

Enlargements with Negative Scale Factors

Solutions

For Pearson Edexcel GCSE Mathematics (1MA1) • 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 (2 marks)

Triangle X has area 6 cm^2 . It is enlarged by scale factor $-\frac{1}{2}$.
Find the area of the image.

Lengths are multiplied by $\frac{1}{2}$ (the minus sign only turns the shape).

$$\text{Area scale factor} = \left(-\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$\text{Area of image} = 6 \times \frac{1}{4} = 1.5$$

Answer: 1.5 cm^2

Tip: Square the scale factor for areas. Multiplying by $\frac{1}{2}$ gives 3, which is wrong.

Marks: 1 mark for $\left(-\frac{1}{2}\right)^2$ or $\frac{1}{4}$. 1 mark for 1.5.

2 (2 marks)

Shape Y has area 2 cm^2 .
 Y is enlarged by scale factor k to give a shape with area 50 cm^2 .
Write down the two possible values of k .

$$\text{Area scale factor} = 50 \div 2 = 25$$

$$\text{Area scale factor} = k^2, \text{ so } k^2 = 25$$

$$k = 5 \text{ or } k = -5$$

Both work, because $(-5)^2 = 25$ as well.

Answer: 5 and -5

Marks: 1 mark for $k^2 = 25$. 1 mark for both 5 and -5 .

3 (2 marks)

The point $(5, 2)$ is enlarged by scale factor -3 with centre of enlargement $(2, 1)$
Find the coordinates of the image.

Find the vector from the centre to the point:

From $(2, 1)$ to $(5, 2)$ is $\begin{pmatrix} 3 \\ 1 \end{pmatrix}$

Multiply by -3 : $\begin{pmatrix} -9 \\ -3 \end{pmatrix}$

Add this to the centre: $(2 - 9, 1 - 3) = (-7, -2)$

Answer: $(-7, -2)$

Tip: Add the new vector to the centre, not to the origin or to the original point.

Marks: 1 mark for $\begin{pmatrix} -9 \\ -3 \end{pmatrix}$ (or a correct method). 1 mark for $(-7, -2)$.

4 (2 marks)

Triangle A is rotated 180° about $(-1, -2)$
Describe fully a different single transformation that has the same effect.

A half turn keeps the size and turns the shape upside down.

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

It uses the same centre, $(-1, -2)$.

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

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

5 (4 marks)

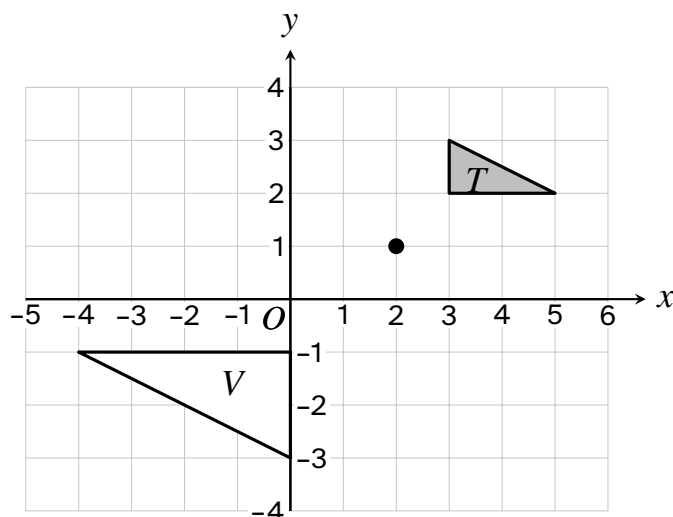
- (a) On the grid, enlarge shape T by scale factor -2 , centre $(2, 1)$
Label the image V .

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

$$(3, 2): \begin{pmatrix} 1 \\ 1 \end{pmatrix} \rightarrow \begin{pmatrix} -2 \\ -2 \end{pmatrix}, \text{ image } (0, -1)$$

$$(5, 2): \begin{pmatrix} 3 \\ 1 \end{pmatrix} \rightarrow \begin{pmatrix} -6 \\ -2 \end{pmatrix}, \text{ image } (-4, -1)$$

$$(3, 3): \begin{pmatrix} 1 \\ 2 \end{pmatrix} \rightarrow \begin{pmatrix} -2 \\ -4 \end{pmatrix}, \text{ image } (0, -3)$$



Answer: $(0, -1)$, $(-4, -1)$, $(0, -3)$

Tip: Measure from the centre $(2, 1)$, not from the origin. A scale factor of -2 makes the image bigger, not smaller.

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

- (b) Shape T is also enlarged by scale factor 2, centre $(2, 1)$, to give shape W . Describe fully the single transformation that maps shape V onto shape W .

V and W are both twice the size of T , so they are the same size as each other.

W is on the same side of $(2, 1)$ as T ; V is on the opposite side, upside down.

For example, the vertex $(3, 2)$ of T goes to $(0, -1)$ on V and to $(4, 3)$ on W .

