and thanking us students for “studying hard and using our bright young minds,” and I counted five uses of the same phrase in his speech. He also grunted thirteen times and said “Um” sixteen. Dad’s leg shook the entire row of seats.

“And now, the third place student in today’s Region III Math Field Day competition, winning the right to attend the state championship next month in Morgantown is,” and Mustache said a name that I did not recognize. From a couple of rows behind me, the tall blond girl wearing the cowboy boots jumped up, and a lady that I can only assume was her mother squealed and jumped up with her. Cowboy boots walked toward the stage, and the room politely applauded. My dad wrung his hands, but I smiled and looked down at my feet because I knew something that he didn’t know—I had this in the bag. I could not wait to see the look on his face.

“In second place in today’s Region III Math Field Day competition, winning the right to attend the state championship next month is,” and when he didn’t say my friend David’s name, my shoulders slumped. The kid whose name was called was the only African-American boy in the whole competition, and when he stood up three rows in front of me to go to the stage, so did his entire family, which must’ve been ten people. More polite applause around the room, more hand-wringing from my dad.

David was the smartest kid I had ever known, but I knew that only one of us was going on to the finals. If his name wasn’t called in second place, and neither was mine, then one of us was about to be heartbroken, and even though I was happy to have done so well during the day, I was sad for David. I knew something, and knew it as well as I have known anything to this point in my life: My name was about to be called.

“And finally, the winner of the Region III Math Field Day competition, and the top student representing Region III in next month’s state championship is . . .”

Time really does slow down occasionally. When you see a beautiful girl walk past you, when you take your first plane ride, when

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you open a door to an unknown room, when you take in your breath seconds before you get sad news, when you get your first kiss, when someone you love takes their last breath. Time. Moves. Slowly. It is not a scientific thing, it is not a mathematical thing, it is a spiritual thing. You can't write out an equation to prove it. It just happens. The human spirit says to the universe, "Hold on a second, we need to experience this moment a little more deeply, for all its beauty or all its pain, just hold on a second, universe. Deep breath. Let's take this in."

The fedora on my dad's head hit the ground in front of me.
"Jørn Earl Otte."

It is quite possible that my dad leapt ten feet in the air.

I stood with a smile and walked past my dad, who grabbed my shoulders and shook me with such force that he could've dislocated a rib. Grinning, I gingerly wrestled myself out of his grip and walked onto the stage, shaking Mustache's hand and taking my trophy, looking out at the audience and their polite but muted applause, and spotting my dad, whose big hands thundered and shook the room.

When we left the auditorium, Dad took off his fedora and put it on my head.

"Now you are worthy to wear this hat," he said. I had no idea what in the world he meant, but I wore it and a smile the rest of the day.

