

SCAVENGER HUNT



COMPOSITIONS OF RIGID MOTIONS

Compositions of Rigid Motions

Two motions on every card · reflections, translations and rotations · the cards check the answers

FREE

ANSWER

(1, 7)

P is at $(6, -4)$. First, reflect it in the x -axis. Then translate it by $\langle 3, 2 \rangle$.
Where does P land?

Write the middle point first. It is where the point stands after the first motion.

D

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1. **Tape the 16 cards around the room**, in any order. Each card has a large letter in its bottom left corner. Start each group at a *different* one of these eight cards: *D H A L P F C K*.
2. **Say this once:** “*Every card has two motions. Do the first one. Write the middle point. Then do the second one. Eight right answers bring you back to your first card.*”
3. **Each group finds the point, then walks to the card with that point at the top.**

16 cards	pages 3–10, one copy. Two cards to a sheet. Cut the stack once, between the two cards.
Record sheet	page 11, one per student. It shows one pair of motions done both ways round, as two pictures.
Answers	pages 12–13, for you only. They do not go in the room.

Every card asks for a point. Fifteen cards give a point and two motions and ask where it lands. One gives where a point lands and asks where it started, so the two motions are undone from the last one back. The *middle point*, on the cards and in the answers, is where the point is after the first motion and before the second. The motions are all three kinds: a reflection and a translation, a translation and a rotation, two reflections in parallel mirrors, and two in mirrors that cross.

Eight of the 16 cards make the ring and the other eight are where a wrong answer goes. They look the same. The most common mistake is doing the same two motions in the other order. On every ring card that mistake gives the point at the top of one of those eight cards. The group does that card, and its answer sends the group back to the card it got wrong. Doing that card in the wrong order too sends the group one more card back. It never puts a group onto the ring.

The check is the length of their list. A clean run is **eight lines**. Each wrong answer adds two. Every card has a short line under its question that says what to check. It helps a group that came by a wrong answer. A group that came by a right answer can skip it. To a group that keeps coming back to the same cards, do not give the answer. Ask: “*Which motion comes first, and what is your middle point?*”



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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ANSWER

$(8, -1)$

P is at $(-6, -1)$. First, rotate it 180° about the origin. Then translate it by $\langle 0, -4 \rangle$. Where does P land?

A half turn about the origin changes both signs. The order of the two motions still matters.

A

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ANSWER

$(-5, -2)$

P is at $(6, 1)$. First, reflect it in the x -axis. Then reflect it in the line $y = -2$. Where does P land?

The second motion moves the middle point, not the start. Check the middle point.

B

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ANSWER

(2, 5)

P is at $(-2, 4)$. First, reflect it in the line $x = 2$. Then reflect it in the y -axis. Where does P land?

A point and its image are the same distance from the mirror. Count the squares.

C

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ANSWER

(1, 7)

P is at $(6, -4)$. First, reflect it in the x -axis. Then translate it by $\langle 3, 2 \rangle$. Where does P land?

Write the middle point first. It is where the point stands after the first motion.

D

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ANSWER

(2, 4)

P is at $(4, -6)$. First, translate it by $\langle 1, 4 \rangle$. Then rotate it 90° counterclockwise about the origin. Where does P land?

Do the two motions in the order they are written, one at a time.

E

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ANSWER

(-2, -7)

P is at $(-4, 6)$. First, rotate it 90° clockwise about the origin. Then translate it by $\langle -4, 1 \rangle$. Where does P land?

Say the first motion. Do it. Write the middle point. Then say the second motion.

F

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ANSWER

(7, -6)

P is at $(-9, 4)$. First, rotate it 180° about the origin. Then reflect it in the line $y = 1$. Where does P land?

Change the order of two motions and the point usually lands somewhere else.

G

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ANSWER

(9, 6)

P is at $(-3, -5)$. First, translate it by $\langle 2, -3 \rangle$. Then rotate it 90° counterclockwise about the origin. Where does P land?

Which way does a counterclockwise turn go? Check it on the grid before you turn.

H

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ANSWER

(2, 7)

P is at $(-1, -2)$. First, translate it by $\langle -3, -3 \rangle$. Then rotate it 90° clockwise about the origin. Where does P land?

