

GCSE MATHS

Transformations and enlargement

Long workbook

Questions on GCSE Maths topics, including challenges beyond typical exam questions.

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Topic recap

Reflections

The mirror line is the perpendicular bisector of the segment joining a point to its image. Points on the mirror line stay fixed.

Rotations and translations

Describe a rotation by its centre, angle and direction. A translation moves every point by the same vector.

Enlargement

From the centre, multiply the vector to each point by the scale factor. A fractional factor between zero and one makes the image smaller. A negative factor puts the image on the opposite side of the centre.

Combinations

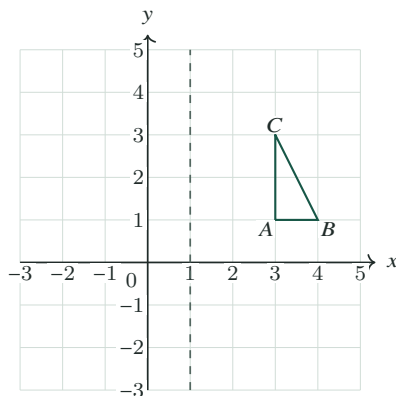
Apply transformations in the stated order. Reflections, rotations and translations preserve lengths and angles. For enlargement, ignore the sign of the scale factor when comparing lengths; square the scale factor when comparing areas.

1. Reflections

Example Problem 1

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Reflect triangle ABC in the line $x = 1$.



The idea

1. Each vertex is reflected to the same distance on the other side of the mirror line.
2. Repeat for every vertex, then join the image vertices.

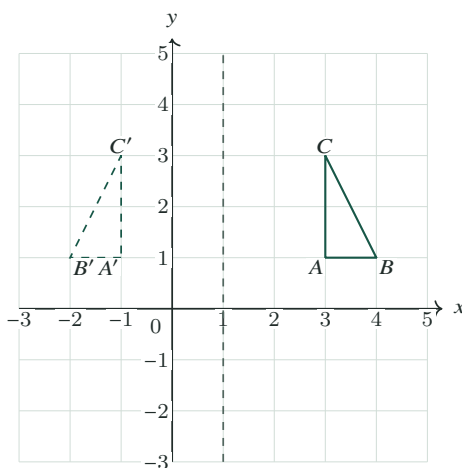
Worked Solution

$$A' = (-1, 1), B' = (-2, 1), C' = (-1, 3)$$

Each vertex is reflected to the same distance on the other side of the mirror line.

Join the image vertices

Draw triangle $A'B'C'$.



1 Reflections

Q1 Write down the coordinates of the point $A(3, 2)$ when reflected in the y -axis.

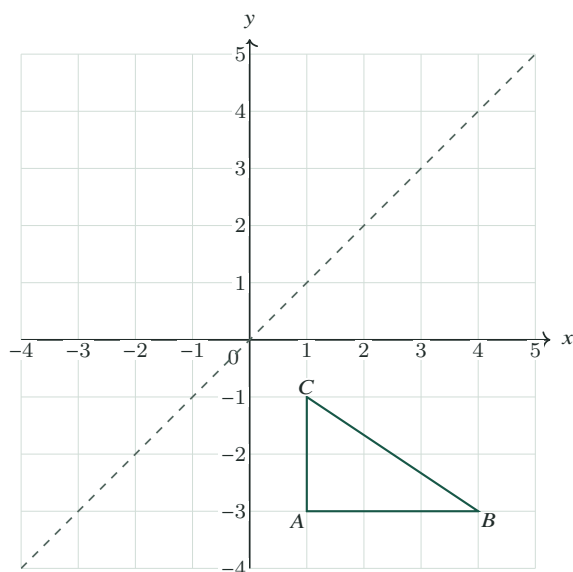
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Q2 Write down the coordinates of the point $A(-4, 1)$ when reflected in the x -axis.

