

Enlargements with Negative Scale Factors

Solutions

For AQA GCSE Mathematics (8300) • Higher tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (1 mark)

A shape is enlarged by scale factor -3

Tick the statement that is true.

The size of the scale factor is 3, so the image is 3 times as big.

The minus sign means the image is on the other side of the centre, upside down.

Answer: The image is upside down and 3 times as big

Tip: A negative scale factor does not make the shape smaller. It turns it upside down.

2 (2 marks)

The point $(4, 3)$ is enlarged by scale factor -2 with centre $(1, 1)$

Work out the coordinates of the image.

Find the vector from the centre to the point:

From $(1, 1)$ to $(4, 3)$ is $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$

Multiply by the scale factor: $-2 \times \begin{pmatrix} 3 \\ 2 \end{pmatrix} = \begin{pmatrix} -6 \\ -4 \end{pmatrix}$

Add this to the centre: $(1 - 6, 1 - 4) = (-5, -3)$

Answer: $(-5, -3)$

Tip: Always measure from the centre, $(1, 1)$, not from the origin.

Marks: 1 mark for the vector $\begin{pmatrix} -6 \\ -4 \end{pmatrix}$ (or a correct method). 1 mark for $(-5, -3)$.

3 (2 marks)

Triangle T has area 5 cm^2

T is enlarged by scale factor -3

Work out the area of the image.

Lengths are multiplied by 3 (the minus sign only turns the shape).

Area scale factor $= (-3)^2 = 9$

Area of image $= 5 \times 9 = 45$

Answer: 45 cm^2

Tip: An area can't be negative. Square the scale factor: $(-3)^2 = 9$, not -9 .

Marks: 1 mark for $(-3)^2$ or 9. 1 mark for 45.

4 (2 marks)

Shape A is rotated 180° about the point $(2, 1)$

Describe fully a **different** single transformation that also maps shape A onto its image.

A rotation of 180° turns the shape upside down but keeps its size.

An enlargement with scale factor -1 does the same thing.

It must use the same centre, (2, 1).

Answer: Enlargement, scale factor -1 , centre (2, 1)

Marks: 2 marks for all three details. 1 mark for an enlargement with scale factor -1 , or with centre (2, 1).

5 (2 marks)

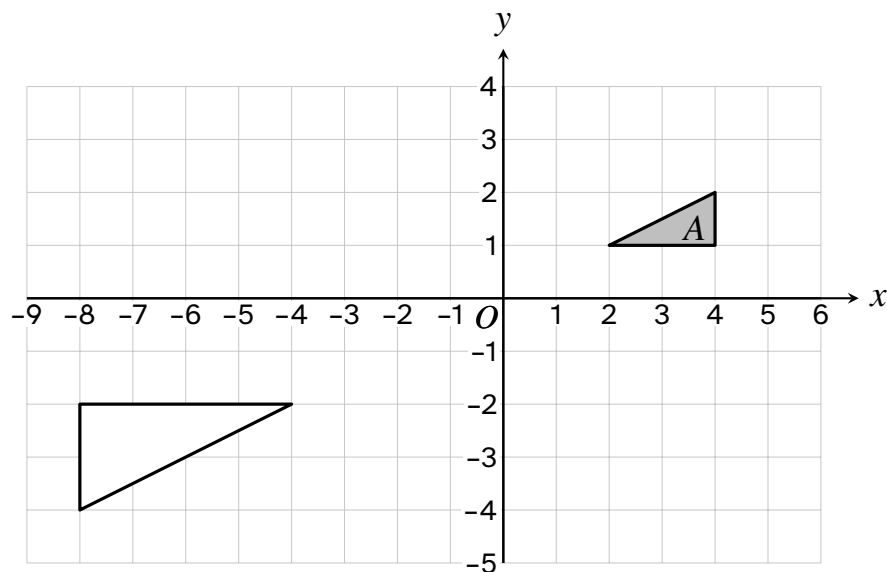
Enlarge triangle *A* by scale factor -2 , centre (0, 0)

With centre (0, 0), multiply each coordinate by -2 .

$$(2, 1) \rightarrow (-4, -2)$$

$$(4, 1) \rightarrow (-8, -2)$$

$$(4, 2) \rightarrow (-8, -4)$$



Answer: $(-4, -2)$, $(-8, -2)$, $(-8, -4)$

Tip: Check your image is upside down. If it is the same way up, you have used $+2$.

