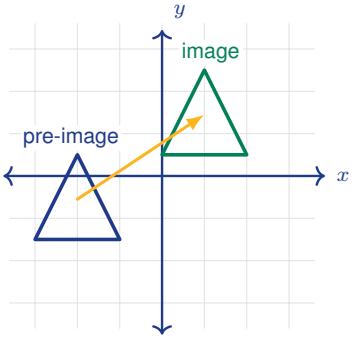
# Translations, Reflections, and Rotations

| Name: _____ | Date: _____ | Score: _____ / 18 |
|---|---|---|

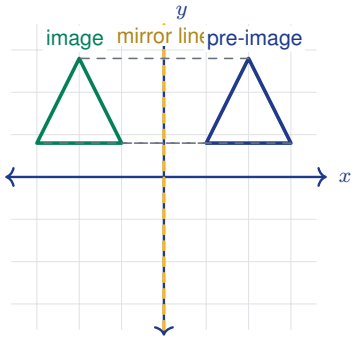
A **transformation** moves or changes a figure on the coordinate plane, and in this topic you will meet three important ones! **Translations** (slides) shift every point the same distance in the same direction; **reflections** (flips) mirror a figure across a line like the $x$-axis or $y$-axis; and **rotations** (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!

**Translation**
**slide right 3, up 2**



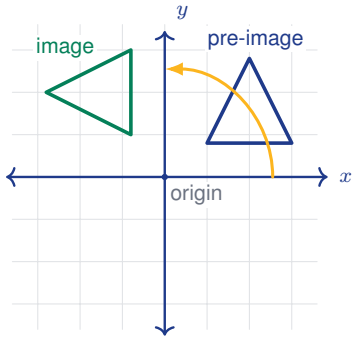

Rule: $(x, y) \to (x + 3,\ y + 2)$

**Reflection over $y$-axis**
**mirror across the line**




Rule: $(x, y) \to (-x,\ y)$

**Rotation $90°$ CCW**
**turn about origin**




Rule: $(x, y) \to (-y,\ x)$

## Key Concepts & Quick Review

**Translation** $(x, y) \to (x + a,\ y + b)$: every point shifts $a$ units horizontally and $b$ units vertically.
**Reflection** rules for common lines of reflection:

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

**Rotation about the origin** (counter-clockwise):

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

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 $(x, y) \to (-y, x)$. 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 $(x, y) \to (x + 3, y - 2)$. Write the image point. _____
2. Translate the point $(-2, 5)$ using the rule $(x, y) \to (x - 1, y + 4)$. 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 $(x, y) \to (x - 5, y - 3)$. 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.

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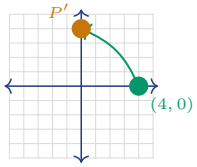


**12.** Reflect the point $(5, 5)$ over the line $y = x$. Write the image point.

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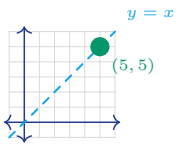


**13.** Rotate the point $(-1, 3)$ $180°$ about the origin. Write the image point. _____

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

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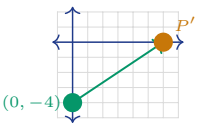
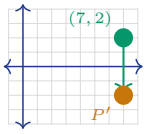


**15.** Reflect the point $(7, 2)$ over the $x$-axis. Write the image point.

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## 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?

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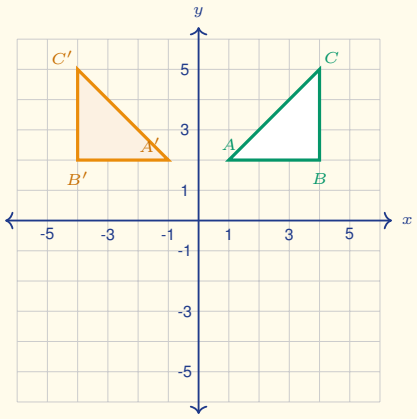
**17.** Point $P(3, -1)$ is reflected over the $x$-axis and then rotated $90°$ counter-clockwise about the origin. What are the final coordinates?

_____

**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., $(x, y) \to (\ldots)$).

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# Answer Keys

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

## 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:** $-\frac{3}{8}t = -4.5 \Rightarrow t = 12\,min$; total: $12 + 15 = 27 < 30\,min$ — 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 $t = 12\,min$. Now add the 15-minute setup time: $12 + 15 = 27\,min$. Since $27 < 30$, the full operation is possible within the required time limit.

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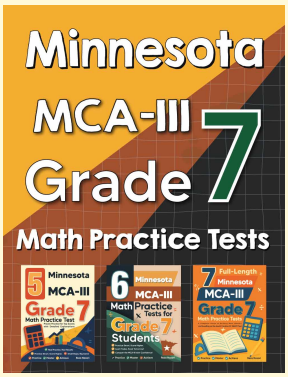


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