

SCAVENGER HUNT



ROTATIONS IN THE COORDINATE PLANE

Rotations in the Coordinate Plane

Quarter, half and three-quarter turns · both directions · a center that is not the origin · the cards check the answers

FREE

ANSWER

(2, 9)

Turn $U(-2, 5)$ a quarter turn counterclockwise about the origin. Where does U land?

Counterclockwise is the way the hands of a clock do not go. Check the direction first.

B

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1. **Tape the 16 cards around the room**, in any order. Send each group to a *different* card. Each card has a large letter in its bottom left corner. **Start each group at one of these eight cards: *B P H K A E J N*.**
2. **Say this once:** *“Before you move a number, write down the center and which way the turn goes. The rules you know are for the origin only. After eight correct answers, you are back at the card where you started.”*
3. **Find the point. Then find the card with that point at the top.**

16 cards	pages 3–10, one copy. There are two cards on each sheet. Cut the stack once, through the middle.
Record sheet	page 11, one per student. The four turns and all their names are printed on it as pictures. Their rules are not printed.
Answers	pages 12–13, for you only. They do not go in the room.

Every card asks for a point. On eleven cards, the group turns a point and finds its image. On three cards, the group has the image and finds the starting point. On two cards, the group sees one point and its image under a turn about the origin, then uses the same turn on another point. Four cards turn about a center that is not the origin: a half turn about *K* or *M*. There the origin's rule gives the wrong point. The center is the midpoint of a point and its image. The turns are named nine different ways. For example, a quarter turn clockwise is also called -90° and a three-quarter turn counterclockwise. A quarter turn counterclockwise is also called 270° clockwise. A half turn is also called the point reflection in its center.

Eight of the 16 cards make the ring. The other eight are where a wrong answer goes. They look like every other card. A group may turn the wrong way, turn forward when it should undo a turn, mix up the half turn with the reflection in $y = -x$ (which also swaps the numbers), or use the origin's rule for a turn about *K*. Then its point is at the top of one of those cards. The group does that card, and its answer sends the group back to the card it got wrong. If the group goes wrong there too, it goes to another of those cards, never onto the ring.

The check is the length of their row. A clean run is **eight lines**. Every wrong answer adds two more. The line under the question on each card says what to check. A group that came by a wrong answer needs it, and a group that came by a right answer can skip it. If a group is going around in circles, do not give the answer. Ask: *“Where is the center? Is your point the same distance from it as the start?”*



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ANSWER

$(-3, 7)$

A turn of -90° about the origin sends V to $V'(-1, -4)$. Find V.

To undo a turn, start at the image and turn the same amount the other way round.

A

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ANSWER

$(2, 9)$

Turn U $(-2, 5)$ a quarter turn counterclockwise about the origin. Where does U land?

Counterclockwise is the way the hands of a clock do not go. Check the direction first.

B

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ANSWER

(3, -7)

A half turn about the origin sends V to $V'(6, -1)$. Find V.

Count the quarter turns, and say which way round each one goes.

C

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ANSWER

(3, -4)

Turn $U(-2, 5)$ a turn of 270° clockwise about the origin. Where does U land?

Where is the center? A rule in letters belongs to the origin and to no other center.

D

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ANSWER

(4, -1)

A turn about the origin carries $S(-2, 7)$ to $S'(7, 2)$. Where does it carry $T(-8, -3)$?

Which way round does S go to reach S' ? Look at the quadrants.

E

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ANSWER

(5, 2)

A turn about the origin carries $S(-1, 6)$ to $S'(6, 1)$. Where does it carry $T(-9, 2)$?

Say the direction aloud before any number moves: with the clock, or against it?

F

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ANSWER

(5, -7)

Turn U(-8, -3) a turn of -90° about the origin. Where does U land?

Where is the center of this turn? Find it before any rule.

G

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ANSWER

(5, -8)

Turn U(6, -1) a turn of 180° about the origin. Where does U land?

Plot both points. The center sits halfway along the segment that joins them.

H

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ANSWER

$(-3, 8)$

Turn $U(-5, 7)$ a turn of 180° about $M(2, 1)$. Where does U land?

A point and its image are one distance from the center, whatever the origin does.

J

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ANSWER

$(-6, 1)$

Turn $U(-7, -3)$ a three-quarter turn counterclockwise about the origin. Where does U land?

