

9.4 Composition of Transformations

ACTIVITIES FOR STUDENTS

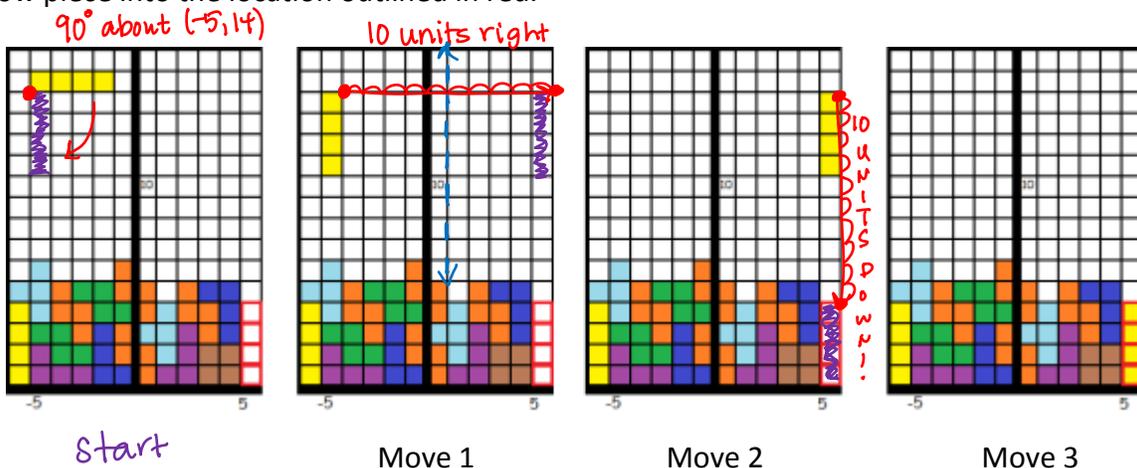
The Geometry of Tetris

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THE GEOMETRY OF TETRIS: Tetris is a game that has achieved worldwide popularity since its release in 1984. We will look at geometric transformations that can be used in this game. In the traditional Tetris game, a player is allowed only to rotate and translate objects. Use the link here to play a version of the original game: <http://www.netrover.com/~kingskid/tetris/tetris.html>. ← Try this at home!

KEY VOCABULARY: We have learned three transformations so far: reflections, translations, and rotations. All of these transformations are considered isometries. We define an *isometry* as a transformation that preserves distance or length. Today we are going to learn about compositions of transformations; specifically the composition of two or more isometries is an isometry. A composition of transformations occurs when we perform multiple transformations on the same object – one transformation after another.

Now that you have played the game of Tetris for a while, we will represent the rotations and translations of the game play using typical mathematical notation. Study the sequence of moves below required to place the falling yellow piece into the location outlined in red.



Move 1: Rotate 90° clockwise about $(-5, 14)$.

Move 2: Translate 10 units to the right.

Move 3: Translate 10 units down.

Composition: $T_{\langle 0, -10 \rangle} \circ T_{\langle 10, 0 \rangle} \circ R(90^\circ, (-5, 14))$
 or
 $T_{\langle 0, -10 \rangle} (T_{\langle 10, 0 \rangle} (R(90^\circ, (-5, 14))))$

If reflections were allowed, how could you modify your moves above to include a reflection?

Move 1: Rotate 90° clockwise about $(-5, 14)$

Move 2: Reflect over the line $x=1$

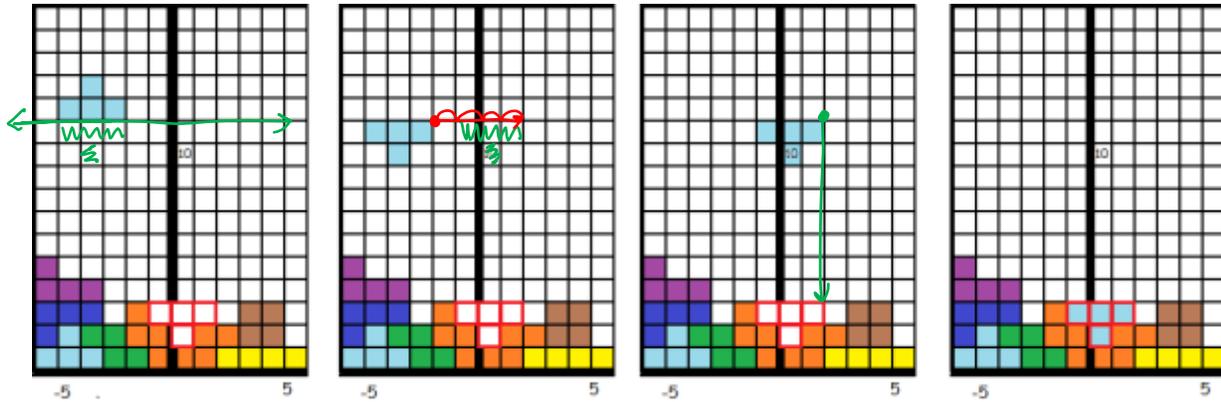
Move 3: Translate 10 units down

Composition: $T_{\langle 0, -10 \rangle} \circ R(x=1) \circ R(90^\circ, (-5, 14))$

Any other possibilities?!

