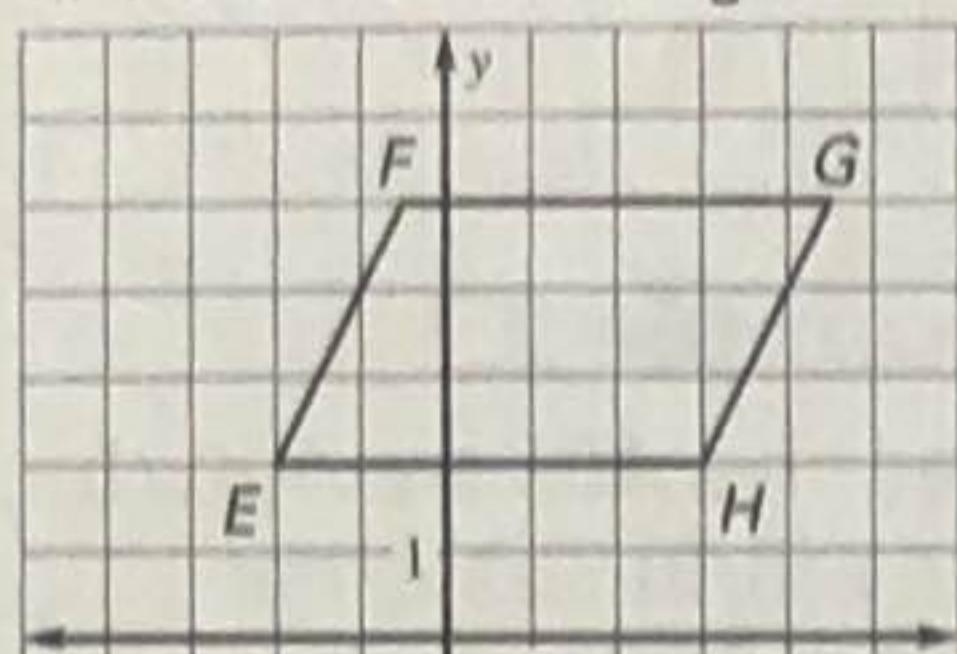


9.4

Perform Rotations

EXAMPLE

Find the image matrix that represents the 90° rotation of $EFGH$ about the origin.



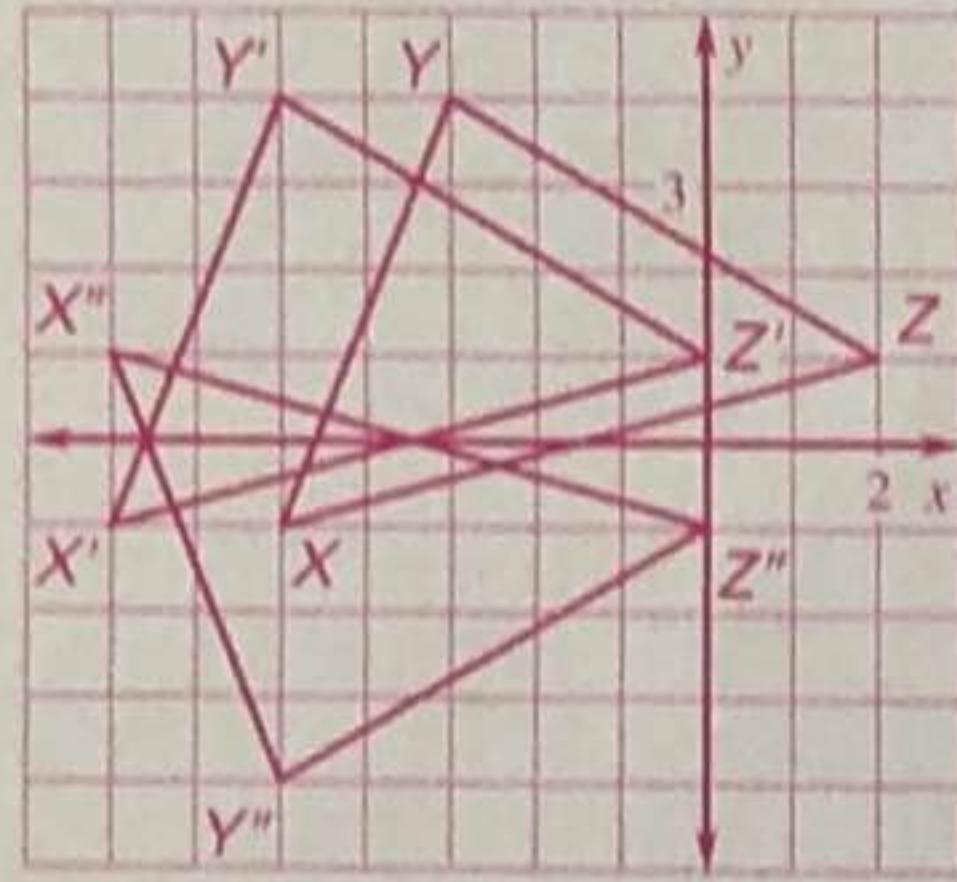
$$\begin{array}{cccc} E' & F' & G' & H' \\ [-2 & -5 & -5 & -2] \\ [-4 & -1 & 9 & 6] \end{array}$$

Extra Example 9.5

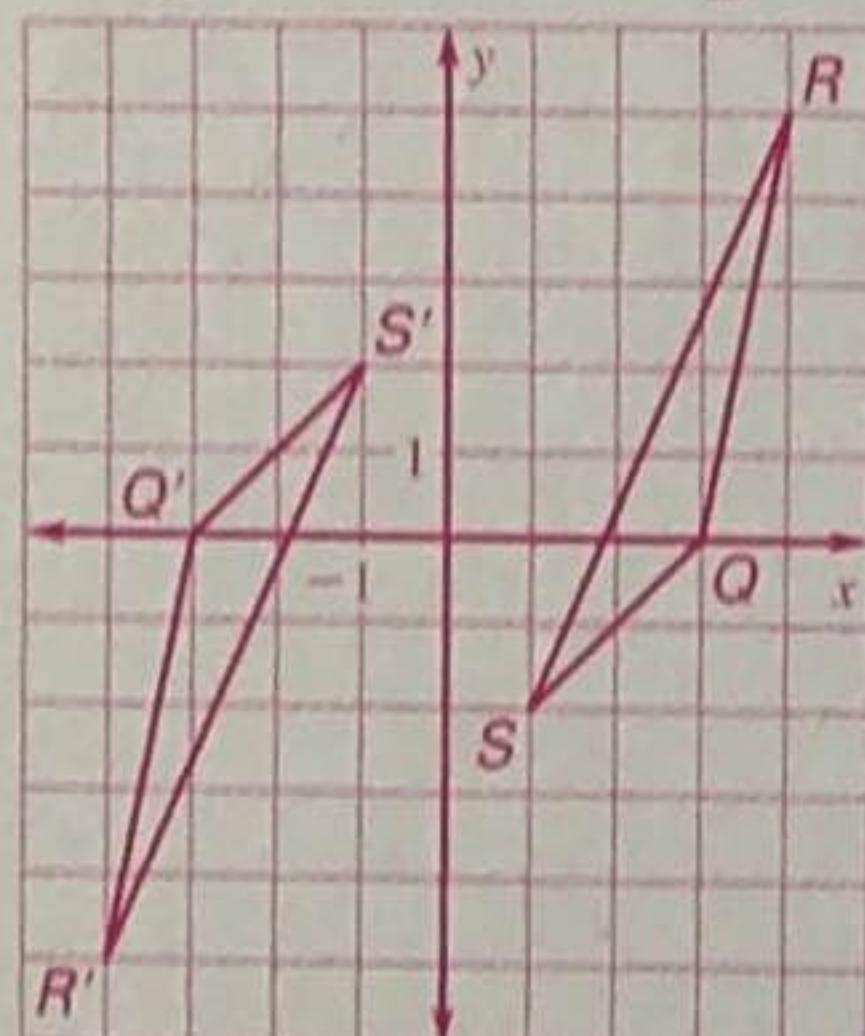
The vertices of $\triangle XYZ$ are $X(-5, -1)$, $Y(-3, 4)$, and $Z(2, 1)$. Graph the image of $\triangle XYZ$ after the glide reflection.

