

Translations, Reflections and Rotations Explained

Grade 10 – Geometry math · Worksheet · Standards: G-CO.A.2, G-CO.A.3, G-CO.A.4, G-CO.A.5

Name: _____ Date: _____ Class: _____

These problems cover G-CO.A.2 through G-CO.A.5: describing transformations as functions on the plane, performing translations, reflections and rotations, deciding which are rigid, finding symmetries and following sequences of motions.

Early problems use single rules on points. Later ones combine motions, rotate about other centers and identify a transformation from a picture.

Standards: G-CO.A.2, G-CO.A.3, G-CO.A.4, G-CO.A.5 · **Level:** Grade 10 Geometry

Problem 1 Translate a point (easy)

A translation uses the rule $(x, y) \rightarrow (x - 5, y + 4)$. Find the image of $P(3, -2)$.

Problem 2 Reflect over an axis (easy)

Find the image of $Q(-4, 6)$ after a reflection over (a) the x-axis and (b) the y-axis.

Problem 3 Half-turn about the origin (easy)

Rotate $R(7, -3)$ by 180° about the origin. Find R' .

Problem 4 Quarter-turn rotation (easy)

Rotate $S(4, -1)$ by 90° counterclockwise about the origin. Find S' .

Problem 5 Reflect over $y = x$ (easy)

Reflect $T(-2, 5)$ over the line $y = x$. Find T' .

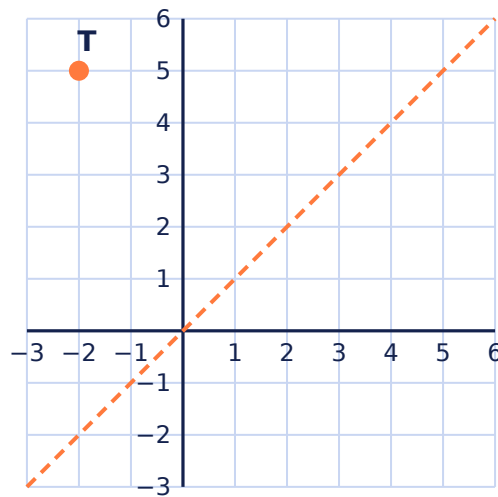


Figure for Problem 5.

Problem 6 Describe a translation (medium)

Triangle ABC has $A(-3, 1)$, $B(0, 1)$ and $C(-2, 4)$. Its image has $A'(2, -2)$. Find the translation vector and the other two image points.

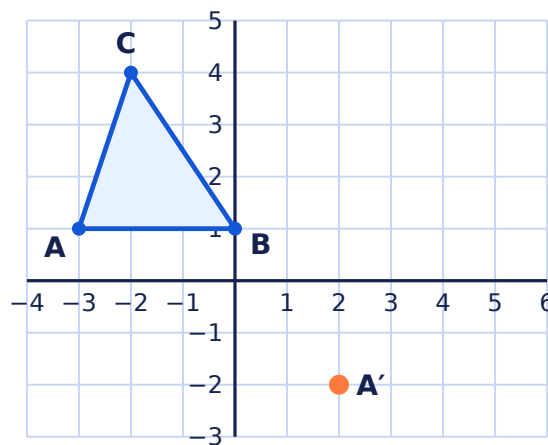


Figure for Problem 6 (image not drawn).

Problem 7 Rigid or not rigid (medium)

Decide whether each rule is a rigid transformation. Test the segment from $(0, 0)$ to $(2, 0)$.

- $(x, y) \rightarrow (x + 4, y - 1)$
- $(x, y) \rightarrow (2x, 2y)$
- $(x, y) \rightarrow (x, -y)$
- $(x, y) \rightarrow (3x, y)$

Problem 8 Reflect a quadrilateral (medium)

Quadrilateral $WXYZ$ has vertices $W(2, 1)$, $X(6, 2)$, $Y(7, 5)$ and $Z(3, 4)$. Find the image after a reflection over the y -axis.

Problem 9 Clockwise rotation (medium)

Triangle DEF has $D(2, 1)$, $E(6, 1)$ and $F(6, 4)$. Rotate it 90° clockwise about the origin and list the image vertices.

