

GEOMETRY

TRANSFORMATIONS

Complete Unit

Rigid Motions & Dilations

Grades 9 – 10

A comprehensive five-progression unit covering **Translations, Reflections, Rotations, Dilations**, and **Compositions of Transformations**.

Includes: visual guided notes • fully worked examples with coordinate-plane diagrams • 12 practice activity pages (3 levels × 4 types) • 20-problem composition challenge set • congruence & similarity connections • transformation art mini-project with rubric • vocabulary card set (20 cards) • cumulative unit review • comprehensive unit test with fully worked answer key.

UM Printables

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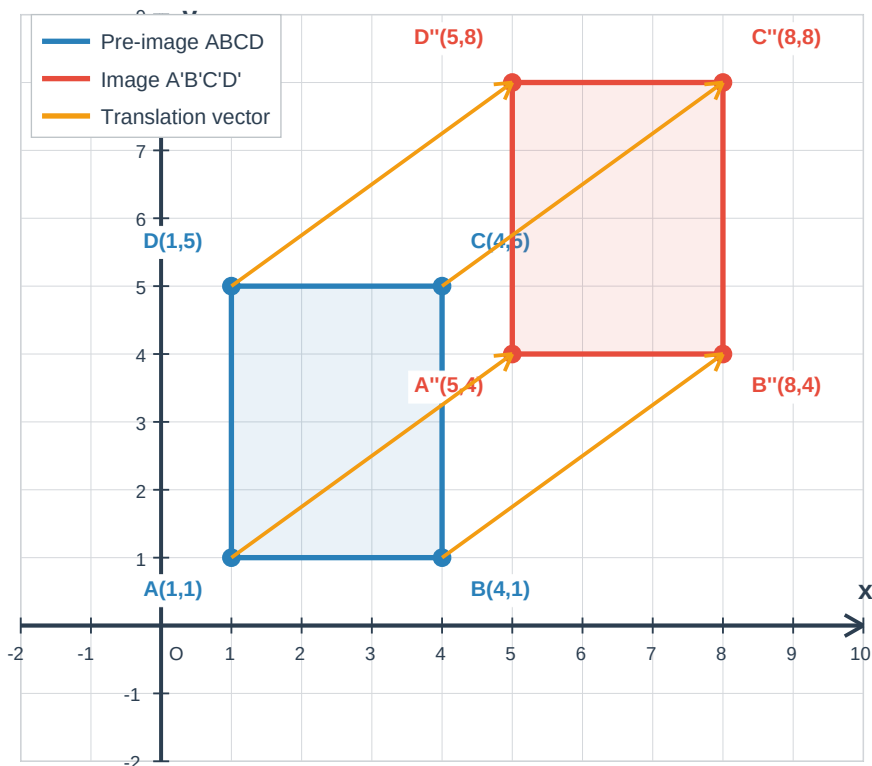
Progression 1

Translations

A **translation** is a transformation that slides every point of a figure the same distance in the same direction. Translations are **rigid motions**: they preserve distances, angle measures, and orientation. The original figure is called the **pre-image**, and the translated figure is called the **image**.

Visualising a Translation

Translation by vector $\langle 4, 3 \rangle$



Vector Notation

A translation can be described by a **vector** written as $\langle a, b \rangle$ or $\begin{pmatrix} a \\ b \end{pmatrix}$. The component a tells us how far to move horizontally (positive = right, negative = left), and b tells us how far to move vertically (positive = up, negative = down).

Translation Coordinate Rule

If a figure is translated by vector $\langle a, b \rangle$,
then every point (x, y) maps to $(x + a, y + b)$.
 $(x, y) \rightarrow (x + a, y + b)$

Worked Example 1 — Translating a Triangle

Problem: Translate $\triangle ABC$ with $A(1, 2)$, $B(4, 2)$, $C(4, 5)$ by the rule $(x, y) \rightarrow (x + 3, y + 2)$. State the coordinates of the image $\triangle A'B'C'$.