Translation: $(x, y) \rightarrow (x - 2, y)$

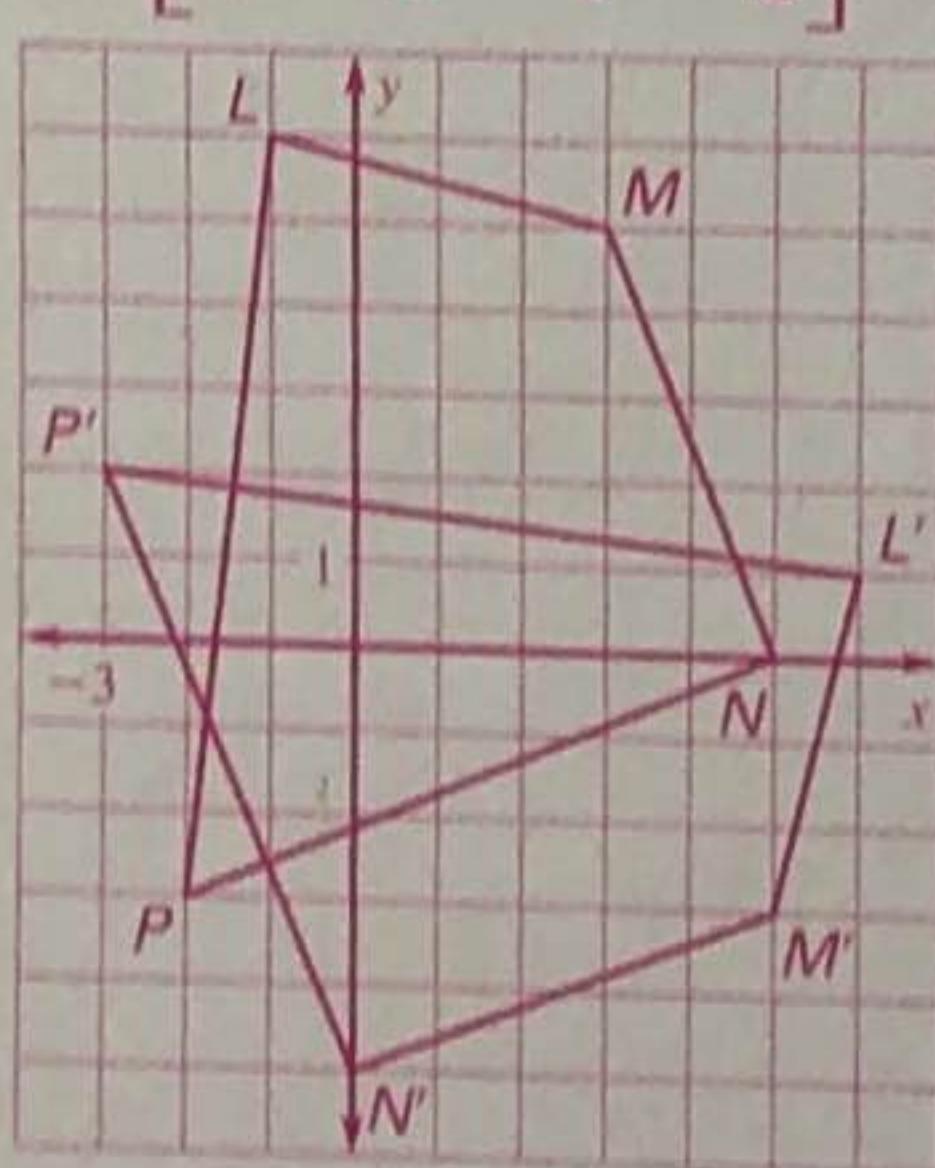
Reflection: in the x -axis



$$13. \begin{bmatrix} Q & R & S \\ -3 & -4 & -1 \\ 0 & -5 & 2 \end{bmatrix};$$



$$14. \begin{bmatrix} L & M & N & P \\ 6 & 5 & 0 & -3 \\ 1 & -3 & -5 & 2 \end{bmatrix};$$



9.5

Apply Compositions of Transformations

EXAMPLE 3
on p. 600
for Exs. 13-14

EXERCISES

Find the image matrix that represents the given rotation of the polygon about the origin. Then graph the polygon and its image. 13, 14. See margin.

$$13. \begin{bmatrix} Q & R & S \\ 3 & 4 & 1 \\ 0 & 5 & -2 \end{bmatrix}; 180^\circ$$

$$14. \begin{bmatrix} L & M & N & P \\ -1 & 3 & 5 & -2 \\ 6 & 5 & 0 & -3 \end{bmatrix}; 270^\circ$$

9.5

Apply Compositions of Transformations

EXAMPLE 1
on p. 608
for Exs. 15-16

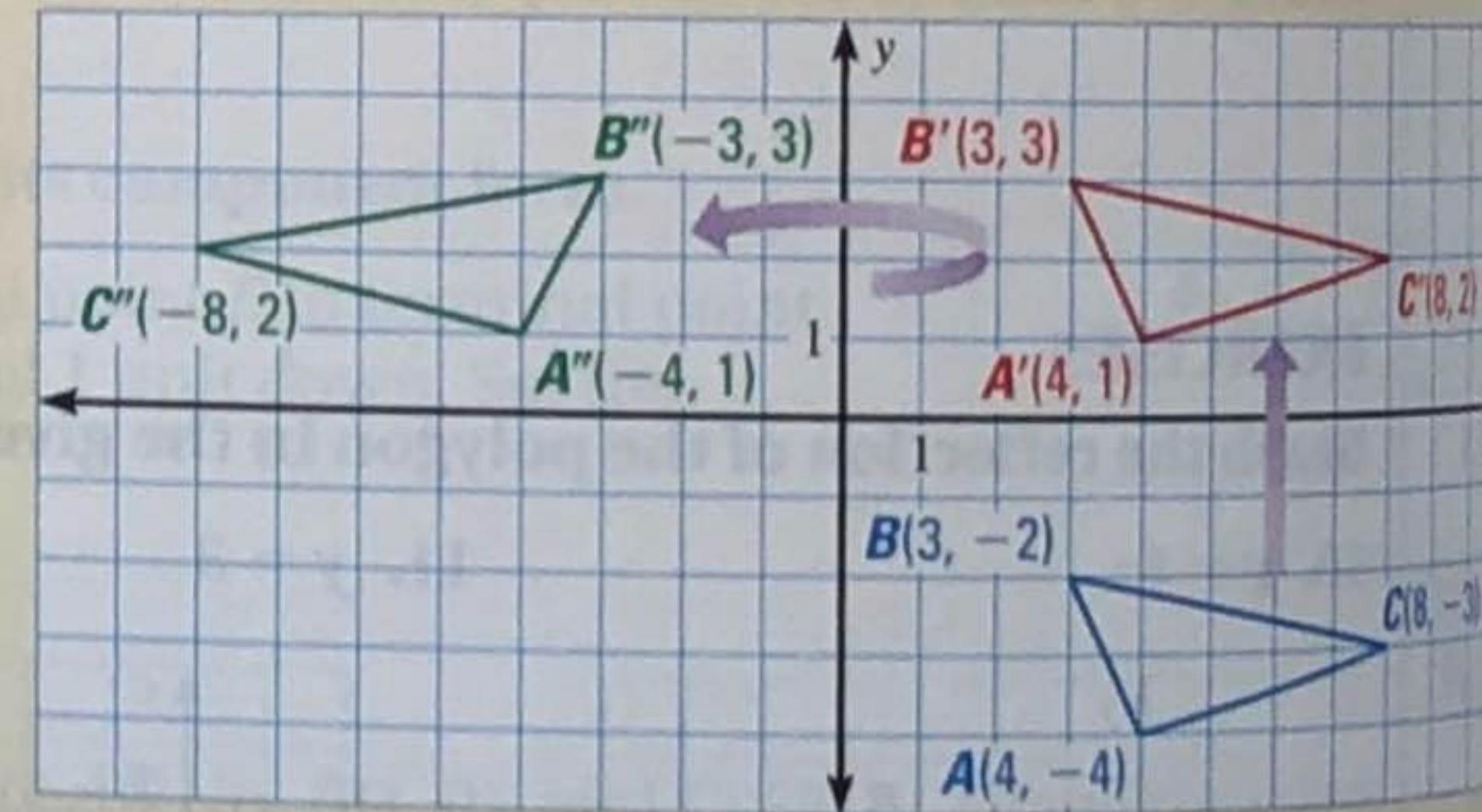
EXAMPLE

The vertices of $\triangle ABC$ are $A(4, -4)$, $B(3, -2)$, and $C(8, -3)$. Graph the image of $\triangle ABC$ after the glide reflection.

Translation: $(x, y) \rightarrow (x, y + 5)$

Reflection: in the y -axis

Begin by graphing $\triangle ABC$. Then graph the image $\triangle A'B'C'$ after a translation of 5 units up. Finally, graph the image $\triangle A''B''C''$ after a reflection in the y -axis.