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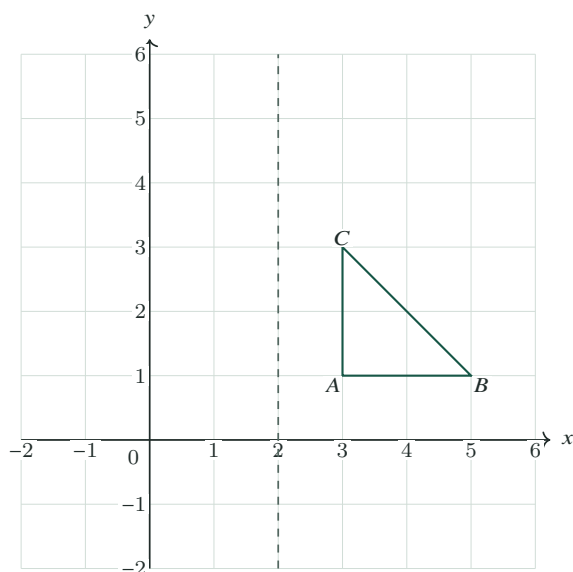
Q3 On the grid, reflect triangle ABC in the line $y = x$. Label the image A' , B' , C' .

**



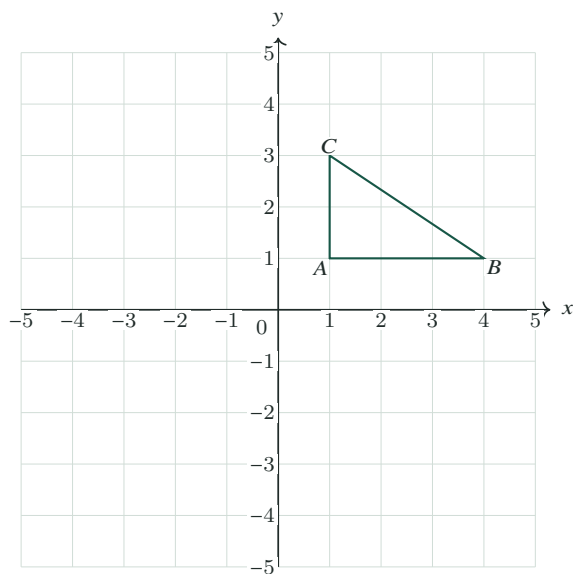
Q4 On the grid, reflect triangle ABC in the line $x = 2$. Label the image A' , B' , C' .

**

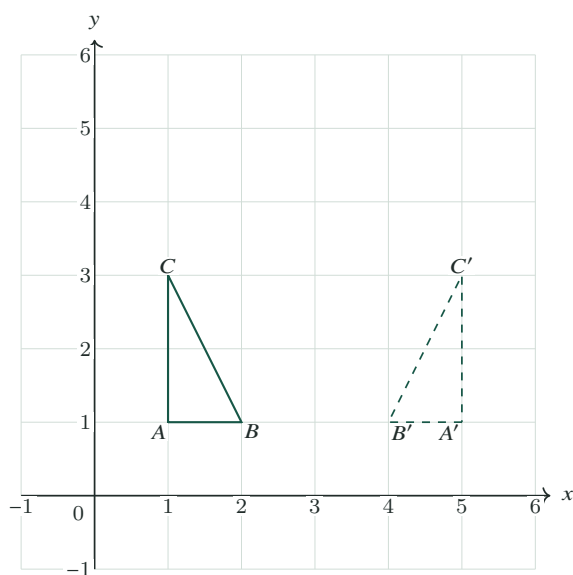


Q5 On the grid, reflect triangle ABC in the y -axis. Label the image A' , B' , C' .

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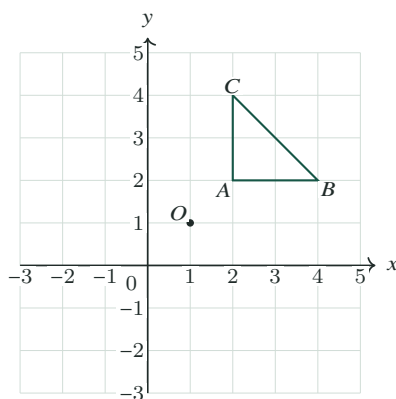
Q6 Triangle $A'B'C'$ is the reflection of triangle ABC . Draw and give the equation of the mirror line.