Marks: 2 marks for the correct triangle. 1 mark for the correct size and orientation in the wrong position.

6 (2 marks)

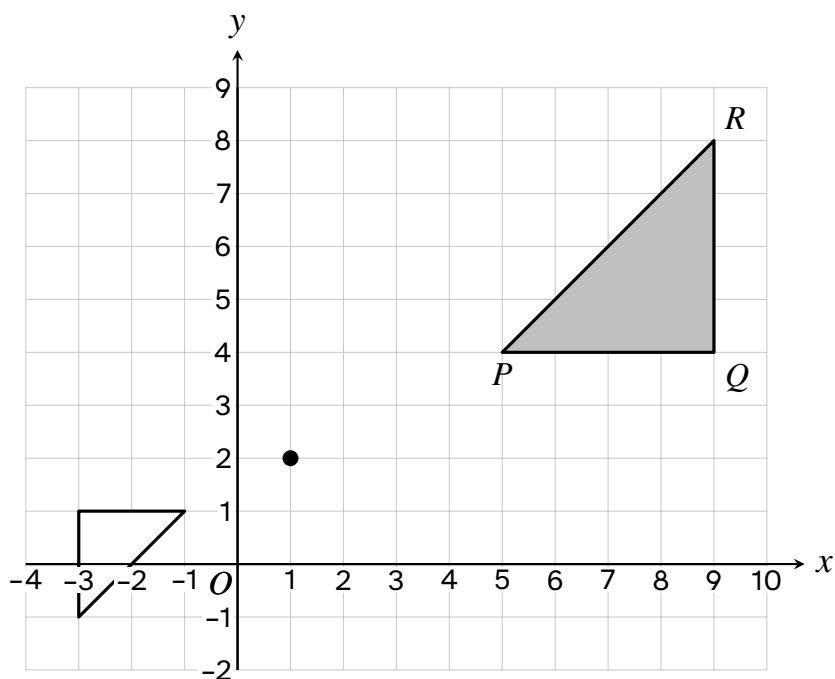
Enlarge triangle PQR by scale factor $-\frac{1}{2}$ with centre $(1, 2)$

Find the vector from the centre $(1, 2)$ to each vertex, and multiply by $-\frac{1}{2}$.

$$P: \begin{pmatrix} 4 \\ 2 \end{pmatrix} \rightarrow \begin{pmatrix} -2 \\ -1 \end{pmatrix}, \text{ so } P \text{ goes to } (-1, 1)$$

$$Q: \begin{pmatrix} 8 \\ 2 \end{pmatrix} \rightarrow \begin{pmatrix} -4 \\ -1 \end{pmatrix}, \text{ so } Q \text{ goes to } (-3, 1)$$

$$R: \begin{pmatrix} 8 \\ 6 \end{pmatrix} \rightarrow \begin{pmatrix} -4 \\ -3 \end{pmatrix}, \text{ so } R \text{ goes to } (-3, -1)$$



Answer: $(-1, 1), (-3, 1), (-3, -1)$

Tip: Measure from the centre $(1, 2)$, not from the origin. The image is half as far from the centre, on the other side.

Marks: 2 marks for the correct triangle. 1 mark for the correct size and orientation in the wrong position, or for using scale factor $\frac{1}{2}$.

7 (5 marks)

Triangle ABC and the point $(1,1)$ are shown on the grid.