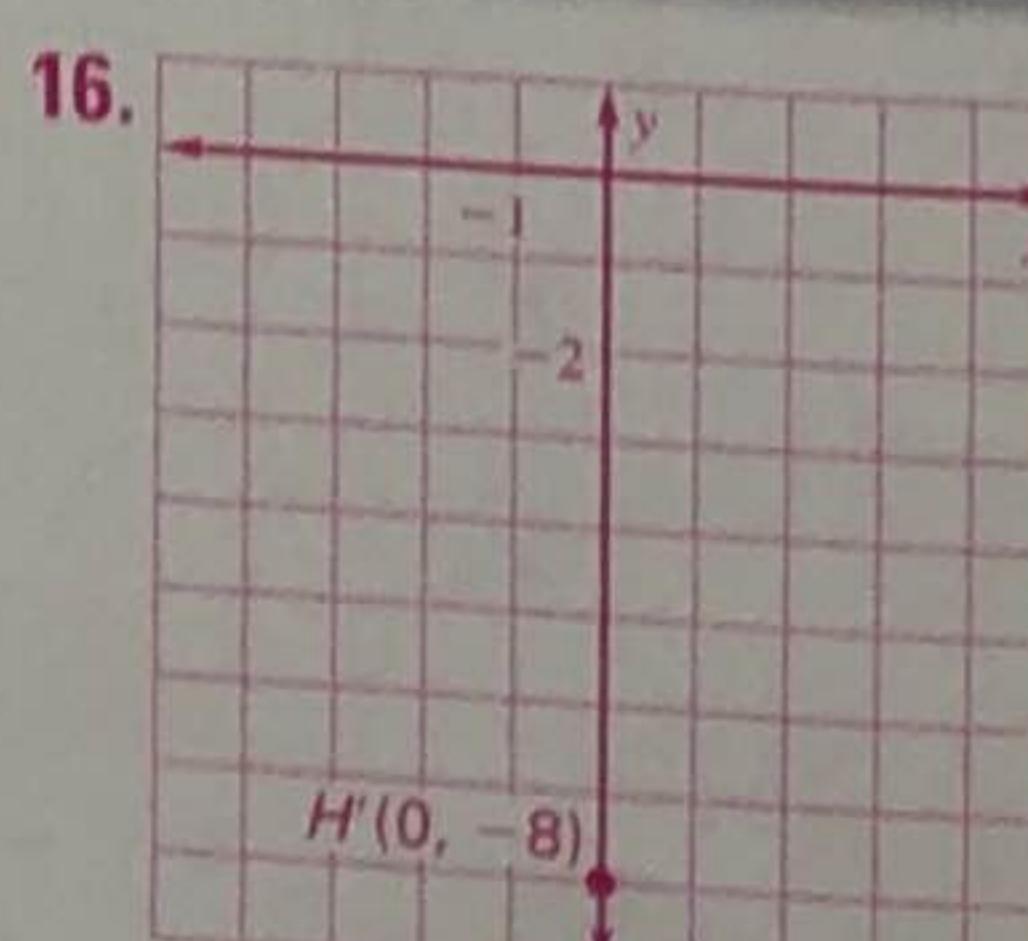
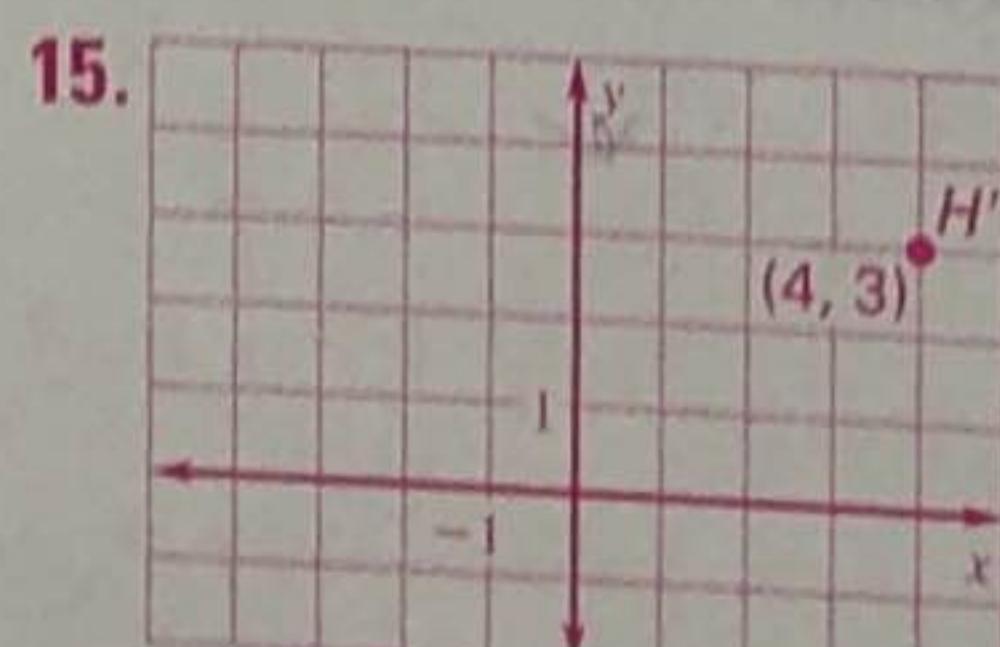


EXERCISES

Graph the image of $H(-4, 5)$ after the glide reflection. 15, 16. See margin.

15. Translation: $(x, y) \rightarrow (x + 6, y - 2)$
Reflection: in $x = 3$

16. Translation: $(x, y) \rightarrow (x - 4, y - 5)$
Reflection: in $y = x$

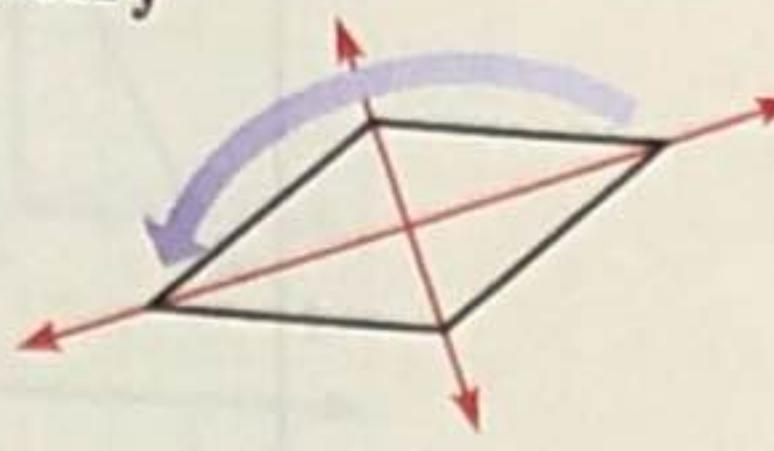


Identify Symmetry

EXAMPLE

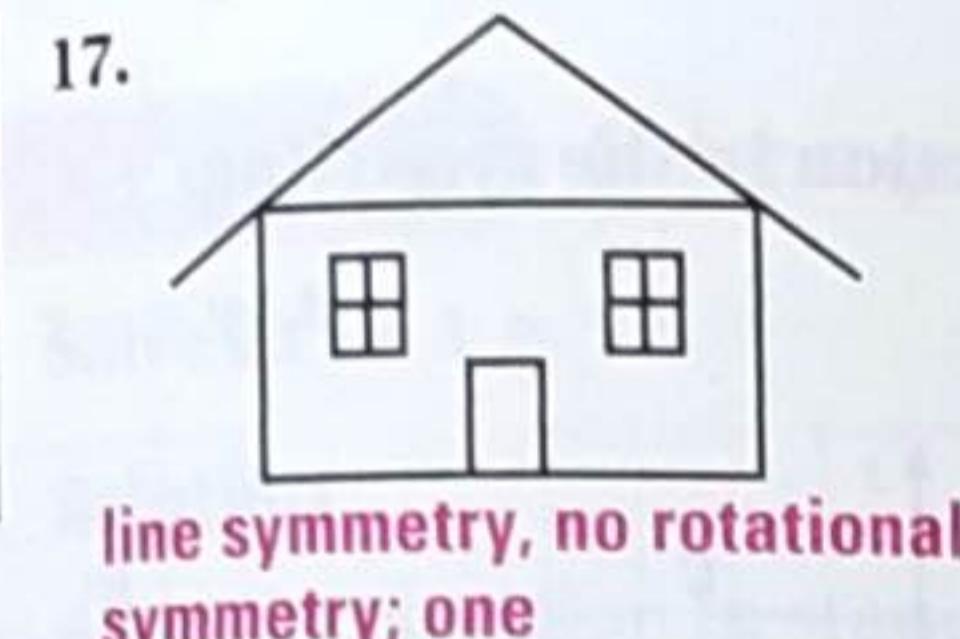
Determine whether the rhombus has *line symmetry* and/or *rotational symmetry*. Identify the number of lines of symmetry and/or the rotations that map the figure onto itself.

