MATHEMAGIC

- MAZE -

Materials:

- Whiteboard or sheet of paper
- Pencil
- Pawn or magnet

How to do the Magic Trick

Goal:

Find which square the pawn (or the magnet) will end up on at the end of the requested movements.

Preparation:

Draw, on a sheet of paper or a board, a squared maze as shown below.

1	2	3
4	5	☆
6	7	8

Trick:

1. The spectator places the pawn (or the magnet) on the starting square, which is the square with the star on it.
2. The magician turns around, so he cannot see the board, and asks the spectator to move his pawn of 4 squares. He can move his pawn horizontally or vertically, but not diagonally. It is possible to come back on the same square.
3. The spectator removes square 1, to the magician's request (see figure 1).
4. He moves the pawn of 5 squares.
5. He removes squares 2 and 7, to the magician's request (see figure 2).
6. He moves the pawn of 7 squares.
7. He removes squares 3, 6 and 8, to the magician's request (see figure 3).
8. He moves the pawn of 3 squares.
9. He removes square 4 and the square with the star (see figure 4).

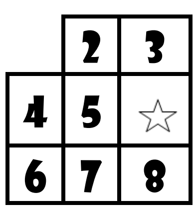


Figure 1

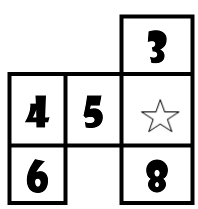


Figure 2

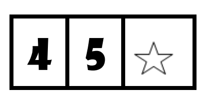


Figure 3

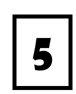


Figure 4

10. The magician reveals that the pawn is on square 5.

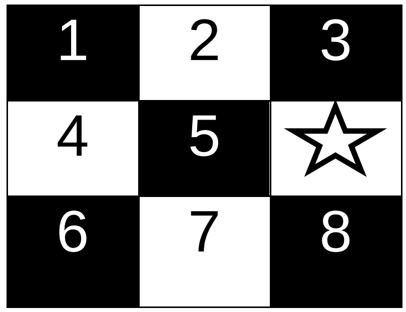
Association Québecoise des Jeux Mathématiques

SCIENCES ET MATHÉMATIQUES EN ACTION

MATHEMATICAL EXPLANATION

Why this trick works.

The trick is based on the notion of parity, that is the properties of even and odd digits.
The maze used for this trick works in the same way as a checkerboard.



On a checkerboard, we notice that the black and white squares alternate.

Let's look at various movements scenarios:

- If we ask the spectator to move of **1 square**, the possible final squares are only the adjacent squares. But, we mentioned earlier that our maze was drawn like a checkerboard, meaning the black and white squares alternate. **We conclude from that that the colour of the final square will be different from the colour of the square on which the pawn was before the movement.**

- If we ask the spectator to move of **2 squares**, it is equivalent to doing two movements of 1 square. But, because each movement changes the colour, we end up changing the colour of the square twice. Therefore, since the colours alternate, **the colour of the final square is necessarily the same colour as the square on which the pawn was before the movements.**

  Each time there is an additional movement, we are sure that there is also an additional change of colour. For example, one movement of 3 squares can be visualized as three movements of 1 square. So, if the pawn is on a black square before the movement, we know that the pawn will go on a white square during the first movement, on a black square during the second movement and on a white square during the third movement.

  In short, all the odd movements change the colour of the final square in comparison with the starting square and all the even movements preserve the colour of the starting square.

At the beginning of the trick, the spectator places the pawn on the square with the star, **which is a white square.**

The first movement asked by the magician is of 4 squares, so an even number of movements. When we do an even number of movements, the colour of the final square is the same as the one where the pawn was before the movement. So, we know that the pawn will end up on a white square after the first movement. Therefore, the magician asks the spectator to remove square 1 because it is black.

At this point, the pawn is on a white square.

The second movement is of 5 squares, so it is a movement of an odd number of squares. Considering that type of movement, we know that the pawn will end up on a black square, because a movement of an odd number changes the colour of the final square. Therefore, after this movement, the magician knows that the pawn is, without a doubt, on a black square. So, he asks the spectator to remove squares 2 and 7, because they are white.

At this point, the pawn is on a black square.

The third movement is of 7 squares. Considering it is a movement of an odd number of squares, we change the colour of the final square. So, the pawn will end up on a white square. The magician asks the spectator to remove squares 3, 6 and 8, since they are black.

At this point, the pawn is on a white square.

The last movement is of 3 squares, so the pawn will certainly end up on a black square, since this is an odd movement again. There is only one possibility of black square left: square 5. The magician asks the spectator to remove square 4 and the square with the star, which are both white squares.

The magician reveals that the pawn is on square 5.