2. Rotations and translations

Example Problem 2

Rotate triangle ABC 90° clockwise about $O = (1, 1)$.



The idea

1. Turn each vertex a quarter-turn clockwise about O , keeping its distance from O .
2. Repeat for every vertex, then join the image vertices.

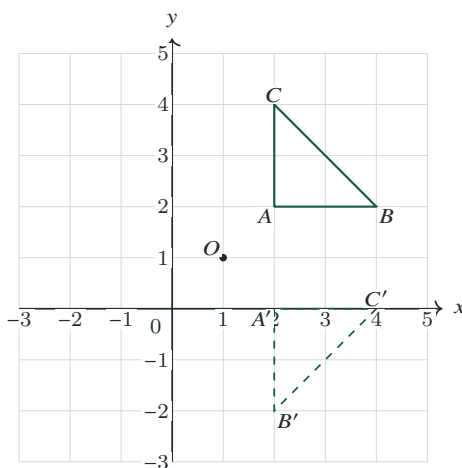
Worked Solution

$$A' = (2, 0), B' = (2, -2), C' = (4, 0)$$

Turn each vertex a quarter-turn clockwise about O , keeping its distance from O .

Join the image vertices

Draw triangle $A'B'C'$.

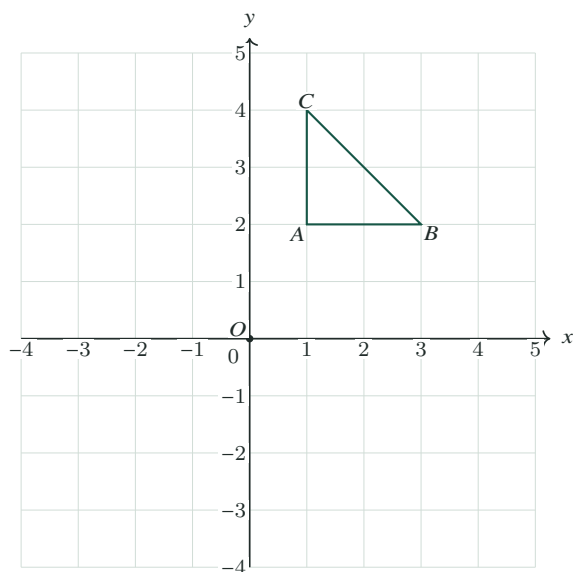


2 Rotations and translations

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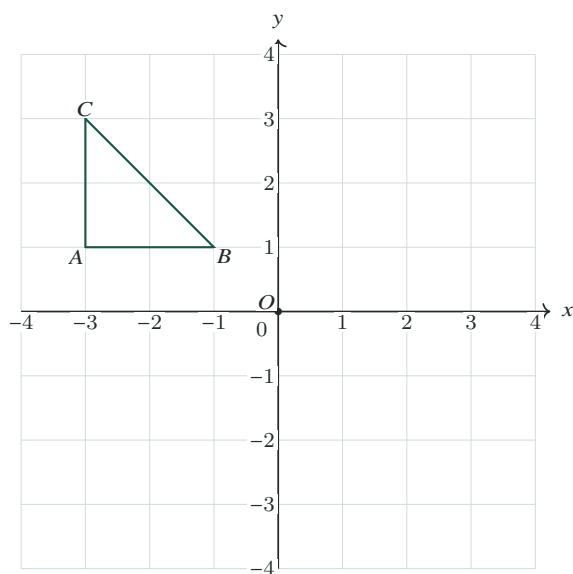
Q7 On the grid, rotate triangle ABC 90° clockwise about the origin. Label the image A' , B' , C' .