The rhombus has two lines of symmetry. It also has rotational symmetry, because a 180° rotation maps the rhombus onto itself.



EXERCISES

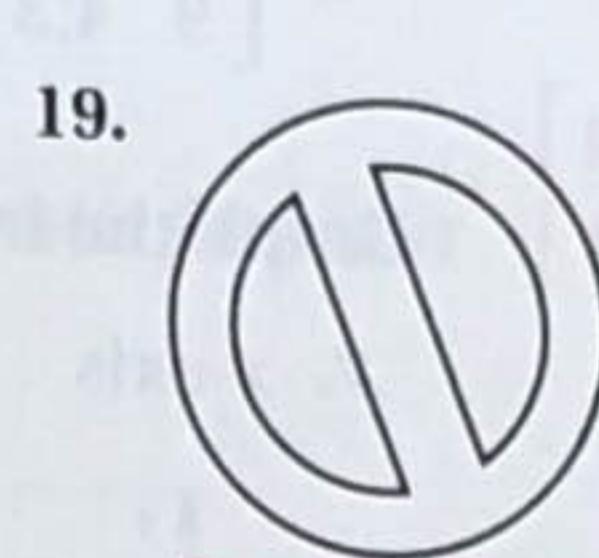
Determine whether the figure has *line symmetry* and/or *rotational symmetry*. Identify the number of lines of symmetry and/or the rotations that map the figure onto itself.



line symmetry, no rotational symmetry; one



no line symmetry, rotational symmetry; 180° about the center



line symmetry, rotational symmetry; two, 180° about the center

pp. 619–624

Identify and Perform Dilations

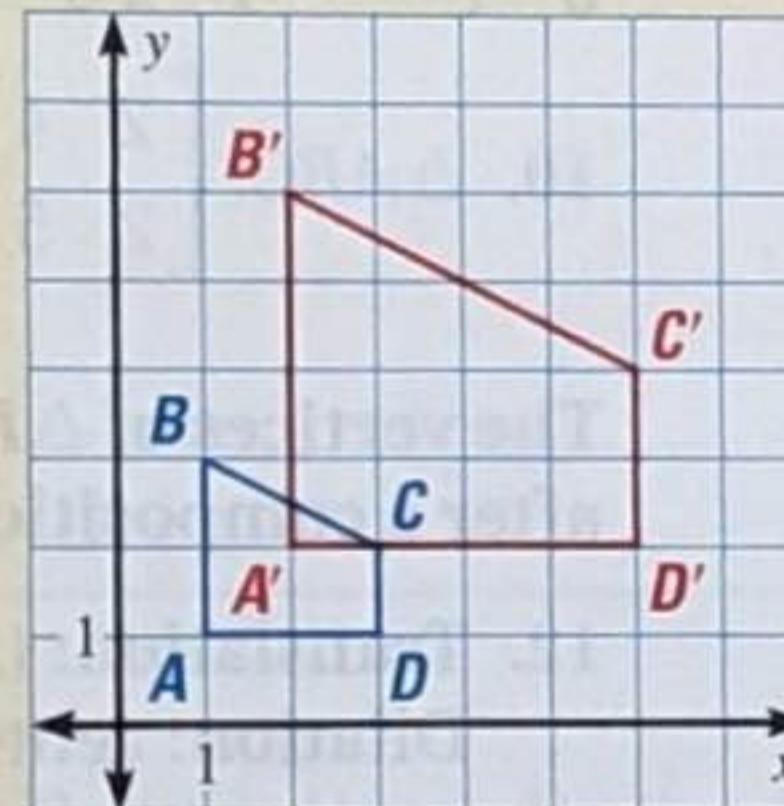
EXAMPLE

Quadrilateral $ABCD$ has vertices $A(1, 1)$, $B(1, 3)$, $C(3, 2)$, and $D(3, 1)$. Use scalar multiplication to find the image of $ABCD$ after a dilation with its center at the origin and a scale factor of 2. Graph $ABCD$ and its image.

To find the image matrix, multiply each element of the polygon matrix by the scale factor.

$$\text{Scale factor } 2 \begin{bmatrix} A & B & C & D \\ 1 & 1 & 3 & 3 \\ 1 & 3 & 2 & 1 \end{bmatrix} = \begin{bmatrix} A' & B' & C' & D' \\ 2 & 2 & 6 & 6 \\ 2 & 6 & 4 & 2 \end{bmatrix}$$

Polygon matrix Image matrix



EXERCISES

Find the image matrix that represents a dilation of the polygon centered at the origin with the given scale factor. Then graph the polygon and its image. 20, 21. See margin.

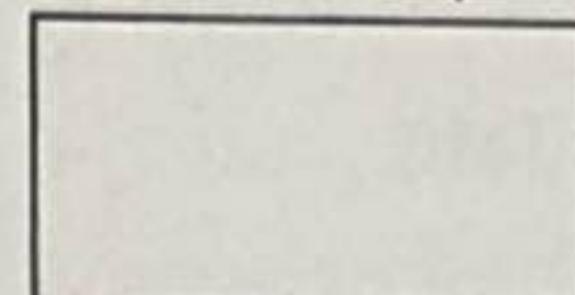
$$20. \begin{bmatrix} Q & R & S \\ 2 & 4 & 8 \\ 2 & 4 & 2 \end{bmatrix}; k = \frac{1}{4}$$

$$21. \begin{bmatrix} L & M & N \\ -1 & 1 & 2 \\ -2 & 3 & 4 \end{bmatrix}; k = 3$$

Chapter Review 639

Extra Example 9.6

Determine whether the rectangle has line symmetry and/or rotational symmetry. Identify the number of lines of symmetry and/or the rotations that map the figure onto itself.