$(2, 1)$ is exactly halfway between $(0, -1)$ and $(4, 3)$.

So V maps onto W by an enlargement with scale factor -1 and centre $(2, 1)$ (this is the same as a rotation of 180° about $(2, 1)$).

Answer: Enlargement, scale factor -1 , centre $(2, 1)$ (or rotation 180° about $(2, 1)$)

Tip: V and W are the same size, so the scale factor has size 1. The minus sign shows that W is on the other side of the centre.

Marks: 2 marks for a complete description. 1 mark for scale factor -1 (or 180° rotation) with no centre or a wrong centre.

6 (2 marks)

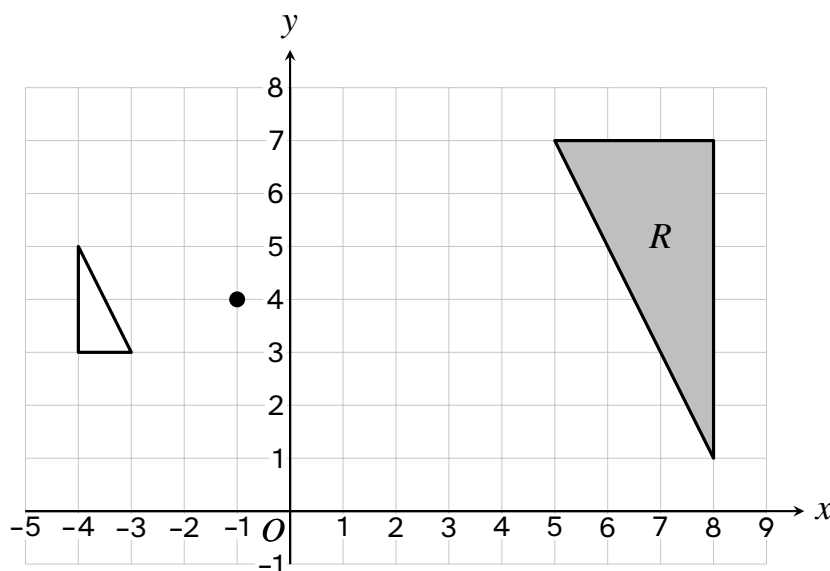
Enlarge triangle R by scale factor $-\frac{1}{3}$ with centre of enlargement $(-1, 4)$

Find the vector from the centre $(-1, 4)$ to each vertex, and multiply by $-\frac{1}{3}$.

$$(5, 7): \begin{pmatrix} 6 \\ 3 \end{pmatrix} \rightarrow \begin{pmatrix} -2 \\ -1 \end{pmatrix}, \text{ image } (-3, 3)$$

$$(8, 7): \begin{pmatrix} 9 \\ 3 \end{pmatrix} \rightarrow \begin{pmatrix} -3 \\ -1 \end{pmatrix}, \text{ image } (-4, 3)$$

$$(8, 1): \begin{pmatrix} 9 \\ -3 \end{pmatrix} \rightarrow \begin{pmatrix} -3 \\ 1 \end{pmatrix}, \text{ image } (-4, 5)$$



Answer: $(-3, 3)$, $(-4, 3)$, $(-4, 5)$

Tip: The image is one third of the size **and** on the other side of the centre, upside down.

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

7 (2 marks)

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

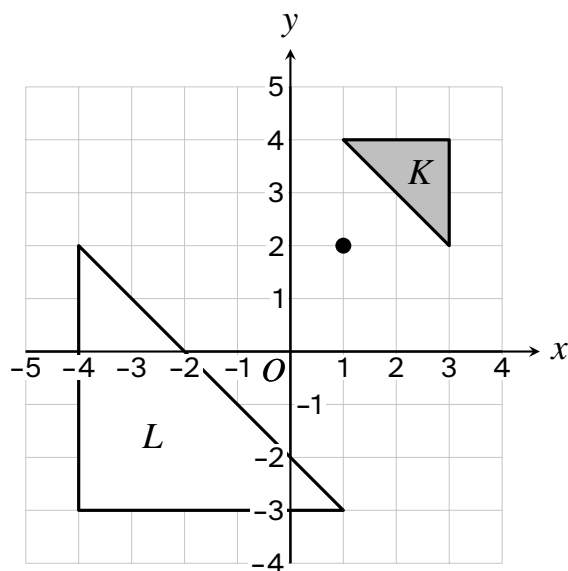
Label the image L .