**

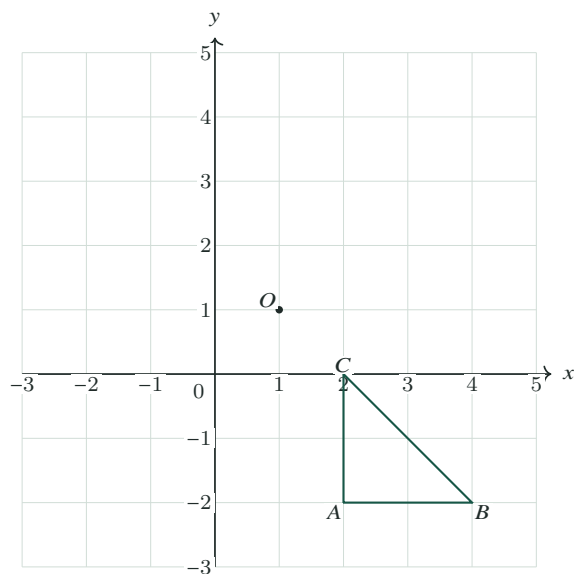


Q8 On the grid, rotate triangle ABC 90° anticlockwise about the origin. Label the image A' , B' , C' .

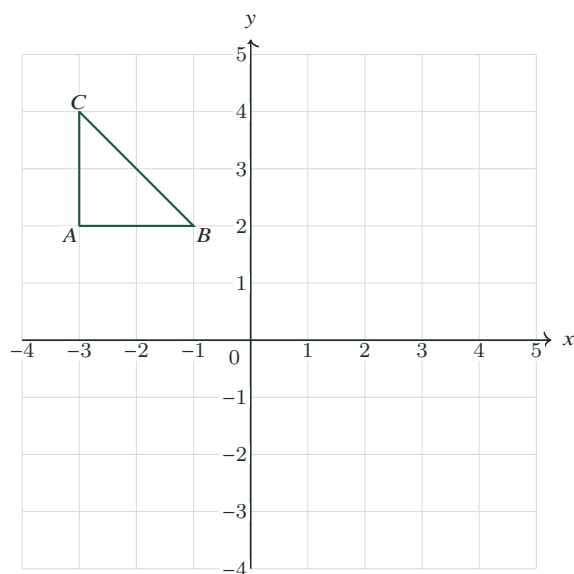
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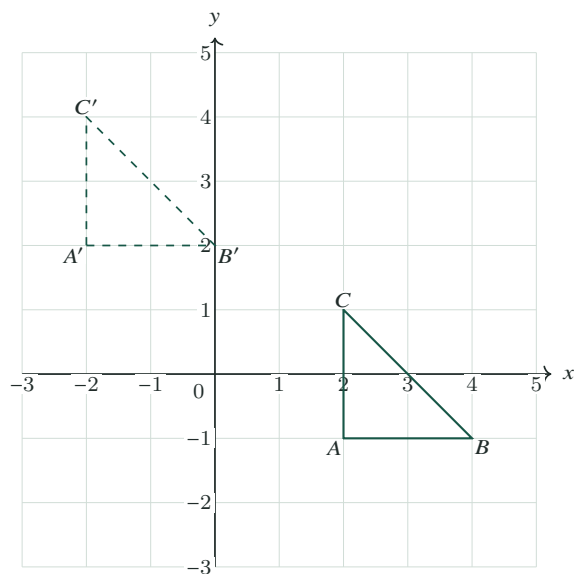
Q9 On the grid, rotate triangle ABC 180° about $O = (1, 1)$. Label the image A' , B' , C' . **