Three quarter turns one way end where one quarter turn the other way ends.

K

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ANSWER

$(-4, 1)$

Turn $U(-7, -3)$ a quarter turn clockwise about the origin. Where does U land?

Which point is the start and which is the image? Read the card twice.

L

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ANSWER

$(-2, -9)$

A turn of 180° about $M(2, 1)$ sends V to $V'(-5, 7)$. Find V .

Turn the sheet a quarter turn with a finger on the start, and look where the point goes.

M

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ANSWER

$(9, -5)$

Turn $U(-9, 2)$ a quarter turn clockwise about the origin. Where does U land?

Clockwise is the way the hands of a clock go, and a minus angle goes that way too.

N

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ANSWER

$(-5, -2)$

Turn $U(-3, 4)$ a half turn about $K(1, -2)$. Where does U land?

The center of a half turn is the midpoint of a point and its image. Check it.

P

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ANSWER

(1, -6)

Turn $U(-3, 4)$ the point reflection in $K(1, -2)$. Where does U land?

Is the center halfway between the start and your answer? If not, look again.

Q

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ANSWER

(3, -8)

Turn $U(-1, -4)$ a turn of 90° counterclockwise about the origin. Where does U land?

Name the quadrant of the start and of your answer. Which way round is that?

R

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Scavenger Hunt — where I went

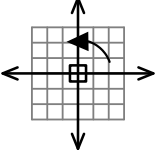
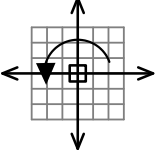
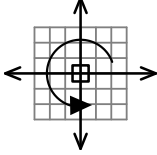
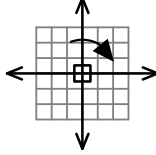
Rotations in the coordinate plane

Name _____

Period _____

Date _____

Do the card you are at, fill in one line, then find the card with your answer at the top. **Write the center and the direction first:** they change from card to card. A clean run is eight lines. **Wrong answer? Read the line under the question. It says what to check on the card before this one. Right answer? Skip that line.**

 quarter turn counterclockwise +90° · the center stays put	 half turn · 180°, either way also: the point reflection in the center	 three-quarter turn counterclockwise +270° · the same turn as -90°	 quarter turn clockwise -90° · the same turn as +270°
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Card letter	Center and direction	My point
1		
2		
3		
4		
5		
6		
7		
8		
9		

What is a rotation's favorite dance?

Every point stands for a letter. Write the letter for each of your answers in the box above that point. Leave the other boxes empty. Then read the boxes you filled across. **If it does not spell two words, one answer was wrong.**

(-6, 1) = T (-5, -2) = H (-4, 1) = W (-3, 7) = E (-3, 8) = T (-2, -9) = I (1, -6) = S (2, 9) = W (3, -8) = T
(3, -7) = T (3, -4) = H (4, -1) = I (5, -8) = S (5, -7) = E (5, 2) = T (9, -5) = T

(-6, 1)	(-5, -2)	(-4, 1)	(-3, 7)	(-3, 8)	(-2, -9)	(1, -6)	(2, 9)
(3, -8)	(3, -7)	(3, -4)	(4, -1)	(5, -8)	(5, -7)	(5, 2)	(9, -5)



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Scavenger Hunt — answers

For the teacher

The ring in order. A group may begin anywhere on it. Wherever it begins, eight right answers bring it back to that card.

B → P → H → K → A → E → J → N → B

What is a rotation's favorite dance? *THE TWIST*. Students read it along the boxes of the record sheet. The boxes are in order of the first number of each point, then the second.

The answers on the ring, in that order: $(-6, 1) = T$, $(-5, -2) = H$, $(-3, 7) = E$, $(-3, 8) = T$, $(2, 9) = W$, $(4, -1) = I$, $(5, -8) = S$, $(9, -5) = T$, which spells THE TWIST.

