

# Transformations on the Coordinate Plane

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 24

## Quick Review

On the coordinate plane, every transformation has a tidy rule. A **translation** adds numbers to the coordinates:  $(x, y) \rightarrow (x + a, y + b)$ . A **reflection over the  $x$ -axis** is  $(x, y) \rightarrow (x, -y)$ ; over the  $y$ -axis it is  $(x, y) \rightarrow (-x, y)$ ; over  $y = x$  it is  $(x, y) \rightarrow (y, x)$ . A **rotation** about the origin uses:  $90^\circ$  counterclockwise  $(x, y) \rightarrow (-y, x)$ ,  $180^\circ$   $(x, y) \rightarrow (-x, -y)$ , and  $90^\circ$  clockwise  $(x, y) \rightarrow (y, -x)$ . To transform a whole figure, just apply the rule to *each vertex*.

◇ **Example:** Triangle  $ABC$  has vertices  $A(1, 2)$ ,  $B(4, 2)$ ,  $C(1, 5)$ . Reflect it over the  $y$ -axis. Find the new vertices.  
 ⇒ Reflecting over the  $y$ -axis uses the rule  $(x, y) \rightarrow (-x, y)$  — the  $y$ -value stays put and the  $x$ -value flips its sign. Apply it to each vertex:  $A(1, 2) \rightarrow A'(-1, 2)$ ,  $B(4, 2) \rightarrow B'(-4, 2)$ , and  $C(1, 5) \rightarrow C'(-1, 5)$ . The triangle is the same size and shape, just mirrored to the other side of the  $y$ -axis.

**Answer:**  $A'(-1, 2)$ ,  $B'(-4, 2)$ ,  $C'(-1, 5)$

## PRACTICE

Apply the transformation rule to find the image point.

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| 1. $(3, 4) \rightarrow (x + 2, y + 5)$ _____  | 11. Rotate $(5, 2)$ $90^\circ$ CCW about origin _____  |
| 2. $(6, 1) \rightarrow (x - 4, y - 1)$ _____  | 12. Rotate $(-4, 1)$ $90^\circ$ CCW about origin _____ |
| 3. $(-2, 5) \rightarrow (x + 7, y - 3)$ _____ | 13. Rotate $(3, 6)$ $180^\circ$ about origin _____     |
| 4. $(0, -6) \rightarrow (x - 2, y + 9)$ _____ | 14. Rotate $(-7, -2)$ $180^\circ$ about origin _____   |
| 5. Reflect $(4, 7)$ over $x$ -axis _____      | 15. Rotate $(6, 3)$ $90^\circ$ CW about origin _____   |
| 6. Reflect $(-5, 3)$ over $x$ -axis _____     | 16. Rotate $(-2, 8)$ $90^\circ$ CW about origin _____  |
| 7. Reflect $(8, -2)$ over $y$ -axis _____     | 17. Translate $A(2, 3)$ by $(x - 5, y + 5)$ _____      |
| 8. Reflect $(-1, -9)$ over $y$ -axis _____    | 18. Reflect $(0, 5)$ over $x$ -axis _____              |
| 9. Reflect $(2, 6)$ over $y = x$ _____        | 19. Rotate $(1, 1)$ $90^\circ$ CCW about origin _____  |
| 10. Reflect $(-3, 7)$ over $y = x$ _____      | 20. Reflect $(-6, -6)$ over $y = x$ _____              |

## Word Problems

21. A triangle with vertices  $A(2, 1)$ ,  $B(5, 1)$ ,  $C(2, 4)$  is translated by the rule  $(x, y) \rightarrow (x - 3, y + 2)$ . Find the new vertices of the triangle. \_\_\_\_\_
22. A designer reflects a shape across the  $x$ -axis. A corner point at  $(7, -3)$  is part of the shape. Where does that corner end up, and is the shape's size changed? \_\_\_\_\_
23. A square game piece has a corner at  $(4, 0)$ . The piece is rotated  $90^\circ$  counterclockwise about the origin. Find the new position of that corner. \_\_\_\_\_
24. A drone flies a path that starts at  $(6, 8)$ . It is rotated  $180^\circ$  about the origin in a simulation. Where does the starting point move to, and how far from the origin is it now? \_\_\_\_\_