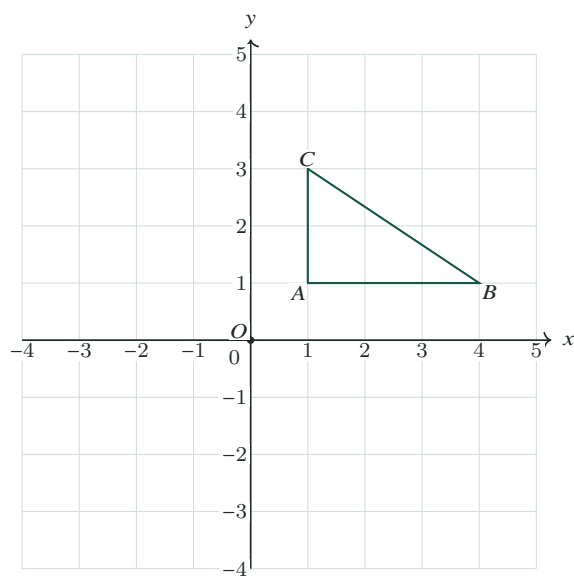
Q10 On the grid, translate triangle ABC by the vector $\begin{pmatrix} 4 \\ -3 \end{pmatrix}$. Label the image A' , B' , C' . *



Q11 Triangle ABC is translated to triangle $A'B'C'$. Write the translation vector. **



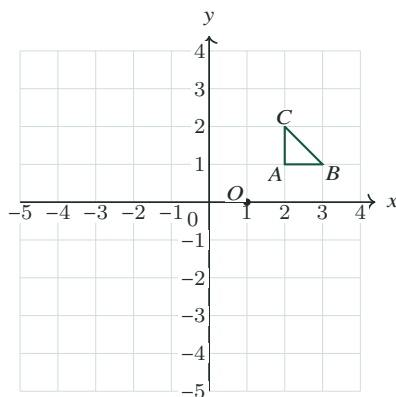
Q12 On the grid, rotate triangle ABC 90° anticlockwise about the origin. Label the image A' , B' , C' . **



3. Enlargement

Example Problem 3

Enlarge triangle ABC by scale factor -2 , centre $O = (1, 0)$.



The idea

1. Draw rays from each vertex through O . Double the distance from O and place the image on the opposite side.
2. Repeat for every vertex, then join the image vertices.

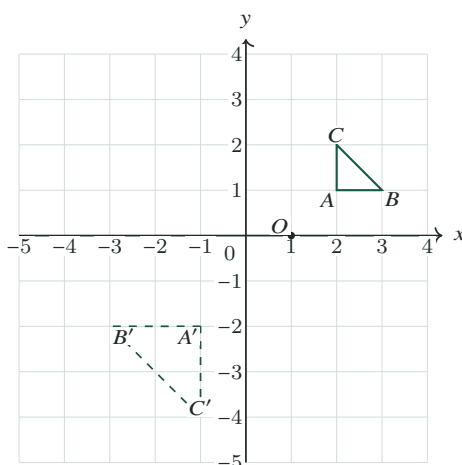
Worked Solution

$$A' = (-1, -2), B' = (-3, -2), C' = (-1, -4)$$

Draw rays from each vertex through O . Double the distance from O and place the image on the opposite side.

Join the image vertices

Draw triangle $A'B'C'$.