Undo means go from the end to the start. Which motion comes at the end?

J

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ANSWER

(-6, 4)

P is at $(-5, 6)$. First, translate it by $\langle 4, 1 \rangle$. Then reflect it in the y -axis. Where does P land?

Is your point the middle point or the final point? Check that both motions are done.

K

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ANSWER

$(6, -3)$

Q is moved in two steps. First, reflect it in the x -axis. Then translate it by $\langle -2, 3 \rangle$. It lands at $(-7, -1)$. Where did Q start?

To undo two motions, start with the second motion. Undo it. Then undo the first one.

L

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ANSWER

$(9, 7)$

P is at $(-2, -4)$. First, rotate it 180° about the origin. Then reflect it in the line $x = -2$. Where does P land?

With two mirrors, the order matters. Which mirror is first?

M

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ANSWER

(6, 5)

P is at (3, 5). First, rotate it 90° clockwise about the origin. Then translate it by $\langle 3, 2 \rangle$. Where does P land?

Which motion comes first on the card? Start with that one, not with the easy one.

N

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ANSWER

(-5, 4)

P is at (7, -2). First, reflect it in the line $y = x$. Then reflect it in the x -axis. Where does P land?

Which mirror comes first? Find it before you reflect. Say it out loud.

P

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ANSWER

(7, 8)

P is at (7, 2). First, rotate it 90° counterclockwise about the origin. Then reflect it in the x -axis. Where does P land?

Write the order as a list: first motion, middle point, second motion, final point.

Q

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ANSWER

(9, 2)

P is at $(-3, 5)$. First, rotate it 90° clockwise about the origin. Then translate it by $\langle -4, 4 \rangle$. Where does P land?

Read the word First on the card. That motion comes first, and the order matters.

R

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Scavenger Hunt — where I went

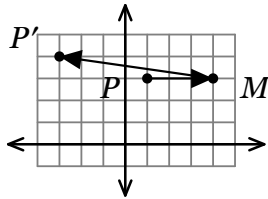
Compositions of rigid motions

Name _____

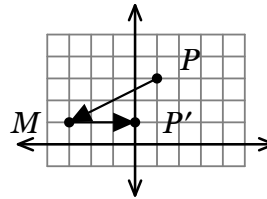
Period _____

Date _____

Do the card you are at. Fill in one line. Then find the card with your answer at the top. **Do the first motion first and write the middle point.** A clean run is eight lines. **If you are on a card because you went wrong, its line says what to check. If you were right, skip it.**



First, translate by $\langle 3, 0 \rangle$. Then rotate 90° counterclockwise about the origin.
 $P(1, 3) \rightarrow M(4, 3) \rightarrow P'(-3, 4)$



First, rotate 90° counterclockwise about the origin. Then translate by $\langle 3, 0 \rangle$.
 $P(1, 3) \rightarrow M(-3, 1) \rightarrow P'(0, 1)$

The same two motions, in the other order, end in a different place. Always write the middle point M.

Card letter	Middle point	My point
1		
2		
3		
4		
5		
6		
7		
8		
9		

What does the first motion say to the second motion?

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, left to right. **If they do not spell two words, one answer is wrong.**

$(-6, 4) = A$ $(-5, -2) = O$ $(-5, 4) = F$ $(-2, -7) = T$ $(1, 7) = E$ $(2, 4) = Y$ $(2, 5) = R$ $(2, 7) = F$ $(6, -3) = Y$ $(6, 5) = U$
 $(7, -6) = R$ $(7, 8) = E$ $(8, -1) = O$ $(9, 2) = T$ $(9, 6) = U$ $(9, 7) = A$

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



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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.

D → H → A → L → P → F → C → K → D

What does the first motion say to the second motion? *AFTER YOU*. Students read it along the boxes of the record sheet. The boxes are in order of the first coordinate, and then the second.

The answers on the ring, in that order: $(-6, 4) = A$, $(-5, 4) = F$, $(-2, -7) = T$, $(1, 7) = E$, $(2, 5) = R$, $(6, -3) = Y$, $(8, -1) = O$, $(9, 6) = U$, which spells AFTER YOU.

