

Translations, Reflections, and Rotations

Name: _____

Date: _____

Score: _____ / 18

A **transformation** moves or changes a figure on the coordinate plane, and in this topic you will meet three important ones! **Translations** (slides) shift every point the same distance in the same direction; **reflections** (flips) mirror a figure across a line like the x -axis or y -axis; and **rotations** (turns) spin a figure around a fixed point, usually the origin. All three are *rigid motions*—they change position but never size or shape, so the original and the image are always congruent. Each one has a simple coordinate rule (for example, reflecting over the x -axis sends (x, y) to $(x, -y)$), and learning those rules lets you move figures with precision and describe the motion with algebra!



Key Concepts & Quick Review

Translation $(x, y) \rightarrow (x + a, y + b)$: every point shifts a units horizontally and b units vertically.

Reflection rules for common lines of reflection:

- Over the x -axis: $(x, y) \rightarrow (x, -y)$
- Over the y -axis: $(x, y) \rightarrow (-x, y)$
- Over $y = x$: $(x, y) \rightarrow (y, x)$

Rotation about the origin (counter-clockwise):

- 90° : $(x, y) \rightarrow (-y, x)$
- 180° : $(x, y) \rightarrow (-x, -y)$
- 270° : $(x, y) \rightarrow (y, -x)$

All three transformations produce an image **congruent** to the original figure.

Examples

① Translate the point $(3, -2)$ by $(x + 4, y - 1)$.

Think It Through: A translation slides every point the same amount, so just add the shift to each coordinate. For x : $3 + 4 = 7$. For y : $-2 - 1 = -3$. The image lands at $(7, -3)$ —the point moved 4 units



right and 1 unit down, which is exactly what the rule says.

Answer: $(7, -3)$

② Rotate the point $(2, 5)$ by 90° counter-clockwise about the origin.

Think It Through: For a 90° counter-clockwise rotation about the origin, the rule is $(x, y) \rightarrow (-y, x)$. Plug in: the new x -coordinate becomes -5 (flip the sign of the old y), and the new y -coordinate becomes 2 (the old x stays the same). The image is $(-5, 2)$.

Answer: $(-5, 2)$

Practice Problems

Apply the transformation. Write the coordinates of the image point.

1. Translate the point $(1, 4)$ using the rule $(x, y) \rightarrow (x + 3, y - 2)$. Write the image point. _____
2. Translate the point $(-2, 5)$ using the rule $(x, y) \rightarrow (x - 1, y + 4)$. Write the image point. _____
3. Reflect the point $(0, 3)$ over the x -axis. Write the image point. _____
4. Reflect the point $(4, -1)$ over the y -axis. Write the image point. _____
5. Rotate the point $(6, 2)$ 90° counterclockwise about the origin. Write the image point. _____
6. Rotate the point $(3, -4)$ 180° about the origin. Write the image point. _____
7. Reflect the point $(-5, 1)$ over the x -axis. Write the image point. _____
8. Translate the point $(2, 7)$ using the rule $(x, y) \rightarrow (x - 5, y - 3)$. Write the image point. _____
9. Rotate the point $(-3, -2)$ 270° counterclockwise about the origin. Write the image point. _____
10. Reflect the point $(1, -6)$ over the y -axis. Write the image point. _____

11. Rotate the point $(4, 0)$ 90° counterclockwise about the origin. Write the image point. _____



12. Reflect the point $(5, 5)$ over the line $y = x$. Write the image point. _____



13. Rotate the point $(-1, 3)$ 180° about the origin. Write the image point. _____

14. Translate the point $(0, -4)$ using the rule $(x, y) \rightarrow (x + 6, y + 4)$. Write the image point. _____



15. Reflect the point $(7, 2)$ over the x -axis. Write the image point.



Study Tips

- 👉 For **reflections**, think of folding the paper along the line of reflection. The image is the same distance from the line as the original.
- 👉 Memorise the three rotation rules. A quick check: after a 90° CCW rotation, a point in Quadrant I moves to Quadrant II.
- 👉 Rigid motions do **not** change lengths or angles. If the image is a different size, the transformation is not a translation, reflection, or rotation.