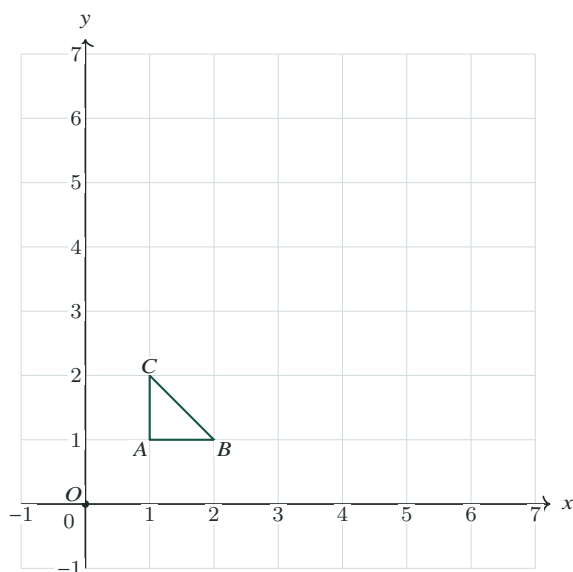


3 Enlargement

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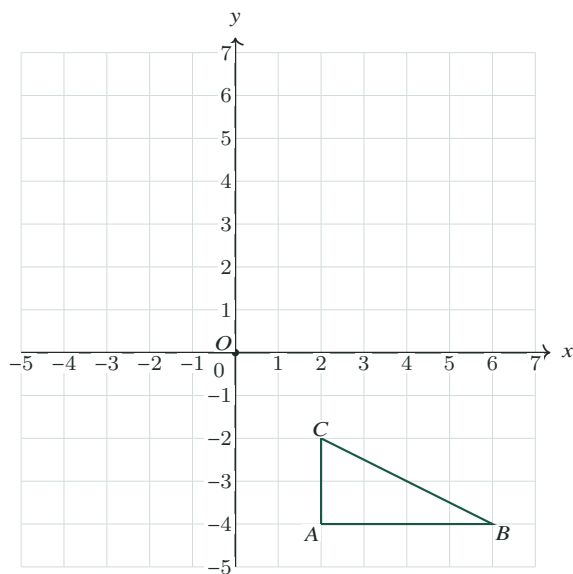
Q13 On the grid, enlarge triangle ABC by scale factor 3, centre the origin. Label the image A' , B' , C' .

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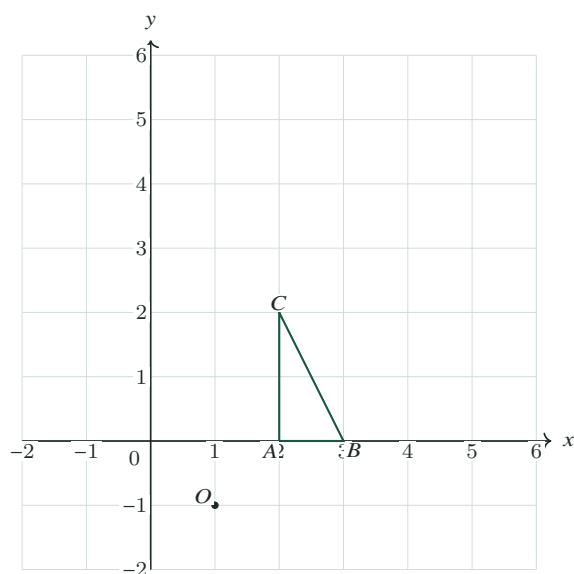


Q14 On the grid, enlarge triangle ABC by scale factor $\frac{1}{2}$, centre the origin. Label the image A' , B' , C' .

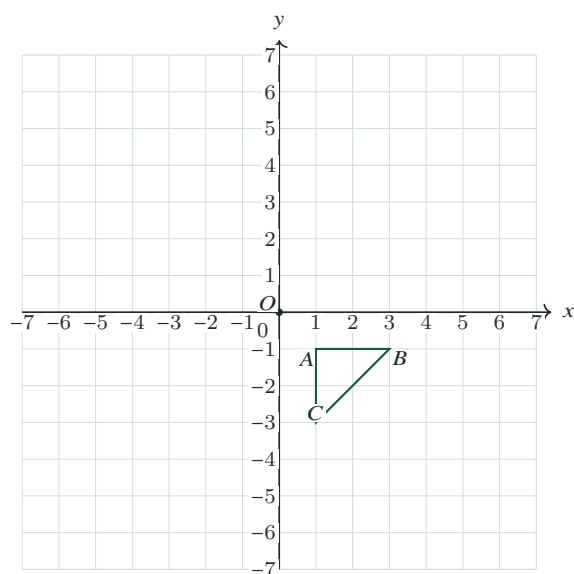
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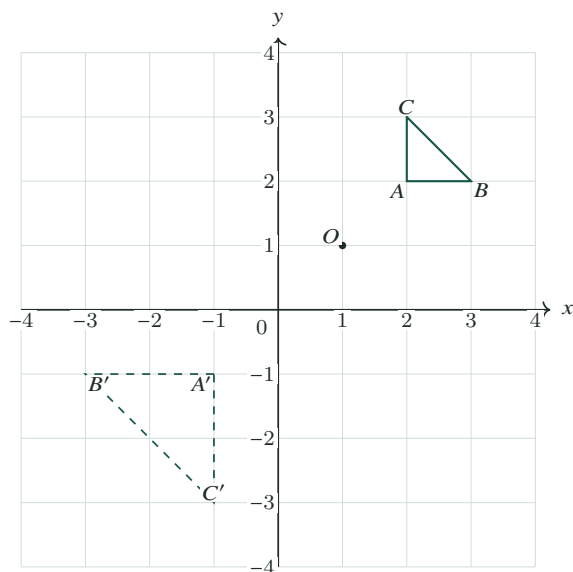
- Q15** On the grid, enlarge triangle ABC by scale factor 2, centre $O = (1, -1)$. Label the image A' , B' , C' . ***