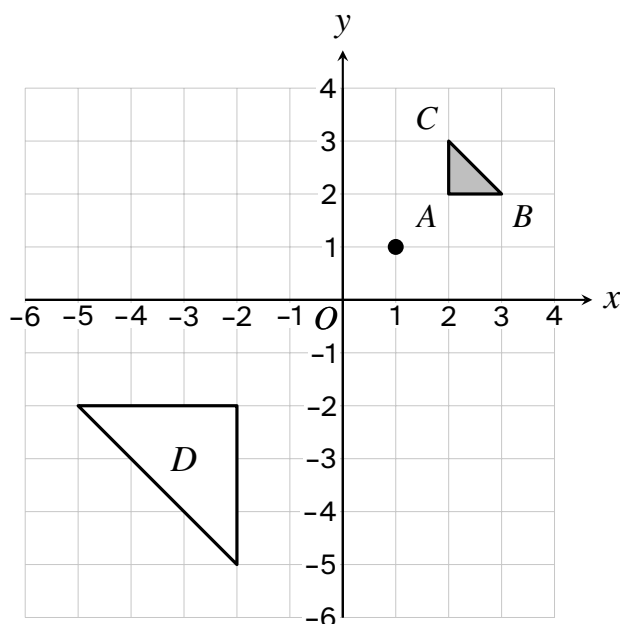
- (a) Enlarge triangle ABC by scale factor -3 , centre $(1,1)$
Label the image D .

Find the vector from the centre $(1,1)$ to each vertex, and multiply by -3 .

$$A: \begin{pmatrix} 1 \\ 1 \end{pmatrix} \rightarrow \begin{pmatrix} -3 \\ -3 \end{pmatrix}, \text{ so } A \text{ goes to } (-2, -2)$$

$$B: \begin{pmatrix} 2 \\ 1 \end{pmatrix} \rightarrow \begin{pmatrix} -6 \\ -3 \end{pmatrix}, \text{ so } B \text{ goes to } (-5, -2)$$

$$C: \begin{pmatrix} 1 \\ 2 \end{pmatrix} \rightarrow \begin{pmatrix} -3 \\ -6 \end{pmatrix}, \text{ so } C \text{ goes to } (-2, -5)$$



Answer: $(-2, -2), (-5, -2), (-2, -5)$

Marks: 2 marks for the correct triangle. 1 mark for the correct size and orientation in the wrong position.

- (b) Triangle D is rotated 180° about $(1,1)$ to give triangle E .
Describe fully the single transformation that maps triangle ABC onto triangle E .

The enlargement with scale factor -3 makes the triangle 3 times as big and turns it through 180° about $(1,1)$.

Rotating D through 180° about the same point turns it back the right way up.

So E is 3 times as big as ABC , the same way up, and on the same side of $(1, 1)$ as ABC .

For example, $A(2, 2)$ goes to $(1 + 3 \times 1, 1 + 3 \times 1) = (4, 4)$.

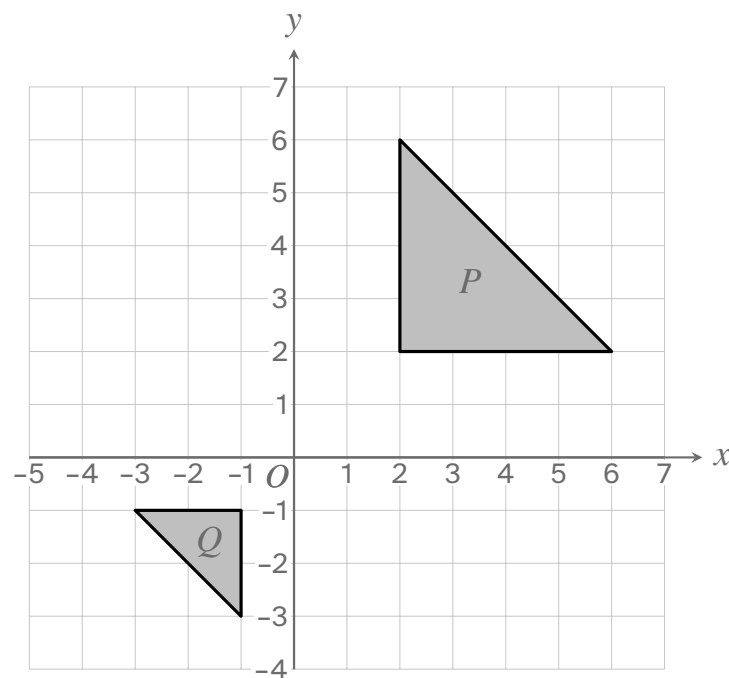
Answer: Enlargement, scale factor 3, centre $(1, 1)$