	Card	Why the answer is right	Answer	A common mistake gives	Letter for its top
1	B	The quarter turn counterclockwise about the origin is $(x, y) \rightarrow (-y, x)$, so $(-2, 5)$ goes to $(-5, -2)$.	$(-5, -2)$	$(5, 2)$: turned the wrong way	W
2	P	The center $K(1, -2)$ is the midpoint of a point and its image. Twice $(1, -2)$ take away $(-3, 4)$ is $(5, -8)$.	$(5, -8)$	$(3, -4)$: the origin's rule used about another center	H
3	H	The half turn about the origin is $(x, y) \rightarrow (-x, -y)$, so $(6, -1)$ goes to $(-6, 1)$.	$(-6, 1)$	$(1, -6)$: the half turn mixed up with the reflection in $y = -x$	S
4	K	The quarter turn clockwise about the origin is $(x, y) \rightarrow (y, -x)$, so $(-7, -3)$ goes to $(-3, 7)$.	$(-3, 7)$	$(3, -7)$: turned the wrong way	T
5	A	The quarter turn clockwise about the origin is $(x, y) \rightarrow (y, -x)$. It sends $(4, -1)$ to $(-1, -4)$, so V is $(4, -1)$.	$(4, -1)$	$(-4, 1)$: turned the wrong way	E
6	E	S goes to S' by the quarter turn clockwise about the origin, $(x, y) \rightarrow (y, -x)$. The same rule sends $T(-8, -3)$ to $(-3, 8)$.	$(-3, 8)$	$(3, -8)$: turned the wrong way	I
7	J	The center $M(2, 1)$ is the midpoint of a point and its image. Twice $(2, 1)$ take away $(-5, 7)$ is $(9, -5)$.	$(9, -5)$	$(5, -7)$: the origin's rule used about another center	T
8	N	The quarter turn clockwise about the origin is $(x, y) \rightarrow (y, -x)$, so $(-9, 2)$ goes to $(2, 9)$.	$(2, 9)$	$(-2, -9)$: turned the wrong way	T

Each point in the column “A common mistake gives” is at the top of a card off the ring.

Those cards are on the next page. Each of these points comes from a mistake students often make with these rules, not from a slip in adding.

Scavenger Hunt — the cards off the ring

For the teacher

These eight cards are where a wrong answer goes. **A group cannot reach one by being right.** The top of each card is the point that a common mistake gives on one ring card. The answer to each card is the top of that ring card, so the group goes back to the card it got wrong. Each card repeats the question of a ring card, with the turn named another way (such as 270° clockwise for a quarter turn counterclockwise) or the question asked another way. So a group that goes wrong twice is never sent forward on the ring.

Card	Why the answer is right	Answer	A common mistake gives	Letter for its top
F	S goes to S' by the quarter turn clockwise about the origin, $(x, y) \rightarrow (y, -x)$. The same rule sends T(-9, 2) to (2, 9).	(2, 9)	(-2, -9): turned the wrong way	T
D	The quarter turn counterclockwise about the origin is $(x, y) \rightarrow (-y, x)$, so (-2, 5) goes to (-5, -2).	(-5, -2)	(5, 2): turned the wrong way	H
Q	The center K(1, -2) is the midpoint of a point and its image. Twice (1, -2) take away (-3, 4) is (5, -8).	(5, -8)	(3, -4): the origin's rule used about another center	S
C	The half turn about the origin is $(x, y) \rightarrow (-x, -y)$. It sends (-6, 1) to (6, -1), so V is (-6, 1).	(-6, 1)	(1, -6): the half turn mixed up with the reflection in $y = -x$	T
L	The quarter turn clockwise about the origin is $(x, y) \rightarrow (y, -x)$, so (-7, -3) goes to (-3, 7).	(-3, 7)	(3, -7): turned the wrong way	W
R	The quarter turn counterclockwise about the origin is $(x, y) \rightarrow (-y, x)$, so (-1, -4) goes to (4, -1).	(4, -1)	(-4, 1): turned the wrong way	T
G	The quarter turn clockwise about the origin is $(x, y) \rightarrow (y, -x)$, so (-8, -3) goes to (-3, 8).	(-3, 8)	(3, -8): turned the wrong way	E
M	A half turn undoes itself. The center M(2, 1) is the midpoint of a point and its image. Twice (2, 1) take away (-5, 7) is (9, -5).	(9, -5)	(5, -7): the origin's rule used about another center	I

Other mistakes lead to no ring card. 40 other wrong points were tried, such as a swap without the sign change, a sign change without the swap, or the right point written in the wrong order. None of them is the top of a ring card. The line under each question says what to check. It never gives a rule in letters.

Guessing does not work. Every simple guessing rule, such as changing both signs of the last point printed, gets at most seven of the sixteen cards right.