Find the vector from the centre $(1, 2)$ to each vertex, and multiply by -2.5 .

$$(3, 2): \begin{pmatrix} 2 \\ 0 \end{pmatrix} \rightarrow \begin{pmatrix} -5 \\ 0 \end{pmatrix}, \text{ image } (-4, 2)$$

$$(3, 4): \begin{pmatrix} 2 \\ 2 \end{pmatrix} \rightarrow \begin{pmatrix} -5 \\ -5 \end{pmatrix}, \text{ image } (-4, -3)$$

$$(1, 4): \begin{pmatrix} 0 \\ 2 \end{pmatrix} \rightarrow \begin{pmatrix} 0 \\ -5 \end{pmatrix}, \text{ image } (1, -3)$$



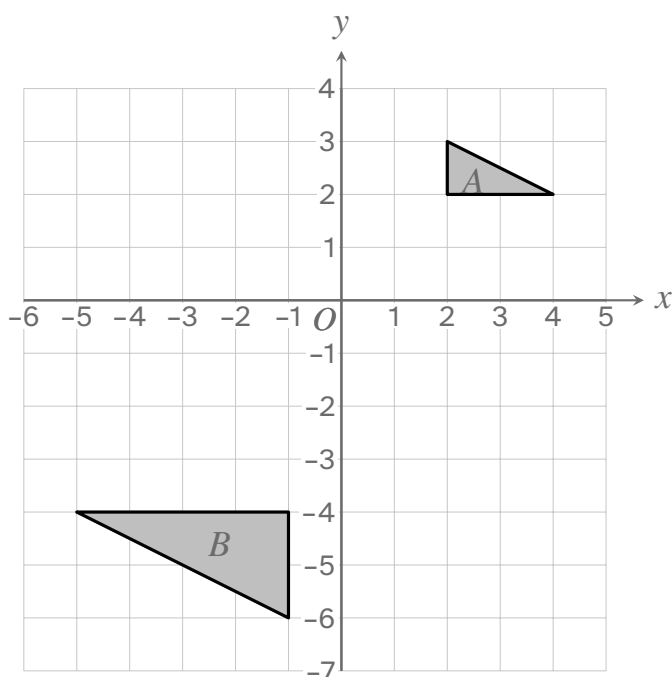
Answer: $(-4, 2), (-4, -3), (1, -3)$

Tip: Plot carefully and check each vertex. The image is on the opposite side of $(1, 2)$ from K , and each side is $2\frac{1}{2}$ times as long.

Marks: 2 marks for the correct triangle. 1 mark for the correct size and orientation, or for two vertices correct.

8 (2 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.

They cross at $(1, 0)$. This is the centre.

B is twice as big as A (e.g. a side of 2 becomes 4).

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

So the scale factor is -2 .

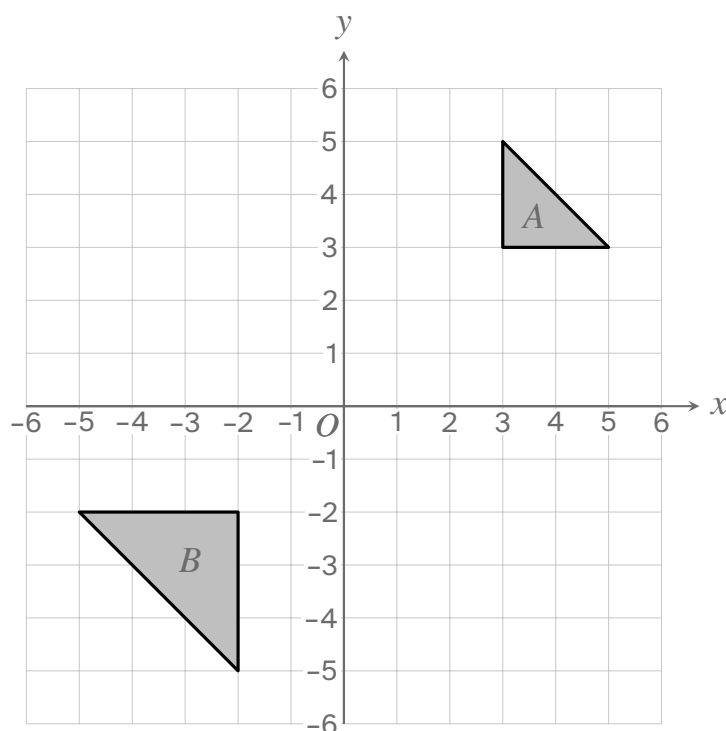
Answer: Enlargement, scale factor -2 , centre $(1, 0)$

Tip: Don't describe it as a rotation followed by an enlargement. The question asks for a **single** transformation.

Marks: 2 marks for all three details. 1 mark for two of: enlargement, -2 , centre $(1, 0)$.

9 (2 marks)

Triangles A and B are drawn on the grid.



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

Join matching vertices of A and B with straight lines.

They cross at $(1, 1)$. This is the centre.

The sides of B are 3 where the sides of A are 2.

So B is $3 \div 2 = 1.5$ times as big.

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

So the scale factor is -1.5 .

Answer: Enlargement, scale factor -1.5 , centre $(1, 1)$

Tip: Scale factor = image length $\div$ original length. Then add the minus sign because the image is inverted.

Marks: 2 marks for all three details. 1 mark for two of: enlargement, -1.5 , centre $(1, 1)$.