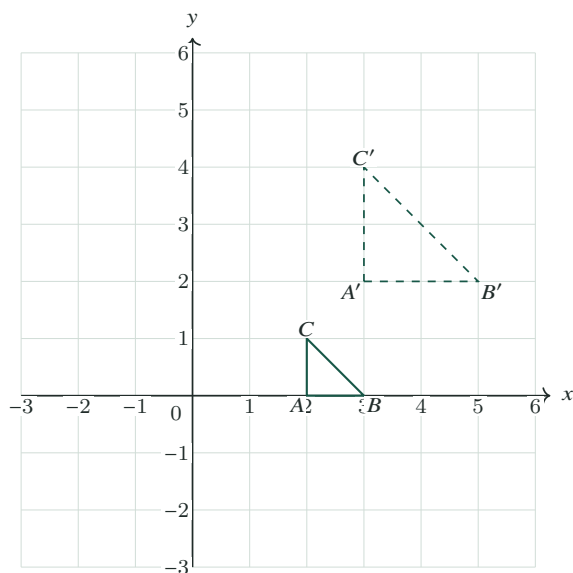
- Q16** On the grid, enlarge triangle ABC by scale factor -2 , centre the origin. Label the image A' , B' , C' . ***



Q17 Triangle ABC is enlarged to triangle $A'B'C'$, centre $O = (1, 1)$. Find the scale factor.



Q18 Triangle ABC is enlarged to triangle $A'B'C'$ with scale factor 2. Find and mark the centre of enlargement.



4. Combined transformations

Example Problem 4

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Reflect a point in $x = 0$, then in $x = 3$. Describe a single equivalent transformation.

The idea

1. Follow a general point so the result applies to the whole shape.

Worked Solution

$$(x, y) \mapsto (-x, y)$$

First reflection.

$$(-x, y) \mapsto (6 + x, y)$$

The second mirror is $x = 3$.

$$\text{Translation by } \begin{pmatrix} 6 \\ 0 \end{pmatrix}$$

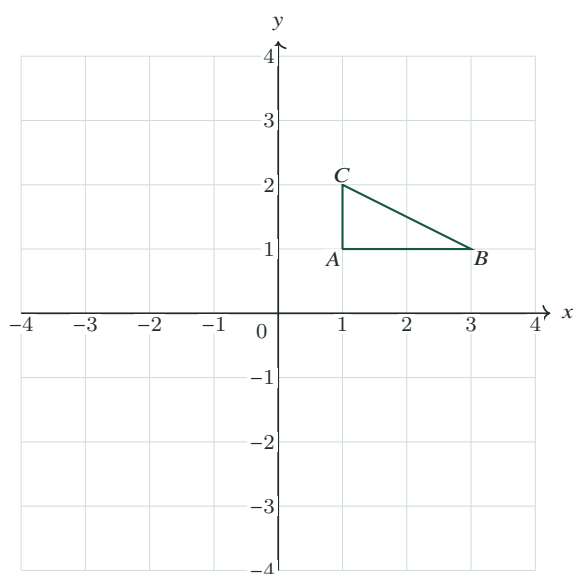
Every point moves six units right.

