

CUT & GLUE SORT

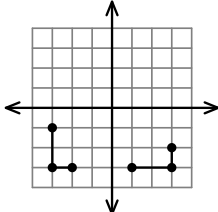


ROTATIONS IN THE COORDINATE PLANE

Which Quarter Turn — or None?

Counterclockwise · clockwise · no turn about the origin does this

FREE

1 A turn about the origin carries $(4, -1)$ to $(1, 4)$.	2 A turn about the origin with the rule $(x, y) \rightarrow (-y, -x)$	3  A turn about the origin carries one L onto the other.	4 A quarter turn counterclockwise about the point $(2, -1)$.
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1. **Hand out pages 3 and 4**, one of each per student, and scissors and glue.
2. **Say this once:** *“For every piece, find the center first. Then find which way the turn goes. If no single turn about the origin can do everything the piece says, it goes in the last row.”*
3. **Check a sheet in ten seconds:** every row gets four pieces.

Student sheets	pages 3 and 4, one of each per student. The four turns and all their names are printed on page 3 as pictures. Their rules are not printed.
Answers	page 5.

The first two rows are the two quarter turns. Students very often turn the wrong way. Each row has four kinds of piece: a rule in letters, a point and its image, a turn in words, and a figure before and after. The words piece in each row uses the turn's other name: 270° clockwise in row 1, and a three-quarter turn counterclockwise in row 2. A student who sorts by the direction word alone puts both of them in the wrong row.

The last row shows where the rules stop working. The rules work only for turns about the origin. This row has a quarter turn counterclockwise about $(2, -1)$, in words. It has an L turned a quarter turn about $(1, 1)$, which looks right but lands in the wrong place. It has two points at different distances from the origin, and no turn about the origin can join them. And it has the rule $(x, y) \rightarrow (-y, -x)$. That rule swaps the numbers and changes both signs. It is the reflection in $y = -x$, not a turn. There is no half turn on this sheet, because a half turn fits neither quarter-turn row.

Guessing does not work. Every simple guessing rule, such as sorting by the direction word alone, gets at most six of the twelve pieces right.



This is the free lesson this activity came from. The worksheet, the full answers and the lesson plan are on it, at three levels of difficulty.
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Which quarter turn — or none?

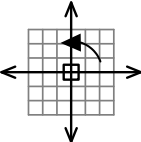
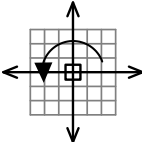
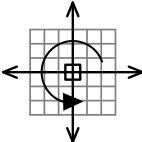
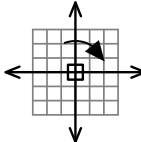
Rules, points, words and figures

Name _____

Period _____

Date _____

Cut out the twelve pieces on the next page. Each one says something about a turn. **Decide which turn about the origin does it, or whether none does, and glue it into that row.** On a drawing, the long arm goes to the long arm and the short arm to the short arm.

			
quarter turn counterclockwise $+90^\circ$ · the center stays put	half turn · 180°, either way <i>also: the point reflection in the center</i>	three-quarter turn counterclockwise $+270^\circ$ · the same turn as -90°	quarter turn clockwise -90° · the same turn as $+270^\circ$

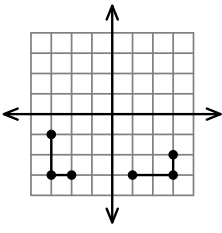
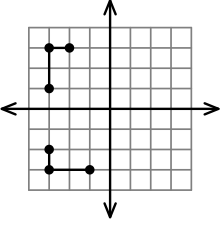
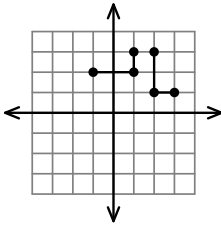
The quarter turn counterclockwise about the origin

The quarter turn clockwise about the origin

No turn about the origin does this — *no one turn about $(0, 0)$ does all that the piece says*

The twelve pieces

Cut along the dotted lines

1 A turn about the origin carries $(4, -1)$ to $(1, 4)$.	2 A turn about the origin with the rule $(x, y) \rightarrow (-y, -x)$	3  A turn about the origin carries one L onto the other.	4 A quarter turn counterclockwise about the point $(2, -1)$.
5 A turn about the origin carries $(-2, -5)$ to $(-5, 2)$.	6 A turn of 270° clockwise about the origin.	7 A turn about the origin with the rule $(x, y) \rightarrow (y, -x)$	8  A turn about the origin carries one L onto the other.
9  A turn about the origin carries one L onto the other.	10 A turn about the origin with the rule $(x, y) \rightarrow (-y, x)$	11 A turn about the origin carries $(-4, 3)$ to $(3, 5)$.	12 A three-quarter turn counterclockwise about the origin.



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Cut & Glue Sort — answers

For the teacher

The quarter turn counterclockwise about the origin	1 — The rule $(x, y) \rightarrow (-y, x)$ of the quarter turn counterclockwise sends $(4, -1)$ to $(1, 4)$.	6 — A turn of 270° clockwise about the origin ends in the same place as the quarter turn counterclockwise.	8 — Every corner follows the rule $(x, y) \rightarrow (-y, x)$. For example, the bend $(-3, 3)$ goes to $(-3, -3)$.	10 — This is the rule for the quarter turn counterclockwise. It sends $(1, 0)$ to $(0, 1)$.
The quarter turn clockwise about the origin	3 — Every corner follows the rule $(x, y) \rightarrow (y, -x)$. For example, the bend $(3, -3)$ goes to $(-3, -3)$.	5 — The rule $(x, y) \rightarrow (y, -x)$ of the quarter turn clockwise sends $(-2, -5)$ to $(-5, 2)$.	7 — This is the rule for the quarter turn clockwise. It sends $(1, 0)$ to $(0, -1)$.	12 — A three-quarter turn counterclockwise about the origin ends in the same place as the quarter turn clockwise.
No turn about the origin does this	2 — This rule swaps the numbers and changes both signs. That is the reflection in $y = -x$, not a turn.	4 — The center is $(2, -1)$, not the origin. The rules only work for turns about the origin.	9 — The L is turned about $(1, 1)$, not the origin. The bend $(2, 1)$ lands at $(1, 2)$, but a quarter turn about the origin sends it to $(-1, 2)$ or $(1, -2)$.	11 — A turn about the origin keeps a point's distance from it. The squares of these two distances are 25 and 34, so they differ.

Every row holds four pieces. Each row has a rule, a point and its image, a turn in words, and a drawing.

The rules, for marking. A quarter turn counterclockwise about the origin is $(x, y) \rightarrow (-y, x)$. A quarter turn clockwise about the origin is $(x, y) \rightarrow (y, -x)$. **A check a student can do without you:** a point and its image under a turn about the origin are the same distance from the origin.