Step 1: Identify the translation vector from the rule.

$$(x, y) \rightarrow (x + 3, y + 2) \Rightarrow \text{vector} = \langle 3, 2 \rangle$$

Step 2: Apply the rule to each vertex.

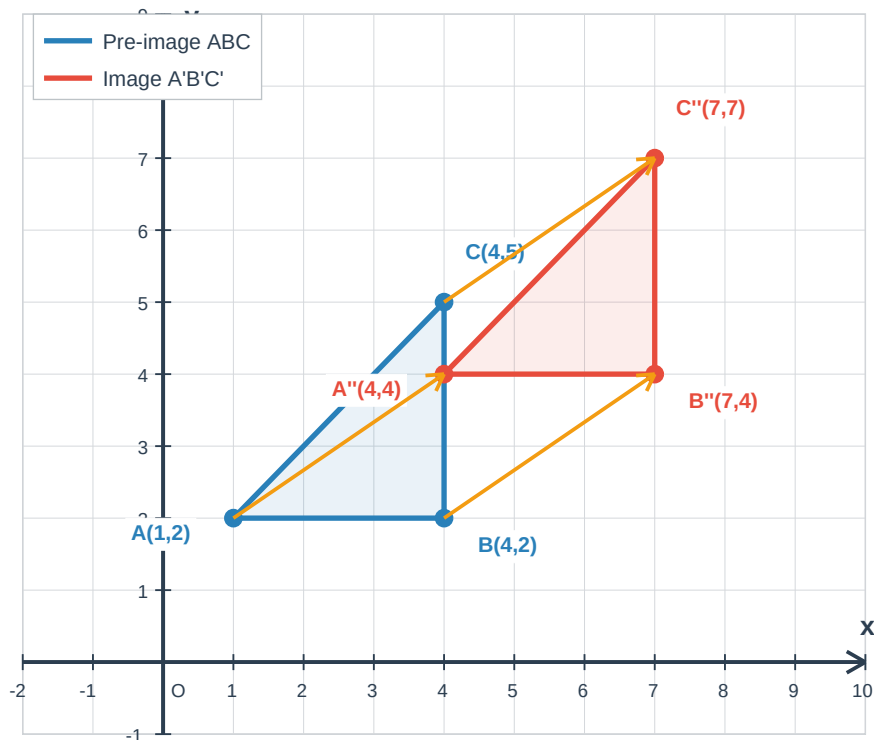
$$A(1, 2) \rightarrow A'(1 + 3, 2 + 2) = A'(4, 4)$$

$$B(4, 2) \rightarrow B'(4 + 3, 2 + 2) = B'(7, 4)$$

$$C(4, 5) \rightarrow C'(4 + 3, 5 + 2) = C'(7, 7)$$

Answer: $A'(4, 4)$, $B'(7, 4)$, $C'(7, 7)$

Example 1: Translation by $\langle 3, 2 \rangle$



Worked Example 2 — Using Vector Notation

Problem: Rectangle DEFG has vertices $D(-2, 1)$, $E(2, 1)$, $F(2, 3)$, $G(-2, 3)$. Translate DEFG by the vector $\langle 4, -3 \rangle$. State the image coordinates and graph the result.

Step 1: The vector $\langle 4, -3 \rangle$ means: move right 4, down 3.

Rule: $(x, y) \rightarrow (x + 4, y - 3)$

Step 2: Apply to each vertex.