- Be careful... R can represent Reflections/Rotations
- Remember Reflections are over a line + Rotations are a degree turn about a pt.

Your job is to move the light blue piece into its final position following the moves that are listed below. List them as separate moves and then write it using composition notation.



Move 1

Move 2

Move 3

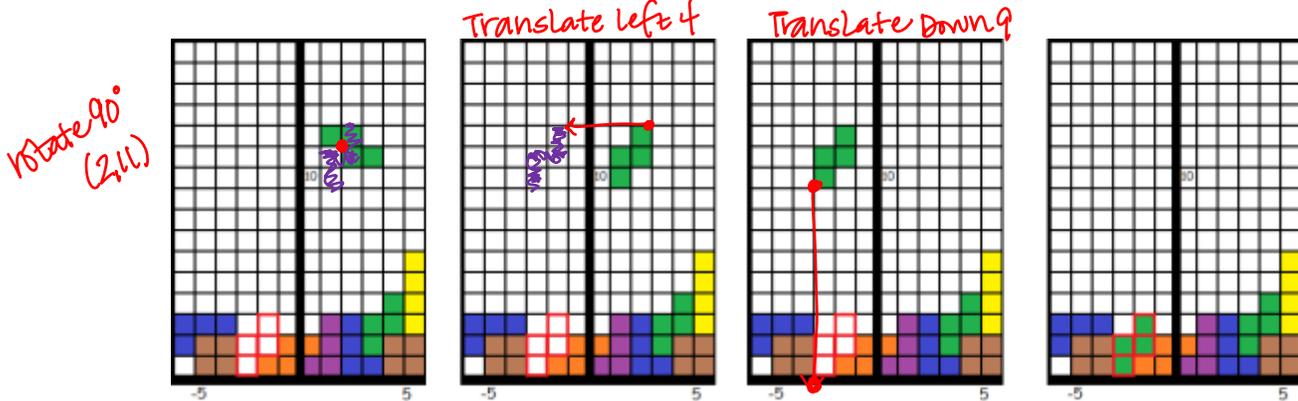
Move 1: Reflected over $y=11$

Move 2: Translate 4 units right

Move 3: Translate 8 units down

Composition: $T_{\langle 0, -8 \rangle} \circ T_{\langle 4, 0 \rangle} \circ R_{(y=11)}$

Your job is to move the green piece into its final position following the moves that are listed below. List them as separate moves and then write it using composition notation.



Move 1

Move 2

Move 3

Move 1: Rotate clockwise 90° about $(2,11)$

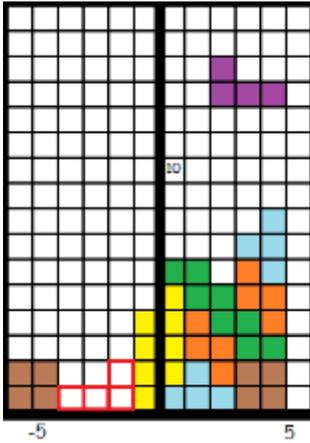
Move 2: Translate left 4

Move 3: Translate Down 9

Composition: $T_{\langle 0, -9 \rangle} \circ T_{\langle -4, 0 \rangle} \circ R_{(90^\circ, (2,11))}$

For each of the three Tetris boards numbered below, write the sequence of moves required to move the piece into the desired location. Try to use the minimum number of moves possible. Then write the moves as a composition of isometries.

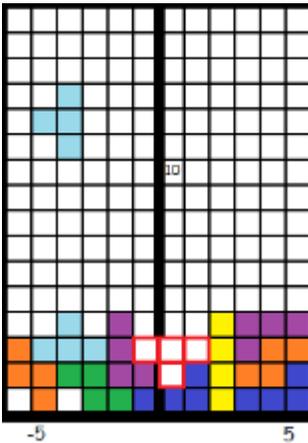
Board 1



Moves:

Composition:

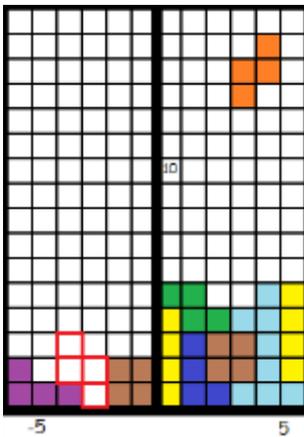
Board 2



Moves:

Composition:

Board 3



Moves:

Composition:
