Transformations on the Coordinate Plane

Applications and design

Name _____ **Date** _____ **Score** _____ / 6

QUICK REVIEW

Apply a sequence in its stated order. Translation by (a, b) gives $(x + a, y + b)$; reflection in $y = x$ swaps coordinates to (y, x). About the origin, $90°$ counterclockwise gives $(-y, x)$, clockwise gives $(y, -x)$, and $180°$ gives $(-x, -y)$. Reflection in $x = c$ gives $(2c - x, y)$. An inverse sequence reverses both the order and each operation.

Worked example

First translate $E(1, -2)$ by $(2, 1)$, then reflect in $y = x$. Find the result.

1. Translate first: $(1 + 2, -2 + 1) = (3, -1)$. The intermediate point is $E\prime = (3, -1)$.

2. Reflecting in $y = x$ swaps the intermediate coordinates, giving $(3, -1) \mapsto (-1, 3)$.

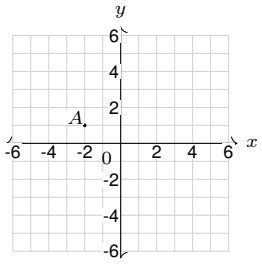
3. The final point is $(-1, 3)$. Swapping the original coordinates before translating would follow a different sequence.

Answer: $E'' = (-1, 3)$

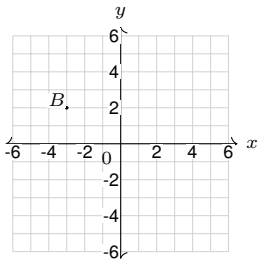
Practice Problems

Show your thinking.

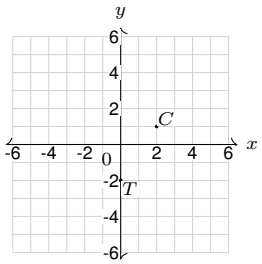
1. A robot at $A(-2, 1)$ reflects across $y = x$ in a simulation, then moves down 3. Find its destination.



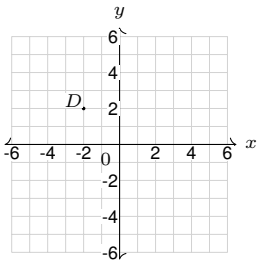
2. A pattern designer reflects $B(-3, 2)$ in $x = 0$, then in $x = 1$. Find the final point and equivalent translation.



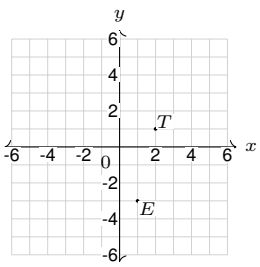
3. A game marker at $C(2, 1)$ must end at $(0, -2)$. First rotate $90°$ clockwise, then choose the translation vector.



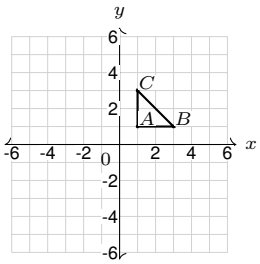
4. A mirror is the horizontal line $y = -1$. A lamp at $D(-2, 2)$ is reflected, then shifted right 4. Find its final location.



5. Design a two-step route from $E(1, -3)$: rotate $180°$, then translate to $T(2, 1)$. Find the translation.



6. Triangle ABC is a badge. Reflect it in $y = x$, then move down 1. List the final vertices for production.



Answer Key

1. $(1, -5)$
2. $(-1, 2)$; right 2.
3. Vector $(-1, 0)$.
4. $(2, -4)$
5. Vector $(3, -2)$.
6. $A'' = (1, 0), B'' = (1, 2), C'' = (3, 0)$

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The simulated reflection swaps the coordinates: $(-2, 1) \mapsto (1, -2)$.

2. The downward move subtracts 3 from the intermediate height: $(1, -2 - 3) = (1, -5)$.

3. The destination is $(1, -5)$. A move down before the reflection would instead change the final horizontal coordinate.

Problem 2

1. The first reflection gives $(-3, 2) \mapsto (3, 2)$.

2. The second uses $x\prime = 2(1) - 3 = -1$, giving $(-1, 2)$. The net horizontal change is $-1 - (-3) = 2$.

3. The two reflections act here as a translation right 2, not a half-turn; the height remains 2.

Problem 3

1. The required first turn sends $(2, 1) \mapsto (1, -2)$ by the rule $(y, -x)$.

2. The remaining displacement is $(0 - 1, -2 - (-2)) = (-1, 0)$.

3. Translate left 1: $(1 - 1, -2) = (0, -2)$. No additional vertical movement is needed after the turn.

Problem 4

1. The lamp is $2 - (-1) = 3$ units above the mirror, so its reflected height is $-1 - 3 = -4$.

2. The reflected point is $(-2, -4)$. Moving right 4 gives $(-2 + 4, -4) = (2, -4)$.

3. The final location is $(2, -4)$; reflecting by merely changing the sign of y would use the wrong mirror.

Problem 5

1. The half-turn sends $(1, -3) \mapsto (-1, 3)$, producing the intermediate position.

2. The required vector is $(2 - (-1), 1 - 3) = (3, -2)$.

3. Check $(-1 + 3, 3 - 2) = (2, 1)$. The designed second step moves right 3 and down 2 to hit the target exactly.

Problem 6

1. Swapping coordinates gives intermediate vertices $(1, 1)$, $(1, 3)$, and $(3, 1)$ for A, B, C.

2. Subtract 1 from each intermediate height: $(1, 0)$, $(1, 2)$, and $(3, 0)$.

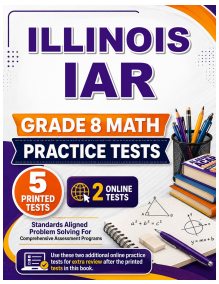
3. Join the final vertices in order. The two perpendicular legs still measure 2 units, so the badge size is unchanged.

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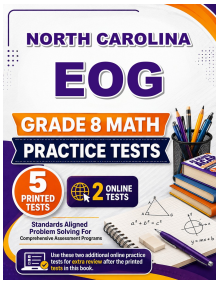
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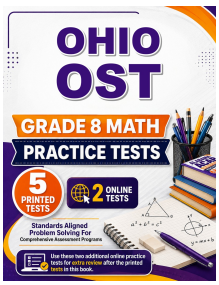
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