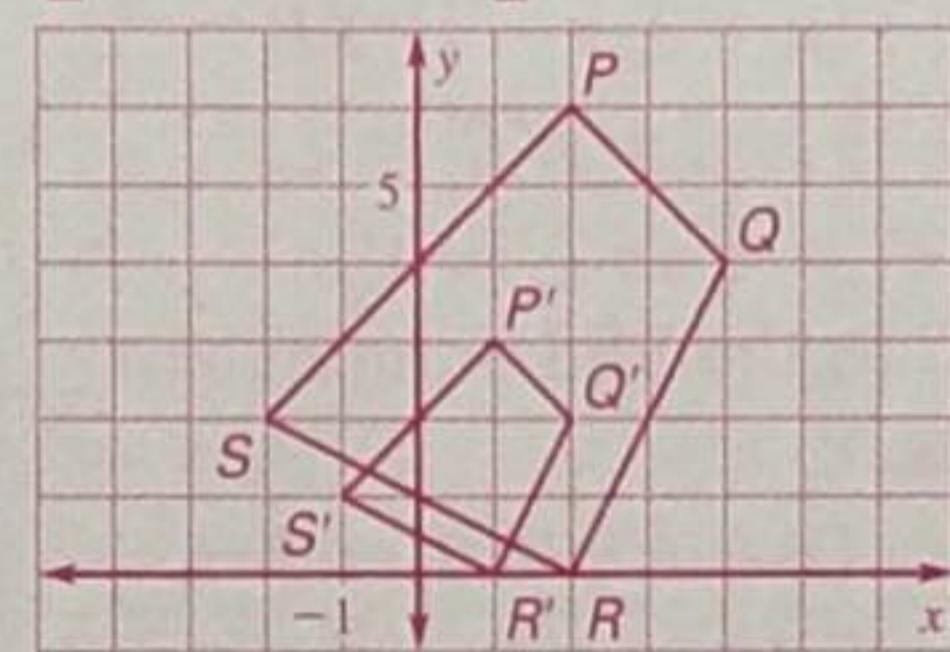


2 lines of symmetry,
 180° rotational symmetry

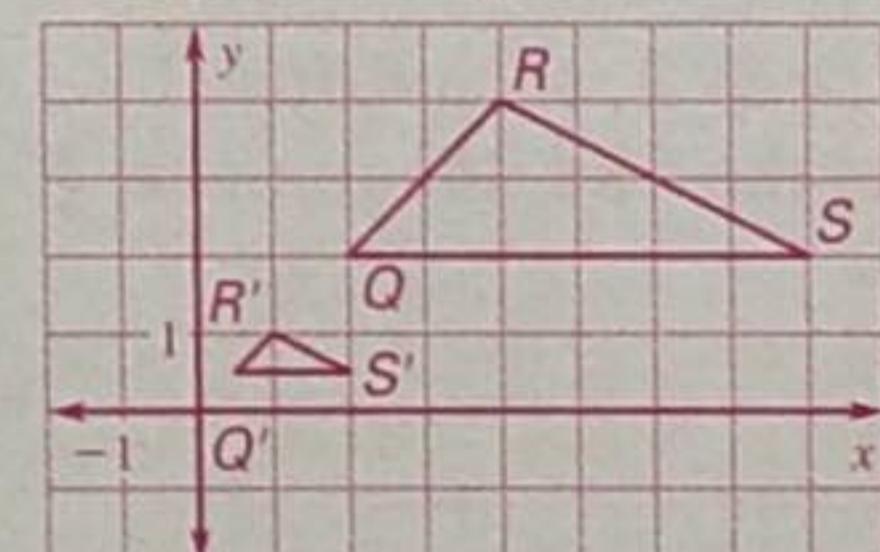
Extra Example 9.7

Quadrilateral $PQRS$ has vertices $P(2, 6)$, $Q(4, 4)$, $R(2, 0)$, and $S(-2, 2)$. Use scalar multiplication to find the image of $PQRS$ after a dilation with its center at the origin and a scale factor of $\frac{1}{2}$. Graph $PQRS$ and its image.

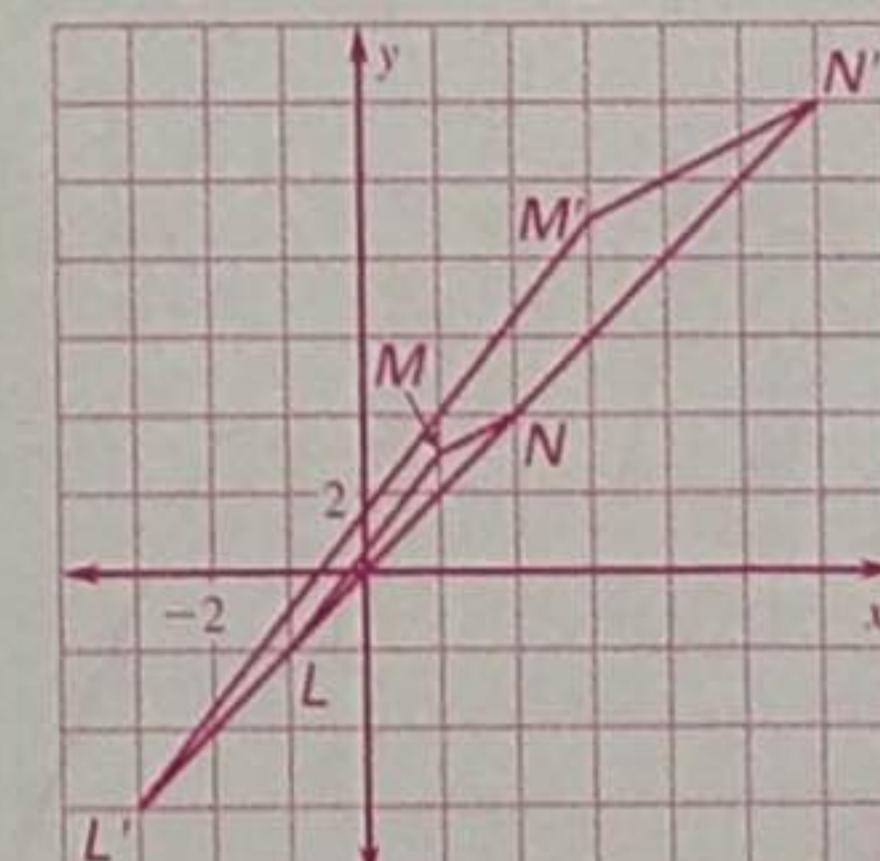
$$\begin{bmatrix} P' & Q' & R' & S' \\ 1 & 2 & 1 & -1 \\ 3 & 2 & 0 & 1 \end{bmatrix}$$



$$20. \begin{bmatrix} Q' & R' & S' \\ \frac{1}{2} & 1 & 2 \\ \frac{1}{2} & 1 & \frac{1}{2} \end{bmatrix};$$



$$21. \begin{bmatrix} L' & M' & N' \\ -3 & 3 & 6 \\ -6 & 9 & 12 \end{bmatrix};$$



Additional Resources**Assessment Book**

- Chapter Test, Levels A, B, C, pp. 128–133
- Standardized Chapter Test, pp. 134–135
- SAT/ACT Chapter Test, pp. 136–137
- Alternative Assessment, pp. 138–139

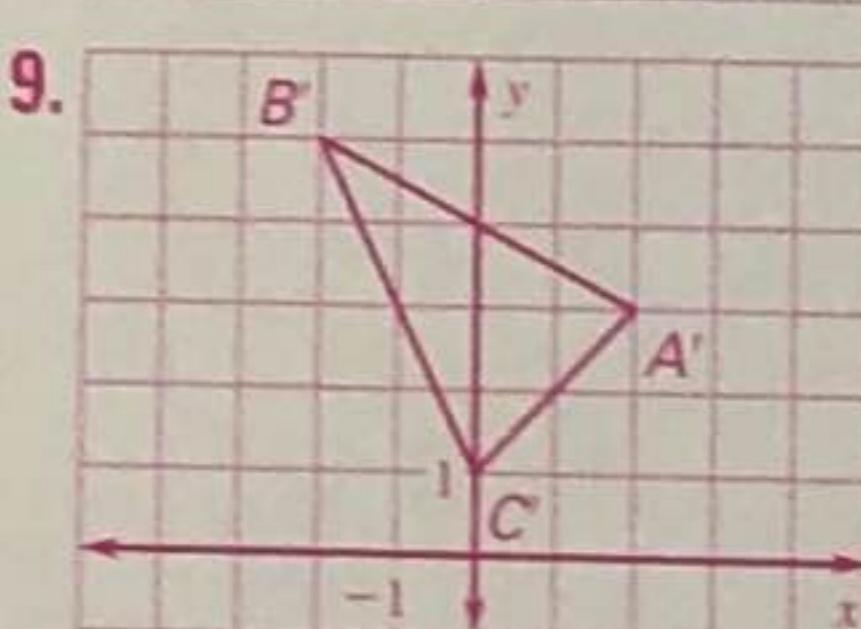
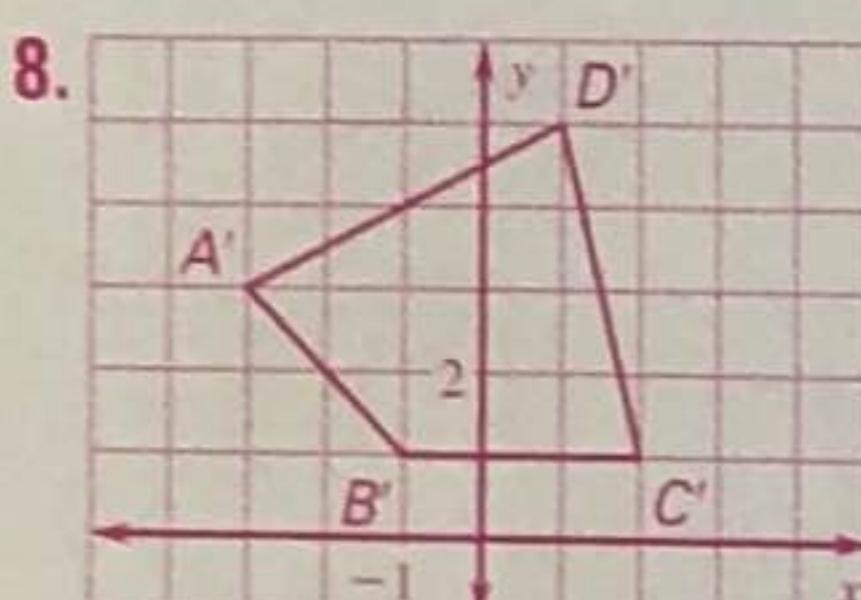
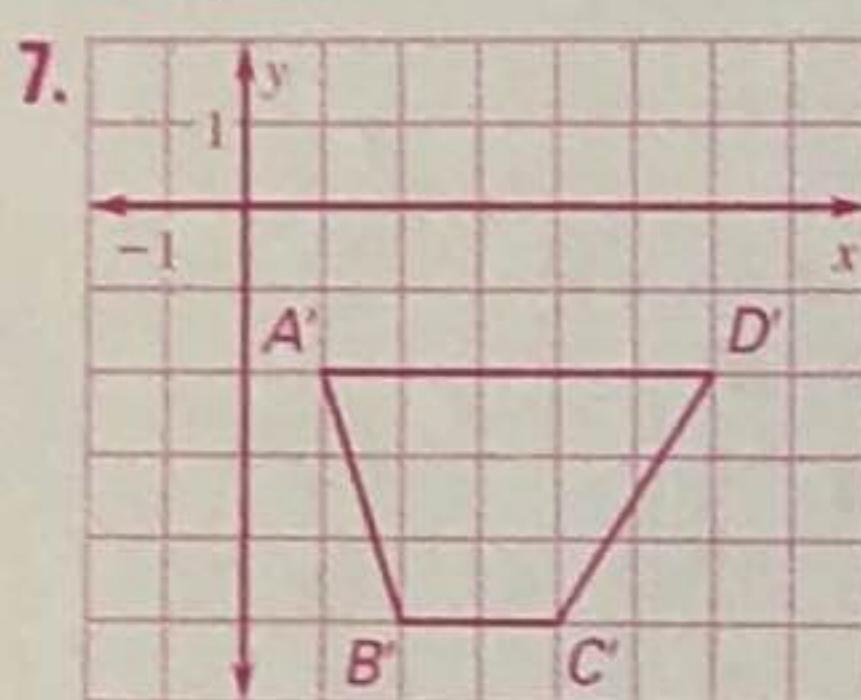
Test Generator CD-ROM**Chapter Test**