$$D(-2, 1) \rightarrow D'(-2 + 4, 1 + (-3)) = D'(2, -2)$$

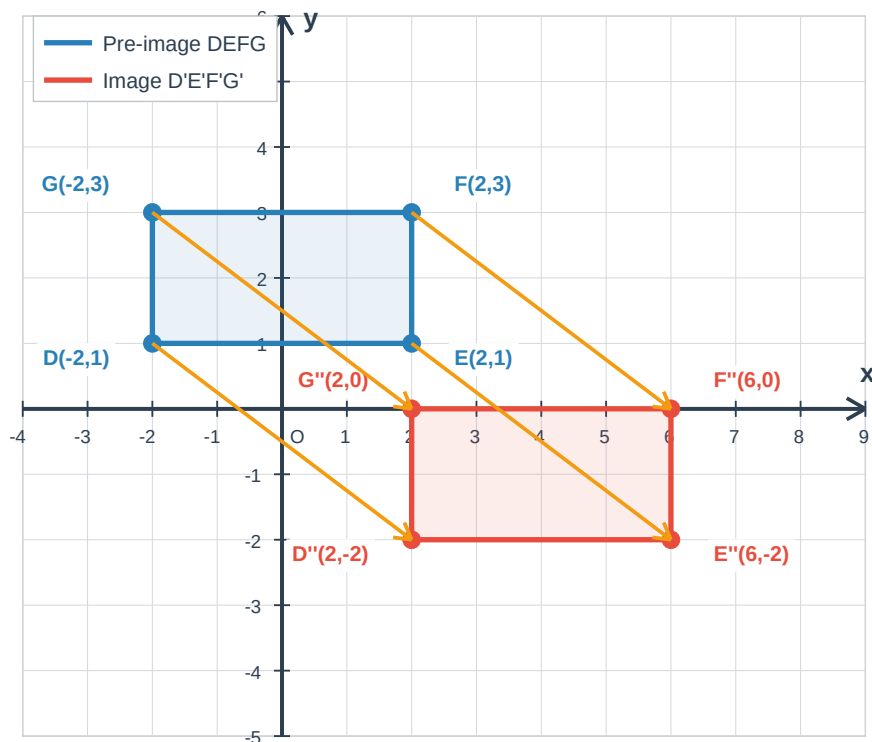
$$E(2, 1) \rightarrow E'(2 + 4, 1 + (-3)) = E'(6, -2)$$

$$F(2, 3) \rightarrow F'(2 + 4, 3 + (-3)) = F'(6, 0)$$

$$G(-2, 3) \rightarrow G'(-2 + 4, 3 + (-3)) = G'(2, 0)$$

Answer: $D'(2, -2)$, $E'(6, -2)$, $F'(6, 0)$, $G'(2, 0)$

Example 2: Translation by $\langle 4, -3 \rangle$



Worked Example 3 — Finding the Translation Vector

Problem: $\triangle PQR$ has vertices $P(0, 0)$, $Q(3, 0)$, $R(3, 4)$. After a translation, the image is $\triangle P'Q'R'$ with $P'(2, 5)$, $Q'(5, 5)$, $R'(5, 9)$. Find the translation vector and write the coordinate rule.

Step 1: Use one pair of corresponding vertices to find the vector.

$$P(0, 0) \rightarrow P'(2, 5)$$

$$a = 2 - 0 = 2, \quad b = 5 - 0 = 5$$

$$\text{Vector} = \langle 2, 5 \rangle$$

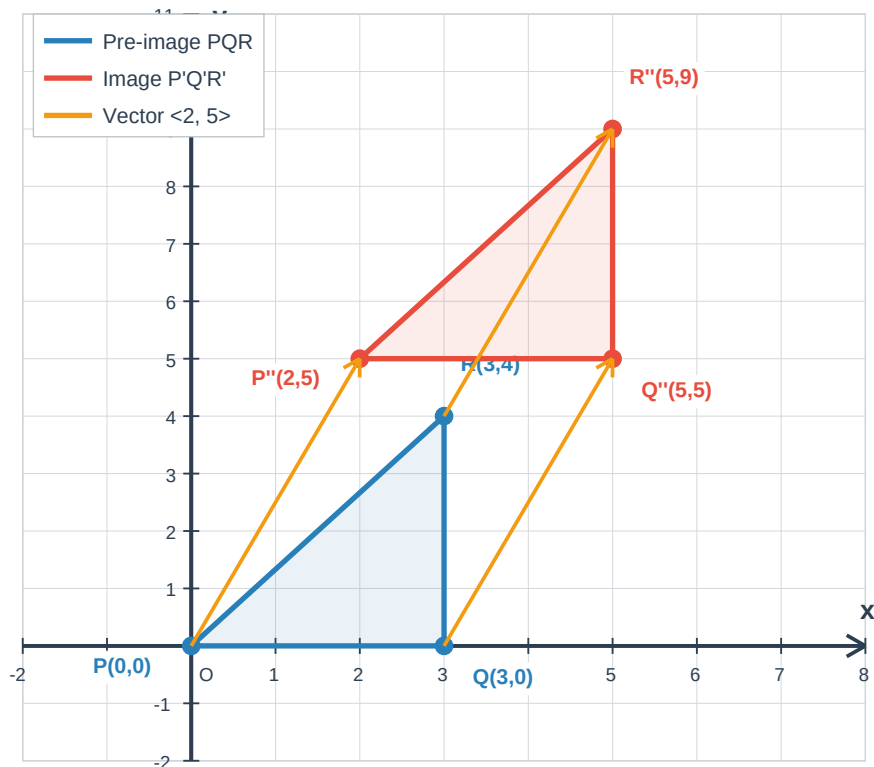
Step 2: Verify with the other vertices.