	Card	Answer, and why	Wrong answer from the other order	Letter of its top point
1	D	(9, 6) The first motion takes $(6, -4)$ to the middle point $(6, 4)$. The second takes $(6, 4)$ to $(9, 6)$.	$(9, 2)$, from doing the second motion first	E
2	H	(8, -1) The first motion takes $(-3, -5)$ to the middle point $(-1, -8)$. The second takes $(-1, -8)$ to $(8, -1)$.	$(7, -6)$, from doing the second motion first	U
3	A	(6, -3) The first motion takes $(-6, -1)$ to the middle point $(6, 1)$. The second takes $(6, 1)$ to $(6, -3)$.	$(6, 5)$, from doing the second motion first	O
4	L	(-5, 4) Undo the second motion first: $(-7, -1)$ goes back to $(-5, -4)$. Then undo the first: $(-5, -4)$ goes back to $(-5, 4)$.	$(-5, -2)$, from undoing the first motion first	Y
5	P	(-2, -7) The first motion takes $(7, -2)$ to the middle point $(-2, 7)$. The second takes $(-2, 7)$ to $(-2, -7)$.	$(2, 7)$, from doing the second motion first	F
6	F	(2, 5) The first motion takes $(-4, 6)$ to the middle point $(6, 4)$. The second takes $(6, 4)$ to $(2, 5)$.	$(7, 8)$, from doing the second motion first	T
7	C	(-6, 4) The first motion takes $(-2, 4)$ to the middle point $(6, 4)$. The second takes $(6, 4)$ to $(-6, 4)$.	$(2, 4)$, from doing the second motion first	R
8	K	(1, 7) The first motion takes $(-5, 6)$ to the middle point $(-1, 7)$. The second takes $(-1, 7)$ to $(1, 7)$.	$(9, 7)$, from doing the second motion first	A

Each wrong answer in the table is the point at the top of a card off the ring. Those cards are on the next page. A group gets that wrong answer by doing the same two motions in the other order.

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 wrong point that the order mistake gives on one ring card. Its answer is the top of that ring card, so the group goes back to the card it got wrong. Each card here uses two different motions from the ring card before it. They give the same answer and the same wrong point. So a group that goes wrong twice is never sent forward.

Card	Answer, and why	Wrong answer from the other order	Letter of its top point
R	(1, 7) The first motion takes $(-3, 5)$ to the middle point $(5, 3)$. The second takes $(5, 3)$ to $(1, 7)$.	$(9, 7)$, from doing the second motion first	T
G	(9, 6) The first motion takes $(-9, 4)$ to the middle point $(9, -4)$. The second takes $(9, -4)$ to $(9, 6)$.	$(9, 2)$, from doing the second motion first	R
N	(8, -1) The first motion takes $(3, 5)$ to the middle point $(5, -3)$. The second takes $(5, -3)$ to $(8, -1)$.	$(7, -6)$, from doing the second motion first	U
B	(6, -3) The first motion takes $(6, 1)$ to the middle point $(6, -1)$. The second takes $(6, -1)$ to $(6, -3)$.	$(6, 5)$, from doing the second motion first	O
J	(-5, 4) The first motion takes $(-1, -2)$ to the middle point $(-4, -5)$. The second takes $(-4, -5)$ to $(-5, 4)$.	$(-5, -2)$, from doing the second motion first	F
Q	(-2, -7) The first motion takes $(7, 2)$ to the middle point $(-2, 7)$. The second takes $(-2, 7)$ to $(-2, -7)$.	$(2, 7)$, from doing the second motion first	E
E	(2, 5) The first motion takes $(4, -6)$ to the middle point $(5, -2)$. The second takes $(5, -2)$ to $(2, 5)$.	$(7, 8)$, from doing the second motion first	Y
M	(-6, 4) The first motion takes $(-2, -4)$ to the middle point $(2, 4)$. The second takes $(2, 4)$ to $(-6, 4)$.	$(2, 4)$, from doing the second motion first	A

Other mistakes lead to no ring card. Stopping after the first motion, doing only the second motion, or, on the undo card, doing the motions forward from the landing point never gives the top of a ring card.

Guessing does not work. Every simple rule that only plays with the printed numbers, such as swapping the two coordinates, gives the right answer on at most one of the 16 cards.