Easily-readable reduced copies (with answers) of Chapter Test B, the Standardized Chapter Test, and the Alternative Assessment from the Assessment Book can be found on pp. 570G–570H.

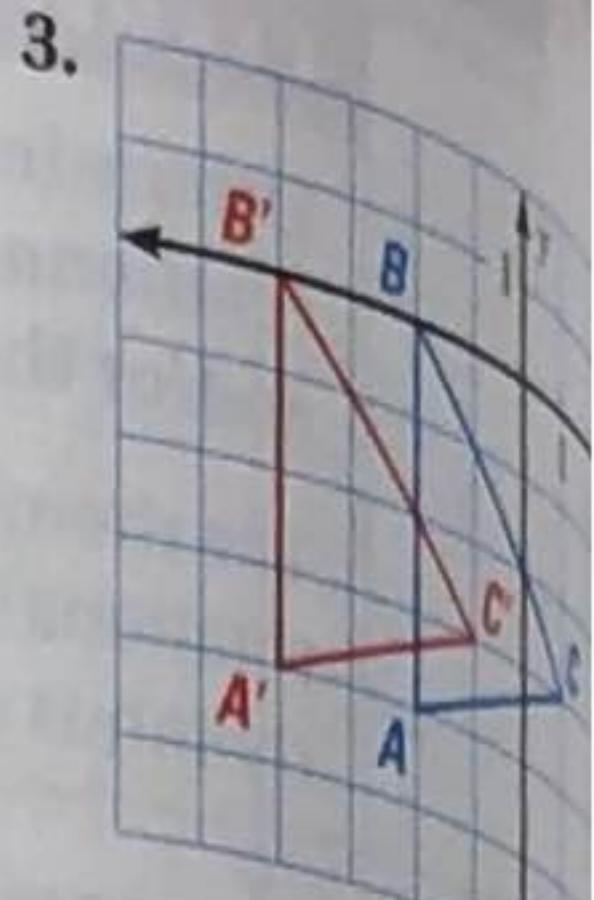
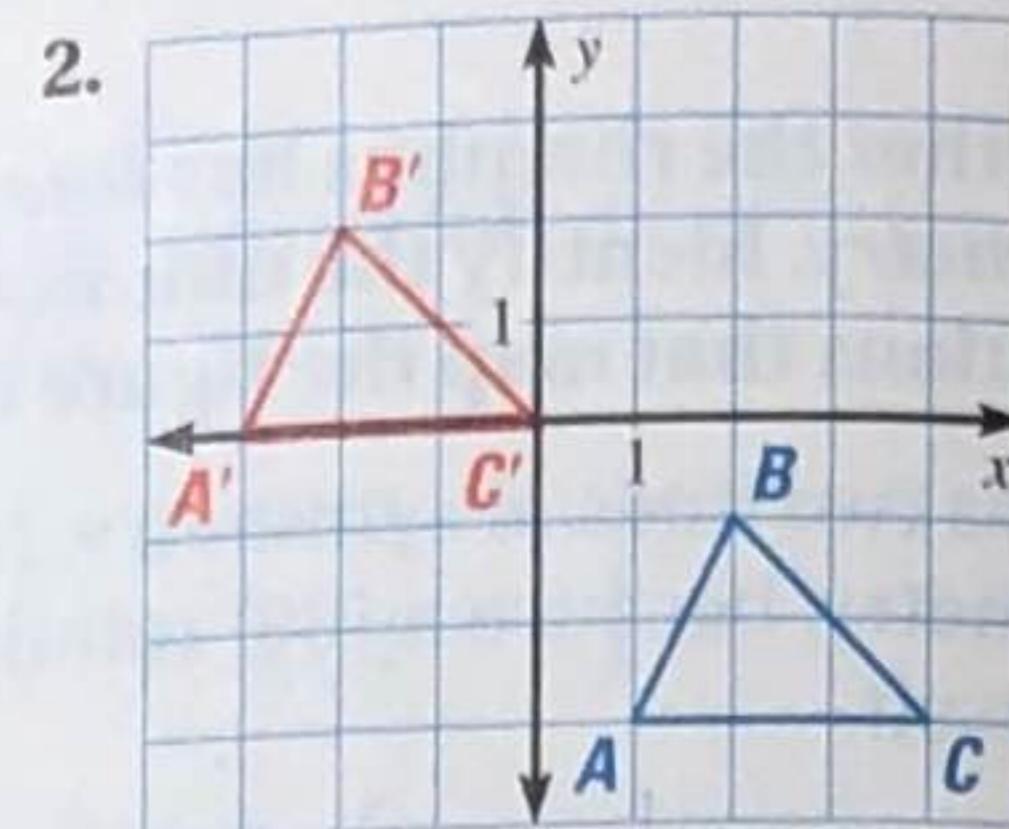
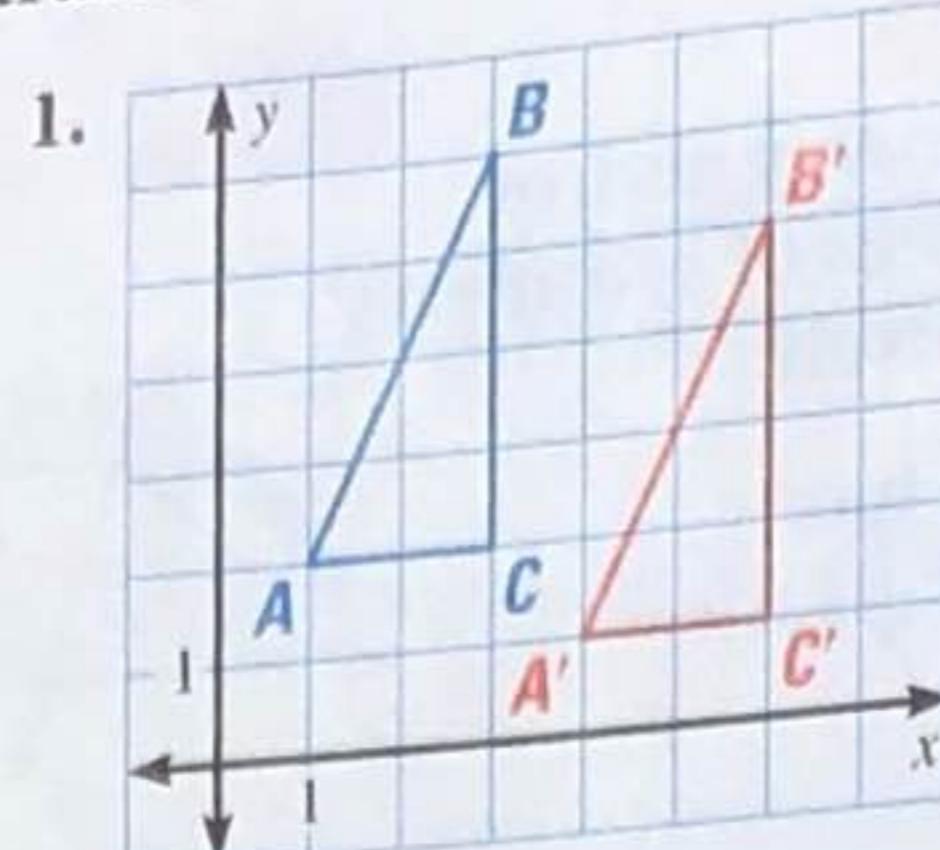
1. $(x, y) \rightarrow (x + 3, y - 1)$; $AB = A'B' = 2\sqrt{5}$, $AC = A'C' = 2$, $BC = B'C' = 4$, so $\triangle ABC \cong \triangle A'B'C'$ by the SSS Congruence Postulate.

