1. A pattern for a new fabric is made by rotating the figure 90° counterclockwise about the origin and then translating along the vector \((-1, 2)\). Draw the resulting figure in the pattern.

2. \(\triangle LMN\) is reflected across the line \(y = x\) and then reflected across the \(y\)-axis. What are the coordinates of the final image of \(\triangle LMN\)?

Choose the best answer.

3. \(\triangle EFG\) has vertices \(E(1, 5), F(0, -3),\) and \(G(-1, 2)\). \(\triangle EFG\) is translated along the vector \((7, 1)\), and the image is reflected across the \(x\)-axis. What are the coordinates of the final image of \(G\)?
   - A \((6, -3)\)
   - C \((-6, 3)\)
   - B \((6, 3)\)
   - D \((-6, -3)\)

4. \(\triangle KLM\) with vertices \(K(8, -1), L(-1, -4),\) and \(M(2, 3)\) is rotated 180° about the origin. The image is then translated. The final image of \(K\) has coordinates \((-2, -3)\). What is the translation vector?
   - F \((6, 4)\)
   - H \((-1, -11)\)
   - G \((6, -4)\)
   - J \((-10, -2)\)

5. To create a logo for new sweatshirts, a designer reflects the letter \(T\) across line \(h\). That image is then reflected across line \(j\). Describe a single transformation that moves the figure from its starting position to its final position.

6. Which composition of transformations maps \(\triangle QRS\) into Quadrant III?
   - F Translate along the vector \((-6, 4)\) and then reflect across the \(y\)-axis.
   - G Rotate by 90° about the origin and then reflect across the \(x\)-axis.
   - H Reflect across the \(y\)-axis and then rotate by 180° about the origin.
   - J Translate along the vector \((1, 2)\) and then rotate 90° about the origin.
Compositions of Transformations continued

Any translation or rotation is equivalent to a composition of two reflections.

**Composition of Two Reflections**

To draw two parallel lines of reflection that produce a translation:
- Draw \( \overrightarrow{PP'} \), a segment connecting a preimage point \( P \) and its corresponding image point \( P' \). Draw the perpendicular bisector of \( PP' \).
- Draw \( \overrightarrow{PP''} \), a segment connecting a preimage point \( P'' \) and its corresponding image point \( P'\)'. Draw the perpendicular bisector of \( PP'' \).

To draw two intersecting lines that produce a rotation with center \( C \):
- Draw \( \overrightarrow{PCP''} \), where \( P \) is a preimage point and \( P'' \) is its corresponding image point. Draw \( \overrightarrow{PC} \), the angle bisector of \( \angle PCP'' \).
- Draw \( \overrightarrow{PC} \), the angle bisector of \( \angle PC \) and \( \angle PC' \).

**Problem Solving**

Compositions of Transformations

1. A pattern for a new fabric is made by rotating the figure 90° counterclockwise about the origin and then translating along the vector \((-1, 2)\). Draw the resulting figure in the pattern.

2. \( \triangle LMN \) is reflected across the line \( y = x \) and then reflected across the \( y \)-axis. What are the coordinates of the final image of \( \triangle LMN \)?

\[ L'(-4, -3), M'(-1, 0), N'(4, 1) \]

Choose the best answer.

3. \( \triangle EFG \) has vertices \( E(1, 5), F(0, -3), \) and \( G(-1, 2) \). \( \triangle EFG \) is translated along the vector \((-6, 3)\), and the image is reflected across the \( x \)-axis. What are the coordinates of the final image of \( \triangle EFG \)?

- A \( (6, 3) \)
- B \( (6, 3) \)
- C \( (-6, 3) \)
- D \( (-6, -3) \)

4. \( \triangle KLM \) with vertices \( K(8, -1), L(-1, -4), \) and \( M(2, 3) \) is rotated 180° about the origin. The image is then translated. The final image of \( K \) has coordinates \((-2, -3)\). What is the translation vector?

- A \( (6, 4) \)
- B \( (-1, -1) \)
- C \( (6, 4) \)
- D \( (-10, -2) \)

5. To create a logo for new sweatshirts, a designer reflects the letter \( T \) across line \( T \). That image is then reflected across line \( J \). Describe a single transformation that moves the figure from its starting position to its final position.

- A translation
- B rotation of 110°
- C rotation of 220°
- D reflection across vertical line

6. Which composition of transformations maps \( \triangle ORS \) into Quadrant III?

- A rotation by 90° about the origin and then reflect over the \( x \)-axis.
- B translate along the vector \((-6, 4)\) and then reflect across the \( y \)-axis.
- C translate along the vector \((-6, 4)\) and then reflect across the \( y \)-axis.
- D translate along the vector \((1, 2)\) and then rotate 90° about the origin.

7. The final image of \( \triangle ABC \) has coordinates \((-4, 2)\) when rotated 180° about the origin. It is then translated. What are the coordinates of the final image?

- A \( (4, -2) \)
- B \( (4, 2) \)
- C \( (-4, -2) \)
- D \( (-4, 2) \)

8. The face with the arrow overlaps the face with the zig zag.

- A \( (6, 4) \)
- B \( (-1, -1) \)
- C \( (6, 4) \)
- D \( (-10, -2) \)

9. **Challenge**

Explain why each of the following is not a net for the cube shown above.

- A \( \triangle ABC \)
- B \( \triangle DEF \)
- C \( \triangle GHI \)
- D \( \triangle JKL \)

10. Below is a net for a cube. In the space at the right, make a set of isometric drawings that describe the cube completely.

- Sample answer:

**Reading Strategies**

Use Graphic Aids

A composition of transformations is one transformation followed by another. The graphic aid shows four possible compositions. Use it as a guide.

1. Translate quadrilateral \( FGHU \) along vector \( W \).
2. Reflect it along line \( t \).

Reflect then translate

Reflect then translate

Reflect then translate

Reflect then translate

1. Rotate quadrilateral \( ABCD \) 90° about point \( D \).
2. Reflect it across line \( y \).

Draw the result of each composition of transformations.

1. Reflect quadrilateral \( ABCD \) across line \( x \) and then reflect again across line \( y \).