## Answer Keys

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| <p>1. <math>(5, 9)</math></p> <p>2. <math>(2, 0)</math></p> <p>3. <math>(5, 2)</math></p> <p>4. <math>(-2, 3)</math></p> <p>5. <math>(4, -7)</math></p> <p>6. <math>(-5, -3)</math></p> <p>7. <math>(-8, -2)</math></p> <p>8. <math>(1, -9)</math></p> <p>9. <math>(6, 2)</math></p> <p>10. <math>(7, -3)</math></p> <p>11. <math>(-2, 5)</math></p> <p>12. <math>(-1, -4)</math></p> | <p>13. <math>(-3, -6)</math></p> <p>14. <math>(7, 2)</math></p> <p>15. <math>(3, -6)</math></p> <p>16. <math>(8, 2)</math></p> <p>17. <math>(-3, 8)</math></p> <p>18. <math>(0, -5)</math></p> <p>19. <math>(-1, 1)</math></p> <p>20. <math>(-6, -6)</math></p> <p>21. <math>A'(-1, 3), B'(2, 3), C'(-1, 6)</math></p> <p>22. <math>(7, 3)</math>; size is unchanged</p> <p>23. <math>(0, 4)</math></p> <p>24. <math>(-6, -8)</math>; still 10 units from the origin</p> |
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### Step-by-Step Explanations

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| <p>1. Add 2 to <math>x</math> and 5 to <math>y</math>: <math>(3 + 2, 4 + 5) = (5, 9)</math>.</p> <p>2. Subtract 4 from <math>x</math> and 1 from <math>y</math>: <math>(2, 0)</math>.</p> <p>3. <math>-2 + 7 = 5</math> and <math>5 - 3 = 2</math>, so the image is <math>(5, 2)</math>.</p> <p>4. <math>0 - 2 = -2</math> and <math>-6 + 9 = 3</math>, so the image is <math>(-2, 3)</math>.</p> <p>5. Rule <math>(x, y) \rightarrow (x, -y)</math>: keep <math>x</math>, negate <math>y</math>.</p> <p>6. Keep <math>x = -5</math>, negate <math>y</math>: <math>3 \rightarrow -3</math>.</p> <p>7. Rule <math>(x, y) \rightarrow (-x, y)</math>: negate <math>x</math>, keep <math>y</math>.</p> <p>8. Negate <math>x</math>: <math>-1 \rightarrow 1</math>; keep <math>y = -9</math>.</p> <p>9. Rule <math>(x, y) \rightarrow (y, x)</math>: swap the coordinates.</p> <p>10. Swap the coordinates: <math>(-3, 7) \rightarrow (7, -3)</math>.</p> <p>11. Rule <math>(x, y) \rightarrow (-y, x)</math>: <math>(5, 2) \rightarrow (-2, 5)</math>.</p> <p>12. Rule <math>(x, y) \rightarrow (-y, x)</math>: <math>(-4, 1) \rightarrow (-1, -4)</math>.</p> <p>13. Rule <math>(x, y) \rightarrow (-x, -y)</math>: negate both coordinates.</p> <p>14. Negate both: <math>(-7, -2) \rightarrow (7, 2)</math>.</p> | <p>15. Rule <math>(x, y) \rightarrow (y, -x)</math>: <math>(6, 3) \rightarrow (3, -6)</math>.</p> <p>16. Rule <math>(x, y) \rightarrow (y, -x)</math>: <math>(-2, 8) \rightarrow (8, 2)</math>.</p> <p>17. <math>2 - 5 = -3</math> and <math>3 + 5 = 8</math>, so <math>A' = (-3, 8)</math>.</p> <p>18. Keep <math>x = 0</math>, negate <math>y</math>: <math>5 \rightarrow -5</math>.</p> <p>19. Rule <math>(x, y) \rightarrow (-y, x)</math>: <math>(1, 1) \rightarrow (-1, 1)</math>.</p> <p>20. Swapping equal coordinates leaves the point unchanged.</p> <p>21. Apply the rule to each vertex: <math>A(2, 1) \rightarrow (-1, 3)</math>, <math>B(5, 1) \rightarrow (2, 3)</math>, <math>C(2, 4) \rightarrow (-1, 6)</math>.</p> <p>22. Reflection over the <math>x</math>-axis uses <math>(x, y) \rightarrow (x, -y)</math>, so <math>(7, -3) \rightarrow (7, 3)</math>. Reflections are rigid, so the size stays the same.</p> <p>23. A <math>90^\circ</math> counterclockwise rotation about the origin uses <math>(x, y) \rightarrow (-y, x)</math>, so <math>(4, 0) \rightarrow (0, 4)</math>.</p> <p>24. A <math>180^\circ</math> rotation gives <math>(x, y) \rightarrow (-x, -y)</math>, so <math>(6, 8) \rightarrow (-6, -8)</math>. Distance from origin is <math>\sqrt{6^2 + 8^2} = \sqrt{100} = 10</math> units — rotations preserve distance.</p> |
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