Word Problems

16. A triangle has vertices $A(1, 2)$, $B(4, 2)$, and $C(4, 6)$. It is translated 3 units left and 2 units up. What are the new vertices? _____
17. Point $P(3, -1)$ is reflected over the x -axis and then rotated 90° counter-clockwise about the origin. What are the final coordinates? _____
18. This coordinate plane shows a pre-image triangle $\triangle ABC$ and its image $\triangle A'B'C'$. Identify the transformation (translation, reflection, or rotation) that maps the pre-image to the image, list the coordinates of the three image vertices, and write the rule (e.g., $(x, y) \rightarrow (\dots)$). _____



Answer Keys

- | | |
|--|--|
| <p>1) (4, 2)</p> <p>2) (-3, 9)</p> <p>3) (0, -3)</p> <p>4) (-4, -1)</p> <p>5) (-2, 6)</p> <p>6) (-3, 4)</p> <p>7) (-5, -1)</p> <p>8) (-3, 4)</p> <p>9) (-2, 3)</p> <p>10) (-1, -6)</p> | <p>11) (0, 4)</p> <p>12) (5, 5)</p> <p>13) (1, -3)</p> <p>14) (6, 0)</p> <p>15) (7, -2)</p> <p>16) $A'(-2, 4), B'(1, 4), C'(1, 8)$.</p> <p>17) $(-1, 3)$.</p> <p>18) Reflection over the y-axis; $A'(-1, 2), B'(-4, 2), C'(-4, 5)$; rule: $(x, y) \rightarrow (-x, y)$.</p> |
|--|--|

Step-by-Step Explanations

Strategy: For Solving Multi-Step Problems with Rational Numbers, choose the operation that matches the story, then keep fractions and signs organized through every step. The context should tell whether the answer is a total, a change, a distance, or a rate.

Practice 1: $\frac{x}{2} + 3 = 7$ **Answer:** 8

At the beginning of the practice, combine like terms on both sides before choosing the inverse operation.

Practice 15: $2(0.5x-3)=4$ **Answer:** 10

For the second model problem, clear parentheses and constants step by step so the final variable term is visible.

Word-problem notes:

16. Answer: $12.5 + 8.75w = 30 + 5.5w \Rightarrow w = \frac{70}{13} \approx 5.38$ weeks; each will have about \$59.62; Devon saves \$3.25/wk faster.

Write an expression for each friend's savings after w weeks. Devon has $12.5 + 8.75w$, and Kenji has $30 + 5.5w$. Set them equal because the question asks when the amounts match: $12.5 + 8.75w = 30 + 5.5w$. Subtract $5.5w$ to get $12.5 + 3.25w = 30$, then subtract 12.5 and divide by 3.25. This gives $w = \frac{70}{13} \approx 5.38$ weeks. Substituting that value back in shows each will have about \$59.62. Devon saves faster because $8.75 - 5.50 = 3.25$, so he saves \$3.25 more per week.

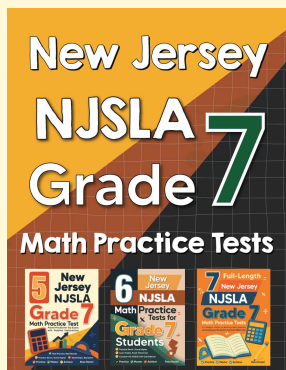
17. Answer: $-\frac{3}{8}t = -4.5 \Rightarrow t = 12 \text{ min}$; total: $12 + 15 = 27 < 30 \text{ min}$ — yes, possible.

The ranger is going downward, so the elevation change equation is $-\frac{3}{8}t = -4.5$. To solve for time, divide both sides by $-\frac{3}{8}$, or multiply by its reciprocal. That gives $t = 12 \text{ min}$. Now add the 15-minute setup time: $12 + 15 = 27 \text{ min}$. Since $27 < 30$, the full operation is possible within the required time limit.



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