$$Q(3, 0) \rightarrow (3+2, 0+5) = (5, 5) = Q' \quad \checkmark$$

$$R(3, 4) \rightarrow (3+2, 4+5) = (5, 9) = R' \quad \checkmark$$

Answer: Vector = $\langle 2, 5 \rangle$; Rule: $(x, y) \rightarrow (x + 2, y + 5)$

Example 3: Finding the Translation Vector



Properties of Translations

Property	Result
Distance (lengths)	Preserved ✓
Angle measures	Preserved ✓
Orientation	Preserved ✓

Parallelism	Preserved ✓
Collinearity	Preserved ✓
Size (area, perimeter)	Preserved ✓

Key Note: Because translations preserve all distances and angles, the pre-image and image are **congruent** (identical in shape and size). A translation is therefore a **rigid motion** (isometry). The orientation of the vertices (clockwise vs. counter-clockwise) does NOT change.

Student Guided Notes: Translations

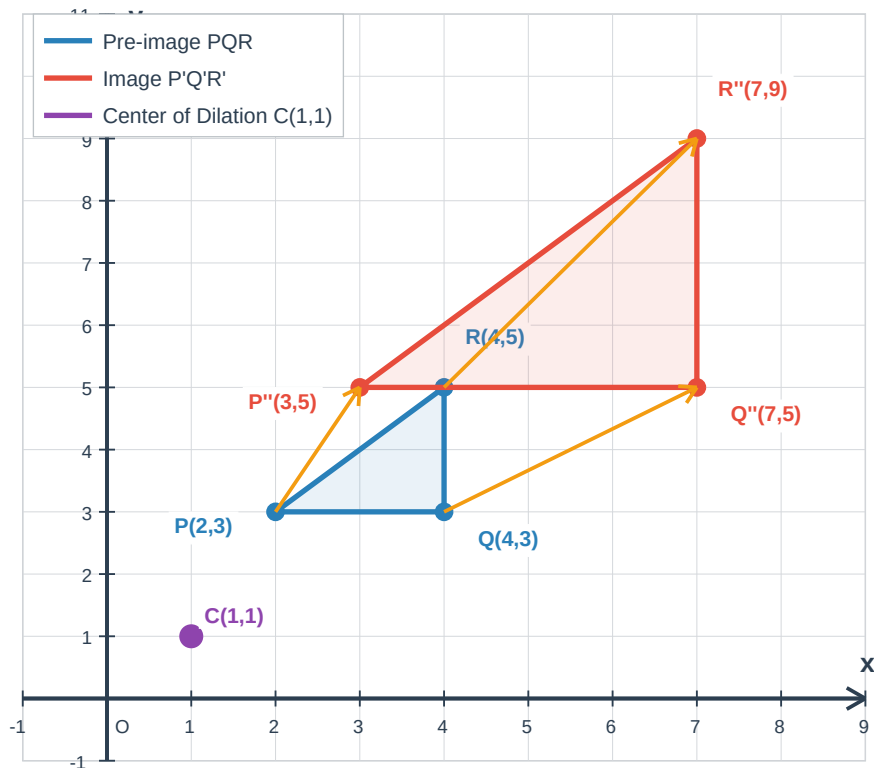
Concept	Your Notes
Definition of Translation	
Translation Vector $\langle a, b \rangle$	$a =$, $b =$
Coordinate Rule	$(x, y) \rightarrow (,)$
Effect on Side Lengths	
Effect on Angle Measures	
Effect on Orientation	
Congruence Relationship	

Practice: Translations

Directions: Apply the given translation rule to each figure. State the coordinates of the image vertices. Graph the pre-image and image on the provided coordinate planes.

