

**International mathematical Olympiad**  
**“Formula of Unity” / “The Third Millennium”**  
**2017/2018 year, final round**

SOLUTIONS TO THE SECOND ROUND FOR PARTICIPANTS.

GRADE: ...38... NUMBER: ...11...

(1)

After the first frosty day, ice covered all parts of the pond which were 10 meters away from the edge or less and the water decreased by 20,2%, the second day ice covered 20 meter away from the edge or less and the water decreased 18,6%, with that information I did a table with the decreasing of the water, knowing that the water decreased the same than day before minus 1,6%.

Days	1	2	3	4	5	6	7
Metres	10	20	30	40	50	60	70
Water decreased	20,2%	18,6%	17%	15,5%	13,8%	12,2%	10,6%

I summed the percent of the water decreased after the result was 100%, The 100% was at the middle of the six and the seven day.

So the pond will become frozen the seven day.


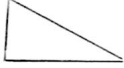


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GRADE: 98 NUMBER: 81

(2)

One example of the table is:

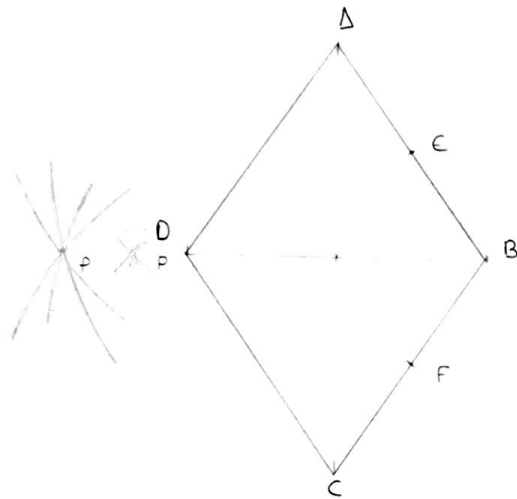
	The figure has an acute angle	Some of the sides are equal	The figure has an	The figure is CONVEX
	1	1	0	1
	1	0	1	1
	0	1	1	1
	1	1	1	0

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GRADE:   88   NUMBER:   33  

③



P lies on the line BD because all the points in the line BD that are from the D to the opposite side of the point B are at the same distance to  $\Delta, E, F, C$ .  
You can see two examples of it on the drawing at the top of the page.

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GRADE: <sup>R8</sup>..... NUMBER: ...A.1..

④

The smallest possible sum of these two numbers is four, to know that I did the table with the smallest numbers possible to use and doing a strategy. Putting a number and a different number (bigger or smaller) in his neighbors, and changing into places the number to be not colored. But to do that I use three numbers (the smallest) the biggest and the smallest to the colored numbers and the middle one for the not colored.

1	3	1	3	1	3	1	3	1	3
3	1	3	1	3	1	3	1	3	1
1	3	2	3	1	3	1	3	1	3
3	1	3	1	3	1	3	1	3	1
1	3	1	3	1	3	2	3	1	3
3	1	3	1	3	1	3	1	3	1
1	3	1	3	1	3	1	3	1	3
3	1	3	1	3	1	3	1	3	1
1	3	1	3	1	3	1	3	1	3
3	1	3	1	3	1	3	1	3	1

● = colored one  
 ✕ = not colored one

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GRADE: R8... NUMBER: 31..

⑤

Ben has the winning strategy because he only need to put other number different of 0, 1, 9, 6, 5 at the final of the number to not be a perfect square, because all the perfect square finish at this numbers. This is the result of a square of a number, because it doesn't sum with other number.

$$\begin{array}{r} 25 \\ \times 25 \\ \hline 125 \\ 500 \\ \hline 625 \end{array}$$

That's number is the result of the square of five

- All of the signed number are the possibilities to finish a perfect square.
- 0 → 0
  - 1 → 1
  - 2 → 4
  - 3 → 9
  - 4 → 16
  - 5 → 25
  - 6 → 36
  - 7 → 49
  - 8 → 64
  - 9 → 81