4 Combined transformations

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- Q19** On the grid, reflect triangle ABC in the x -axis, then reflect the image in the y -axis. Label the first image A', B', C' and the final image A'', B'', C'' .

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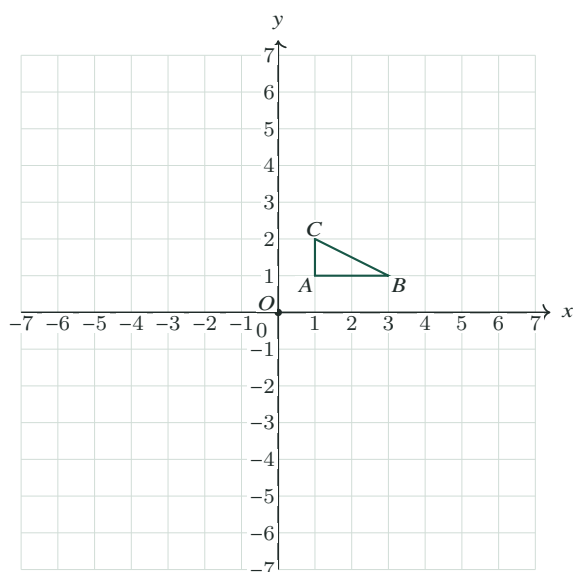


- Q20** Describe a single transformation equivalent to reflection in the x -axis followed by reflection in the y -axis.

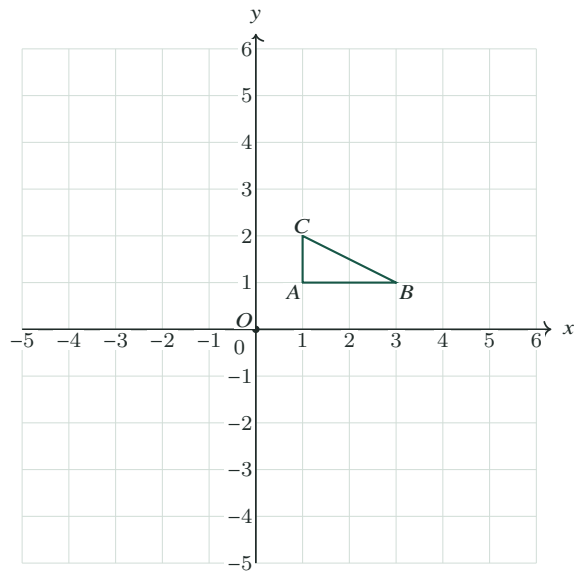
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- Q21** On the grid, translate triangle ABC by the vector $\begin{pmatrix} 3 \\ -1 \end{pmatrix}$, then rotate the image 90° clockwise about the origin. Label the first image A', B', C' and the final image A'', B'', C'' .

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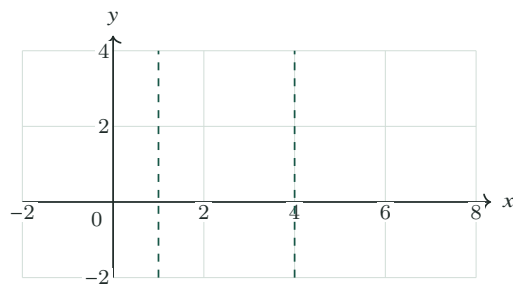


- Q22** On the grid, rotate triangle ABC 90° clockwise about the origin, then translate the image by the vector $\begin{pmatrix} 3 \\ -1 \end{pmatrix}$. Label the first image A', B', C' and the final image A'', B'', C'' . ***



- Q23** A shape is enlarged by scale factor -3 , then translated. Its original area is 7 square units. Find its final area. ***

- Q24** A shape is reflected in $x = 1$, then in $x = 4$. Describe the single equivalent transformation. ****



Solving principles

1. Track a labelled point

Record its coordinates after each operation.

2. Find the centre first

A rotation or enlargement depends on its centre.

3. Check every vertex

A proposed transformation must work for the whole shape.

4. Check the scale

Distances from the centre should have the correct ratio and direction.