1. $\triangle JKL$ has $J(-3, 1)$, $K(0, 1)$, $L(0, 4)$. Translate by the rule $(x, y) \rightarrow (x + 5, y - 2)$.

Example 12: Dilation $k=2$ about $C(1, 1)$



Properties of Dilations

Property	Result
Distance (lengths)	NOT Preserved (multiplied by k)
Angle measures	Preserved ✓
Orientation	Preserved ✓ (if $k > 0$)
Parallelism	Preserved ✓
Collinearity	Preserved ✓
Perimeter	Multiplied by k
Area	Multiplied by k^2

Student Guided Notes: Dilations

Concept	Your Notes
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Transformations & Proof Logic

To prove two figures are congruent using transformations, explicitly state the sequence of rigid motions mapping one to the other, and verify all corresponding vertices align.

To prove two figures are similar using transformations, state the dilation that makes them congruent, then state the rigid motions that align them, or vice versa.

Student Guided Notes: Compositions

Composition Type	Equivalent Single Transformation
Glide Reflection	
Reflection over 2 Parallel Lines	
Reflection over 2 Intersecting Lines	
Definition of Congruent Figures	
Definition of Similar Figures	

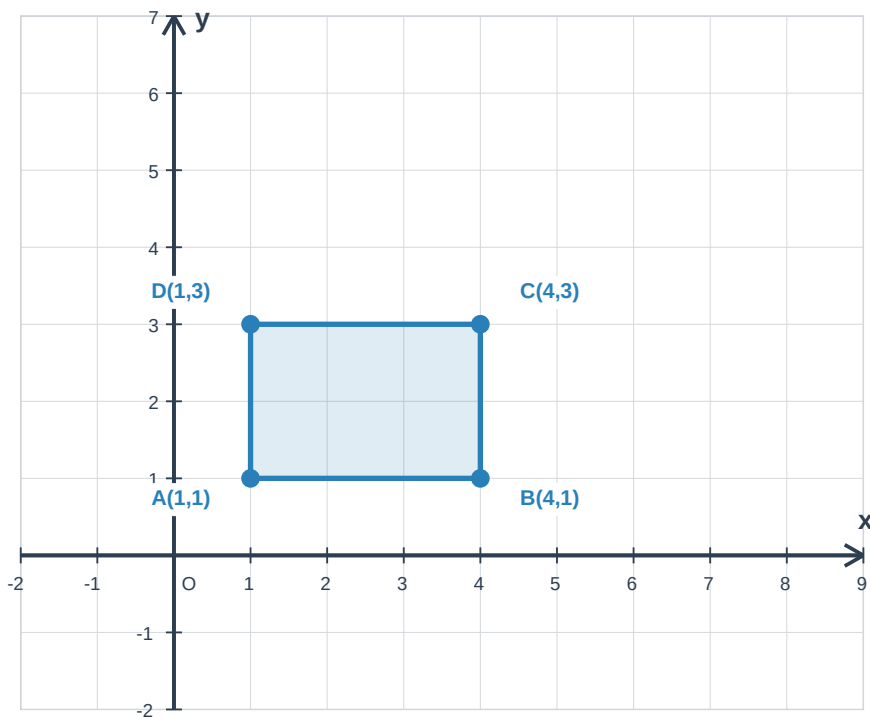
Practice Activity Pages

3 Difficulty Levels × 4 Transformation Types

Translations — Level 1

Directions: Translate the figure by the rule $(x, y) \rightarrow (x + 3, y + 2)$. State the image coordinates.

Translations - Level 1



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