2. $(x, y) \rightarrow (x - 4, y + 3)$; $AB = A'B' = \sqrt{5}$, $AC = A'C' = 3$, $BC = B'C' = 2\sqrt{2}$, so $\triangle ABC \cong \triangle A'B'C'$ by the SSS Congruence Postulate.

3. $(x, y) \rightarrow (x - 2, y)$; $AB = A'B' = 4$, $AC = A'C' = \sqrt{10}$, $BC = B'C' = 3\sqrt{2}$, so $\triangle ABC \cong \triangle A'B'C'$ by the SSS Congruence Postulate.



Write a rule for the translation of $\triangle ABC$ to $\triangle A'B'C'$. Then verify that the translation is an isometry. 1–3. See margin.



Add, subtract, or multiply.

4. $\begin{bmatrix} -7 & -6 \\ 14.1 & -0.7 \end{bmatrix}$

4. $\begin{bmatrix} 3 & -8 \\ 9 & 4.3 \end{bmatrix} + \begin{bmatrix} -10 & 2 \\ 5.1 & -5 \end{bmatrix}$

5. $\begin{bmatrix} -2 & 2.6 \\ 0.8 & 4 \end{bmatrix} - \begin{bmatrix} 6 & 9 \\ -1 & 3 \end{bmatrix}$

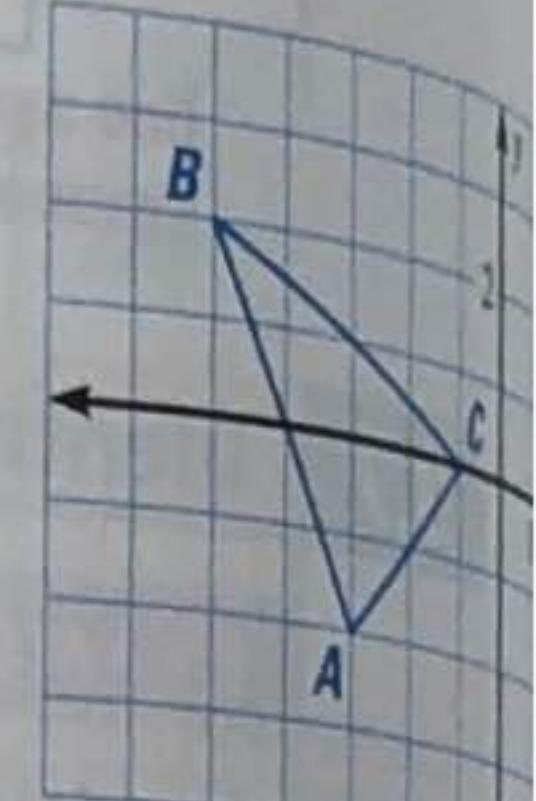
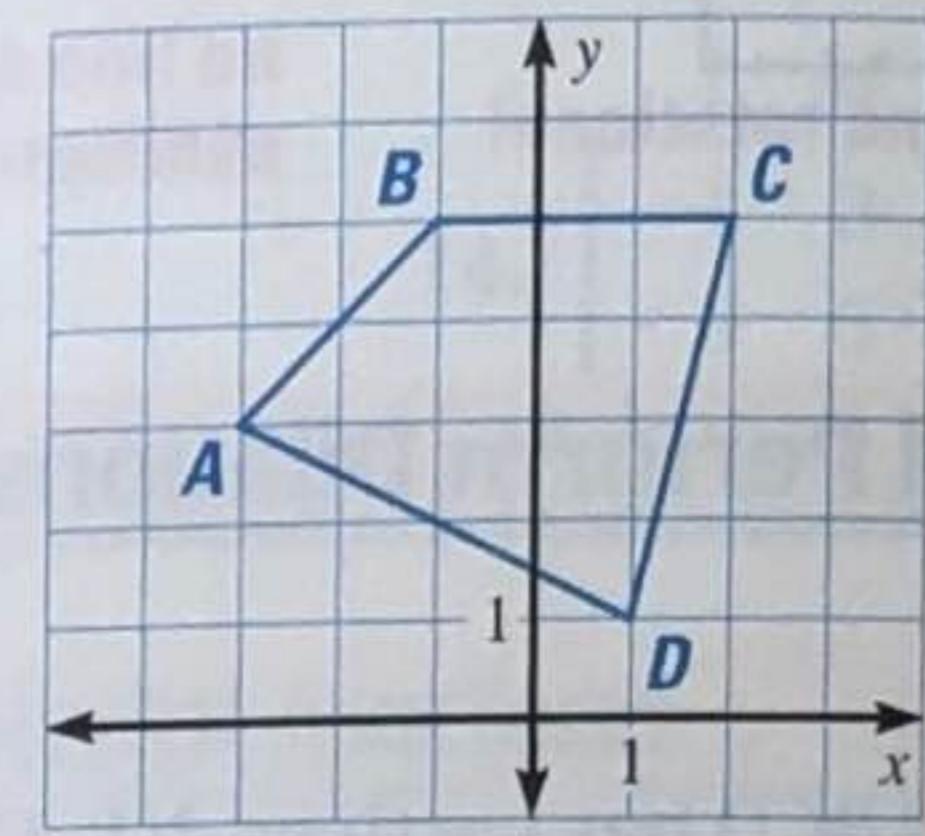
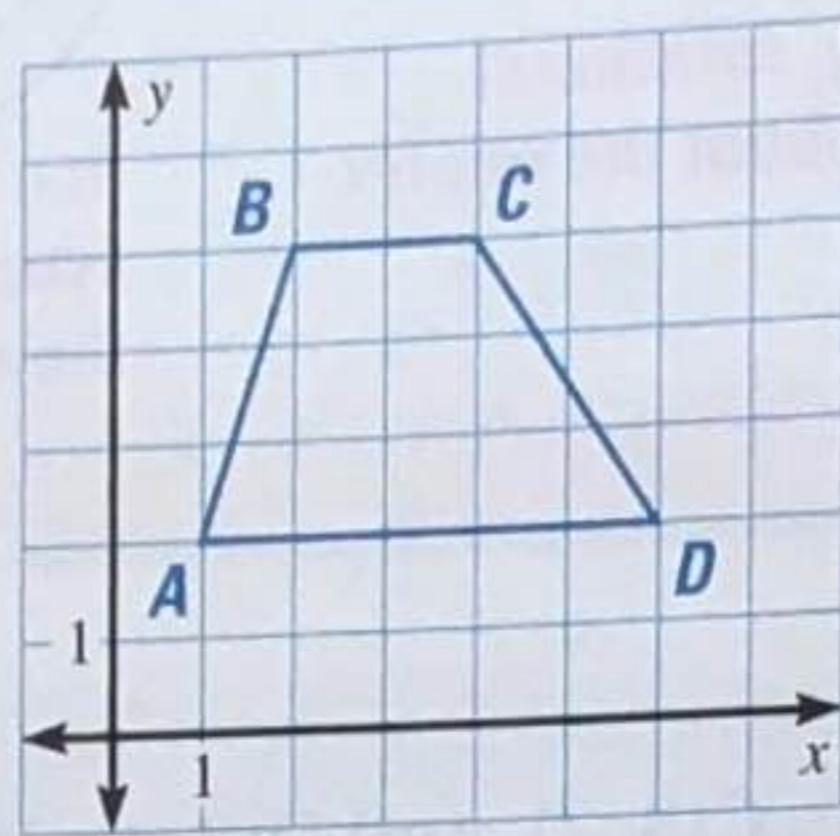
6. $\begin{bmatrix} 7 & -3 & 2 \\ 5 & 1 & -4 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 3 \end{bmatrix}$

5. $\begin{bmatrix} -8 & -6.4 \\ 1.8 & 1 \end{bmatrix}$

6. $\begin{bmatrix} 13 \\ -7 \end{bmatrix}$

Graph the image of the polygon after the reflection in the given line. 7–9. See margin.