Problem 10 Reflect over $y = -x$ (medium)

The rule for a reflection over the line $y = -x$ is $(x, y) \rightarrow (-y, -x)$. Find the images of $P(3, -5)$ and $Q(-2, -6)$.

Problem 11 Symmetries of a rectangle (medium)

A 6 by 4 rectangle sits at the origin with sides parallel to the axes. Name each reflection and each turn about the origin (less than 360°) that carries it onto itself, then compare with a square.

Problem 12 Regular polygon symmetry (medium)

For a regular pentagon, a regular octagon and a regular 12-gon, find the number of lines of symmetry and the smallest positive angle of rotational symmetry.

Problem 13 Order of two motions (medium)

Point $M(-7, 4)$ is translated by $\langle 8, -9 \rangle$ and reflected over the x -axis. Find the final point. Then perform the two steps in the opposite order and compare.

Problem 14 Find the line of reflection (medium)

A reflection maps $A(2, 5)$ to $A'(2, -1)$. Find the line of reflection, then find the image of $B(6, -3)$.

Problem 15 Robot docking route (hard)

A robotics club maps its arena on a grid where one unit is one foot. A robot starts at $(-3, 2)$. It moves by the translation $\langle 7, -4 \rangle$, then reflects over the x -axis to reach its dock. Find the dock location and the straight-line length of the first move to the nearest tenth.

Problem 16 Rotation about another center (hard)

Rotate $P(5, 3)$ by 90° counterclockwise about the center $C(2, 1)$. Separately, rotate the original point P by 180° about C . Find both images.

Problem 17 Reflection then translation (hard)

Triangle ABC has $A(1, 1)$, $B(4, 1)$ and $C(4, 3)$. Reflect it over the y -axis, then translate by $\langle 0, -5 \rangle$. Find A'' , B'' and C'' and verify that $AB = A''B''$.

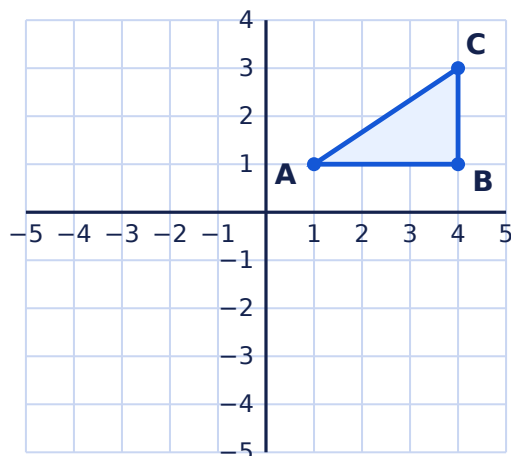


Figure for Problem 17.

Problem 18 Identify the rotation (hard)

Triangle PQR with $P(1, 2)$, $Q(4, 2)$ and $R(4, 4)$ is mapped onto $P'(-2, 1)$, $Q'(-2, 4)$ and $R'(-4, 4)$. Identify the single transformation and write its rule.

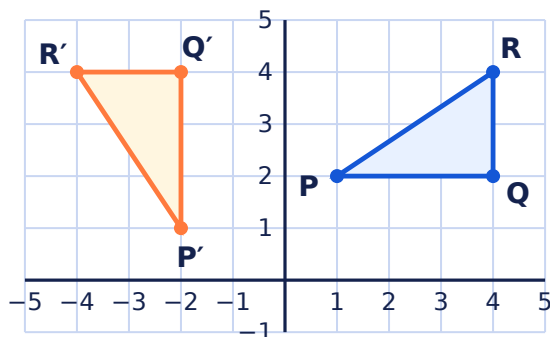


Figure for Problem 18.

Problem 19 Mosaic with four-fold symmetry (hard)

A designer places a tile marker at $(3, 1)$ and turns it by 90° about the origin again and again to build a four-fold mosaic. List the four marker positions. Then name the reflection line that maps $(3, 1)$ onto $(1, 3)$.

Problem 20 Two reflections make a translation (hard)

Reflect $P(0, 2)$ over the line $x = 1$, then reflect the result over the line $x = 4$. Find the final point and the single translation that does the same job. Then show it works for a general point (x, y) .