Tip: The rotation cancels the minus sign, so the scale factor is $+3$. Keep the same centre, $(1, 1)$.

Marks: 1 mark for “enlargement”. 1 mark for scale factor 3. 1 mark for the centre $(1, 1)$.

8 (3 marks)

Triangles P and Q are drawn on the grid.



Describe fully the single transformation that maps triangle P onto triangle Q .

Q is upside down and on the other side of the origin, so the scale factor is negative.

The lengths of Q are half the lengths of P (e.g. 2 squares instead of 4).

So the scale factor is $-\frac{1}{2}$.

Join matching vertices of P and Q . The lines cross at $(0, 0)$, so that is the centre.

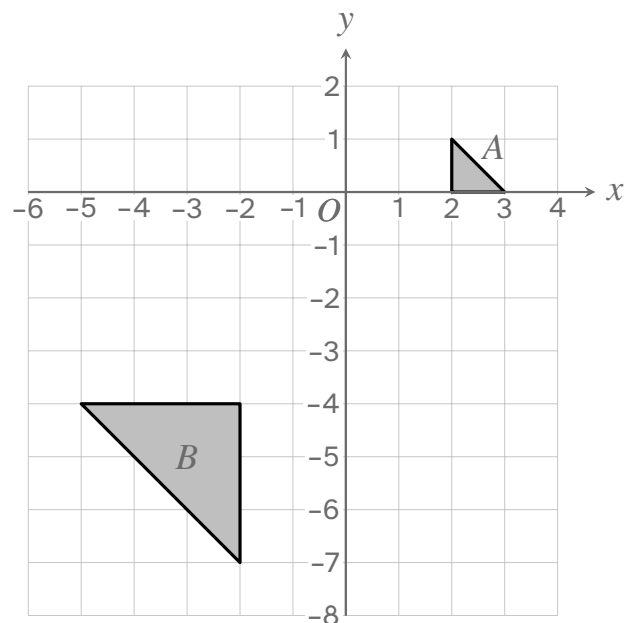
Answer: Enlargement, scale factor $-\frac{1}{2}$, centre $(0, 0)$

Tip: Use the word “enlargement”, even when the image is smaller. Words like “shrink” or “reduction” don’t get the mark.

Marks: 1 mark for “enlargement”. 1 mark for scale factor $-\frac{1}{2}$. 1 mark for the centre $(0, 0)$.

9 (3 marks)

Shapes A and B are drawn on the grid.



Describe fully the single transformation that maps shape A onto shape B .

Join matching vertices of A and B with straight lines.

The lines cross at $(1, -1)$. This is the centre.

B is 3 times as big as A (e.g. a side of 1 becomes 3).

B is upside down, on the other side of the centre.

So the scale factor is -3 .

Answer: Enlargement, scale factor -3 , centre $(1, -1)$

Tip: Give one transformation only. “Rotation and enlargement” gets no marks, because the question asks for a single transformation.

Marks: 1 mark for “enlargement”. 1 mark for -3 . 1 mark for the centre $(1, -1)$.
