Transformations on the Coordinate Plane

Investigate mistakes and missing measures

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 $(3, -1) \mapsto (-1, 3)$.

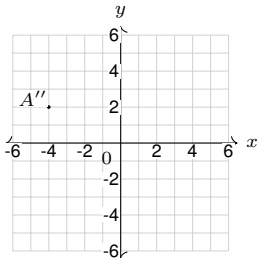
3. The final point is $(-1, 3)$. Swapping the original coordinates before translating would follow a different sequence.

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

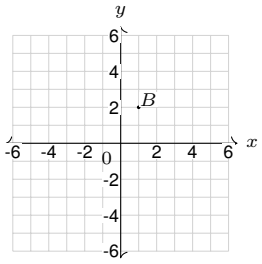
Practice Problems

Show your thinking.

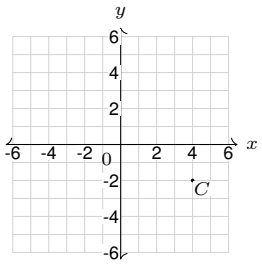
1. A translation by $(2, -1)$ followed by a y-axis reflection ends at $A''(-4, 2)$. Recover A.



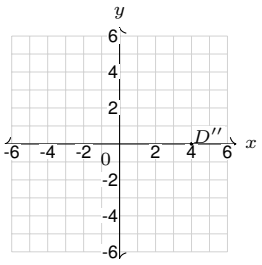
2. At $B(1, 2)$, compare: reflect in $y = x$, then move right 2; versus move right 2, then reflect. Do they agree?



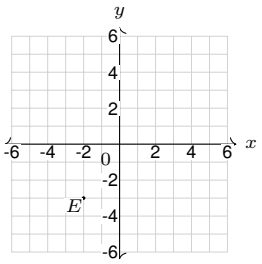
3. Jo reflects $C(4, -2)$ in $x = 1$ and gets $(-4, -2)$. Correct the result using equal distances.



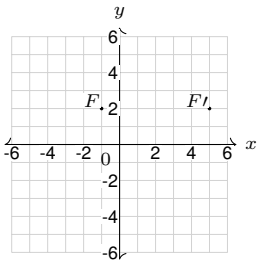
4. A $90°$ clockwise turn followed by translation $(1, 2)$ ends at $D''(4, 0)$. Find D.



5. Sam claims two $90°$ counterclockwise turns return $E(-2, -3)$ to itself. Find the actual result.



6. Find h if reflecting $F(-1, 2)$ in $x = h$ gives $F\prime(5, 2)$. Draw the mirror line.



Answer Key

1. $(2, 3)$
2. No: $(4, 1)$ versus $(2, 3)$.
3. $(-2, -2)$
4. $(2, 3)$
5. $(2, 3)$
6. $h = 2$

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Undo the reflection first: $(-4, 2) \mapsto (4, 2)$. This is the point after the translation.

2. Undo the vector $(2, -1)$ by adding $(-2, 1)$: $(4 - 2, 2 + 1) = (2, 3)$.

3. Check forward: $(2, 3) \mapsto (4, 2) \mapsto (-4, 2)$. The recovered original is $A = (2, 3)$.

Problem 2

1. Reflect first: $(1, 2) \mapsto (2, 1)$, then translate to $(2 + 2, 1) = (4, 1)$.

2. Translate first: $(1 + 2, 2) = (3, 2)$, then reflect to $(2, 3)$.

3. Since $(4, 1) \neq (2, 3)$, these operations do not commute. Plot both final points to see the distinction.

Problem 3

1. The source is $4 - 1 = 3$ units right of $x = 1$, not 4 units from that mirror.

2. The image is 3 units left: $x\prime = 1 - 3 = -2$ and $y\prime = -2$.

3. Thus $C\prime = (-2, -2)$. Jo used the y-axis rule instead of the requested vertical line.

Problem 4

1. Undo the last translation: $(4 - 1, 0 - 2) = (3, -2)$.

2. Undo the clockwise turn with a counterclockwise turn: $(3, -2) \mapsto (2, 3)$.

3. Check: $(2, 3) \mapsto (3, -2) \mapsto (4, 0)$. Therefore the starting point is $D = (2, 3)$.

Problem 5

1. The first quarter-turn gives $(-2, -3) \mapsto (3, -2)$ using $(-y, x)$.

2. The second gives $(3, -2) \mapsto (2, 3)$. The total angle is $90^\circ + 90^\circ = 180^\circ$.

3. Thus the result is $(2, 3)$, not $(-2, -3)$. Four such quarter-turns, not two, return every point.

Problem 6

1. The mirror lies halfway between the horizontal coordinates: $h = (-1 + 5)/2 = 2$.

2. The distances are $2 - (-1) = 3$ and $5 - 2 = 3$, so both sides agree.

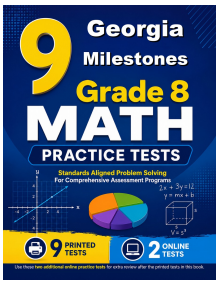
3. Draw the vertical line $x = 2$. Substitution into $(2h - x, y)$ gives $(4 - (-1), 2) = (5, 2)$.

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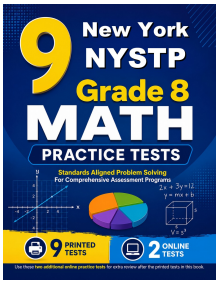
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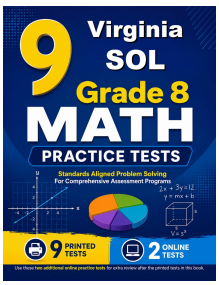
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