

# NSF Math Column



## Problem of the month

Bob and Jack play a shooting game. In this game, they have a net at a distance. The net is made up of 1 mm thick wires. The wires run vertically and horizontally to form a mesh that has 5 mm square openings between them. A bullet 2 mm in diameter must be shot in such a way that it goes through the net without touching the wires. Such a shot would result in 100 points. All other scenarios will result in 0 points. Bob is set to start the game. What is the probability that Bob scores 100 points from his first shot?

Would you like submit your answer? Please click on the following link:

<https://spreadsheets.google.com/viewform?formkey=dHR6ek5BazVnRVM3d01nbG1fNVdybxc6MA>

***Names of everybody who submitted correct answers will be published in the next edition!***



***Interested to know the solution for last column's problems? Refer to the end of this document!***

***For any questions or comments, please contact the team at [NSFMathColumn@gmail.com](mailto:NSFMathColumn@gmail.com)***

# NSF Math Column

## Answer to Problem of the month (Vol 2-1)

6

### Solution:

After trying the first few steps, we notice that the boxes resemble the set of positive integers in quinary (base 5). In particular, the first box corresponds to the ones digit, the second corresponds to the fours digit, and so forth. An empty box corresponds to the digit 0 and a box with  $k$  balls,  $1 \leq k \leq 4$  corresponds to the digit  $k$ .

We need to verify that this is true. On the first step, the boxes represent the number 1. For the  $n^{\text{th}}$  step, suppose that the ones digit of  $n$  in quinary is not equal to 4, so that the first box is not full. The operation of adding 1 in quinary simply increments the ones digit of  $n$  by 1. Indeed, Mady performs the corresponding operation by adding a ball to the first box. Otherwise, if the ones digit of  $n$  in quinary is equal to 4, suppose that the rightmost  $m$  consecutive quinary digits of  $n$  are equal to 3. Then, adding 1 to  $n$  entails carrying over multiple times, so that the  $(m + 1)^{\text{th}}$  digit will be incremented once and the other  $m$  digits will become zero. Mady does the same: she places a ball in the first available box  $((m + 1)^{\text{th}})$ , and empties all of the previous boxes.

It follows that the number of filled boxes on the  $2010^{\text{th}}$  step is just the sum of the digits in the quinary expression for 2010. Converting this to quinary, the largest power of 4 less than 2010 is  $5^4 = 625$ , and that  $3 < 2010/625 < 4$ . Then,  $2010 - 3 \cdot 625 = 135$ . Repeating this step, we find that  $2010 = 3 \cdot 5^4 + 1 \cdot 5^3 + 2 \cdot 5^1$ , so the desired answer is  $3 + 1 + 2 = 6$ .



### Who submitted correct answers?

- Shaan Bhandarkar (Sterling VA)
- Akshaj Kadaveru (Fairfax VA)
- Sushovan Guha (Missouri City TX)
- Siddarth Guha (Missouri City TX)
- Aayush Gupta (Saratoga CA)
- Varun Singh (Tampa FL)
- Tanushree Pal (Ventura CA)
- Deepankar Gupta (Naperville IL)
- Anika Ramachandran (cupertino CA)
- Aditya Vargheese (Overland Park KS)
- Gargi Sadalgekar (East Windsor NJ)
- Anjali Nambrath (Marlboro NJ)
- Meena Shankar (Bridgewater NJ)
- Pranav Narnur (Suwanee GA)
- Aryaman Khandelwal (Breinigsville PA)
- Riju Datta (Tampa FL)
- Shalini Dangi (Mission Viejo)
- Agni Kumar (Milton GA)
- Abhishek Allamsetty (Herndon VA)
- Anusha Allamsetty (Fairfax VA)
- Rohan Balel (Chicago IL)
- Varun Vepa (Urbandale IA)
- Ajit Kadaveru (Fairfax VA)
- Shwetark Patel (Herndon VA)
- Anna Nixon (Portland OR)
- Maya Shankar (Bridgewater NJ)
- Shritha Gunturu (Aurora CO)
- Sankar Mahadevan (Dayton NJ)
- Nitin Reganti (Princeton Junction NJ)
- yash chandak (Dallas TX)
- rekha chandak (Dallas TX)
- Ashwin Vangipuram (Novi MI)
- Ram Boda (Lewis Center OH)
- Sreenu Pamidi (Shrewsbury MA)
- Mounisha Kovour (Algonquin IL)
- Himanvi Kopuri (Denver CO)
- Savan Kumar (LAWRENCE)
- Krishna Bharathala (Fremont CA)
- Anitha Reganti (Princeton Junction NJ)
- Dhivya Senthil Murugan (Denver CO)
- Meghana Gudavalli (Franklin Park NJ)
- Nithin Gudavalli (Franklin Park NJ)
- Saigautam Bonam (VA)