7. x -axis



Find the image matrix that represents the rotation of the polygon. Then graph the polygon and its image. 10, 11. See margin.

10. $\triangle ABC: \begin{bmatrix} 2 & 4 & 6 \\ 2 & 5 & 1 \end{bmatrix}$; 90° rotation

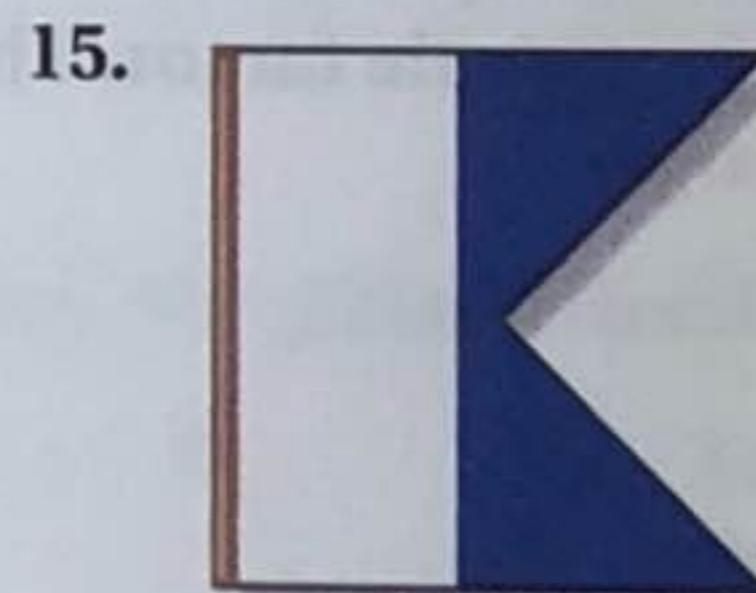
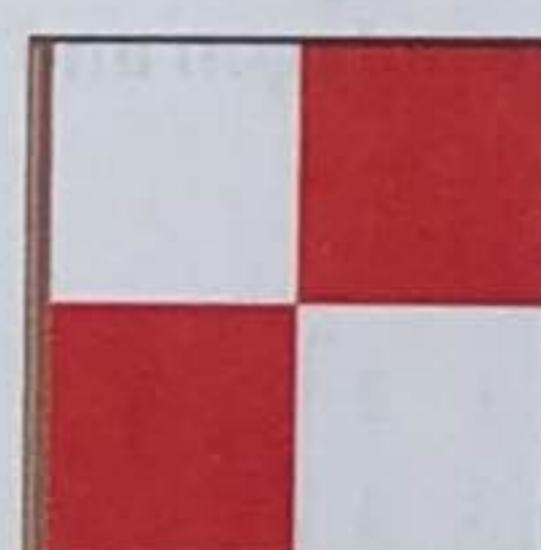
11. $KLMN: \begin{bmatrix} -5 & -2 & -3 & -5 \\ 0 & 3 & -1 & -3 \end{bmatrix}$; 180° rotation

The vertices of $\triangle PQR$ are $P(-5, 1)$, $Q(-4, 6)$, and $R(-2, 3)$. Graph $\triangle P''Q''R''$ after a composition of the transformations in the order they are listed. 12, 13. See margin.

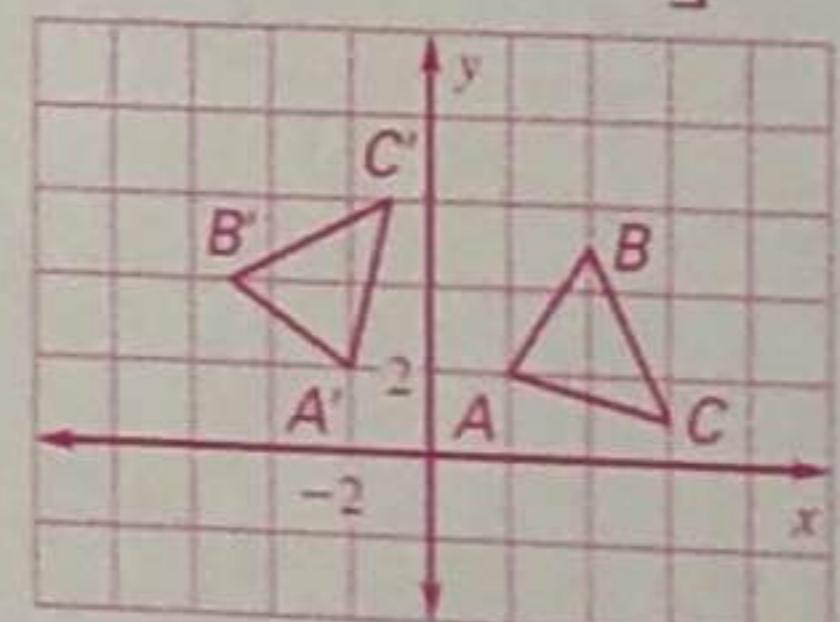
12. Translation: $(x, y) \rightarrow (x - 8, y)$
Dilation: centered at the origin, $k = 2$

13. Reflection: in the y -axis
Rotation: 90° about the origin

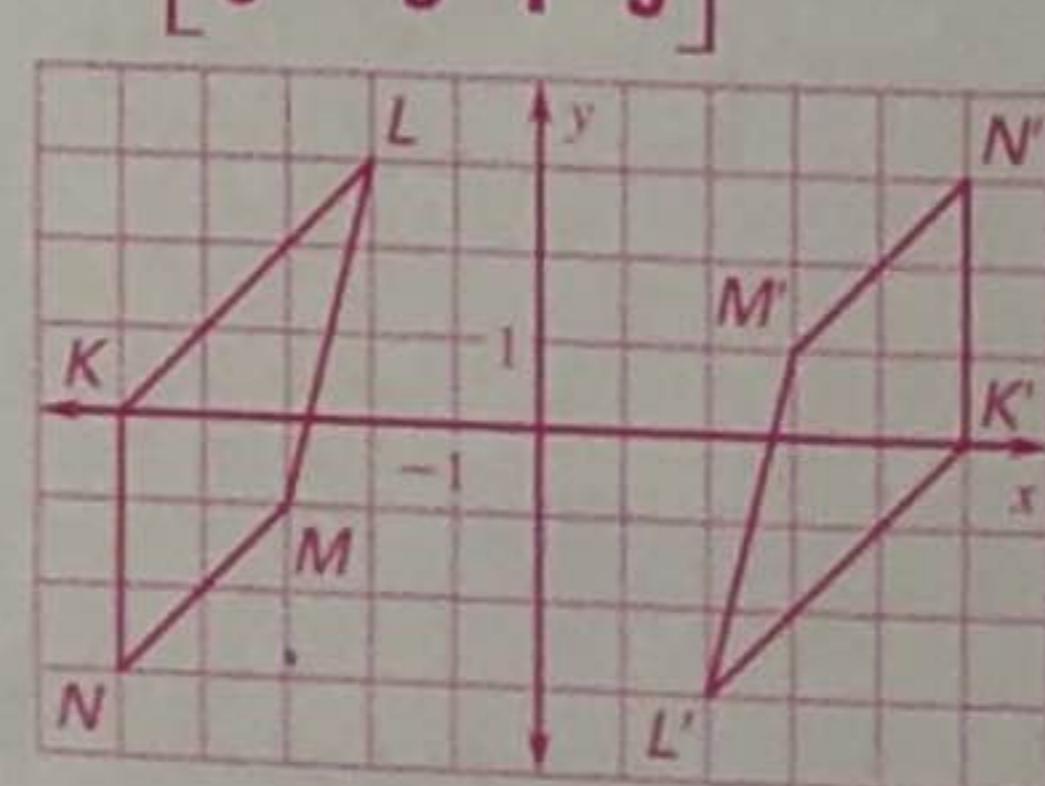
Determine whether the flag has *line symmetry* and/or *rotational symmetry*. Identify all lines of symmetry and/or angles of rotation that map the figure onto itself. 14–16. See margin.



10. $\begin{bmatrix} A' & B' & C' \\ -2 & 2 & 2 \\ 2 & 4 & 6 \end{bmatrix}$;



11. $\begin{bmatrix} K' & L' & M' & N' \\ 5 & 2 & 3 & 5 \\ 0 & -3 & 1 & 3 \end{bmatrix}$;



12.