## NSF Math Column

- Rama devi kodali (Cary NC)
- Arav Karighattam (Davis CA)
- Mythri Challa (Coralville IA)
- Adithya Mummidi (San Antonio TX)
- Anirudh Kuchibhatla (Hyderabad India)
- Anitha Ramakodi (Parsippa NJ)
- Anupam Sharma (Haymarket VA)
- Syamantak Payra (Friendswood TX)
- Neha Khandelwal (Haymarket VA)
- yash nalla (Concord NC)
- Alap Sahoo (Bakersfield CA)
- PRANAM KALLA (Simi Valley CA)
- Shruthi Santhanam (Suwanee GA)
- Gayathri Srirajan (Waukegan IL)
- Anish Madala (Chantilly VA)
- Rahul Madala (Chantilly VA)
- Vijaya Madala (Chantilly VA)
- Simoni Maniar (grapevine TX)
- Sanjana Vadlamudi (Cary NC)
- Meghana Nambiyur (Round Rock TX)
- Desigamoorthy Nainar (Champaign IL)
- Srimi Malempati (Newark DE)
- shilpi veludadni (spring)
- Chandana Kandru (Monmouth Junc NJ)
- Ananth Sankaralingam (Dayton NJ)
- Pranay Malempati (Newark DE)
- Meyyappan Kathir (Tyngsboro MA)
- Arvind Subramanian (Olathe KS)
- Chandrasekhar Sundarrajan (TX)
- Hemanth Chitti (Bangalore India)
- Sreekar Chitti (Bangalore India)
- Indumathi Prakash (Sharon MA)
- Sneha Prasath (Westford MA)
- Pranav Nagarajan (Fremont CA)
- Subashni Rajiv (Los Angeles CA)
- Sanjana Akula (Morganville NJ)
- Bhavana Akula (Morganville NJ)
- Sayuj Shajith (Suwanee GA)
- Keerti Vajrala (Aurora CO)
- Nikita Agarwal (India)
- Sundar Sankaran (Voorhees)
- Srujan Gubbi (Commerce Twp MI)
- Bharath Mohan (Simi valley CA)
- Soumika Guduru (San Diego CA)
- Shraeya Madhu (Clarksburg MD)
- Monal garg (NJ)
- Anju Garg (NJ)
- Sisi Hanley (CO)
- Shreya Bellur (Dunlap IL)
- Pranav Upadhyayula (Plainfield IL)
- Aditya Kumar (Herndon VA)
- Shreeman Nimmagadda (Ann Arbor MI)
- Meghana Annambhotla (Southbury CT)
- Pranav Arunandhi (Rochester Hills MI)
- Avinash Madala (Pembroke Pines FL)
- Mahathi Allepally (Issaquah WA)
- Anjali Gupta (Edison NJ)
- Rohith Saikumar (Mason)
- Mukta Valluru (Austin TX)
- Aviral Somani (Irving TX)
- Sanjana Challa (Herndon VA)
- Ankit Bhatia (San Diego CA)
- Riya Dabbi (Herndon VA)
- surya Jaladi (St Louis MS)
- Varun C (IN)
- Disha Hegde (Plainsboro NJ)
- Mrugank Gandhi (Aurora IL)
- Lalitha Chamarajan (Mount Laurel NJ)
- Geetanjali Khanna (Piscataway NJ)
- Vanitha Sankaranarayanan (Walnut Creek CA)
- Gowri Anupama (Sunnyvale CA)
- Pavani Samala (West Chester PA)
- Andy U (DE)
- Tarang Saluja (Nashua NH)
- Sushil Upadhyayula (Naperville IL)
- shravani samala (West Chester PA)
- Sneha Satish (Lodi NJ)
- Ritika Revoori (Sharon MA)
- Srivani Edupuganti (Cary NC)
- Rohith Edupuganti (Cary NC)
- Sanjna Khanna (Piscataway, NJ)
- Pranav Reddy (Kinnelon, NJ)
- Narahari Bharadwaj (Berwyn, PA)
- Rithvik Garimella (Canton, MI)
- Adityagautham Sezhian (Painted Post, NY)
- Arnav Singh (Tampa, FL)
- Aayush Singh (Tampa, FL)

Thanks to all who attempted to solve the problem of the month. We look forward to your continued interest and increased participation.