

Describing and Combining Transformations

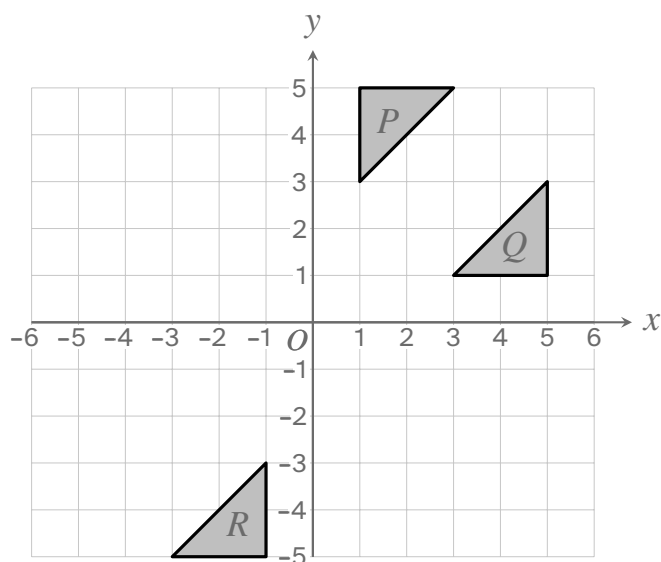
Solutions

For Pearson Edexcel GCSE Mathematics (1MA1) • Foundation 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 (4 marks)

The grid shows three triangles, P , Q and R .



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

Q is a mirror image of P , so it is a reflection.

The mirror line is the diagonal line halfway between them.

It goes through $(0, 0)$, $(1, 1)$, $(2, 2)$, ...

On this line y is always equal to x , so it is the line $y = x$.

Answer: Reflection in the line $y = x$

Tip: Learn the diagonal lines: $y = x$ goes up from left to right through $(1, 1)$; $y = -x$ goes down through $(1, -1)$.

Marks: 1 mark for reflection. 1 mark for $y = x$. No marks if you give more than one transformation.

- (b) Describe fully the single transformation that maps triangle P onto triangle R .

R is P turned upside down: a half turn.

Each vertex (x, y) has moved to $(-x, -y)$, e.g. $(3, 5) \rightarrow (-3, -5)$.

This is a rotation of 180° about the origin.

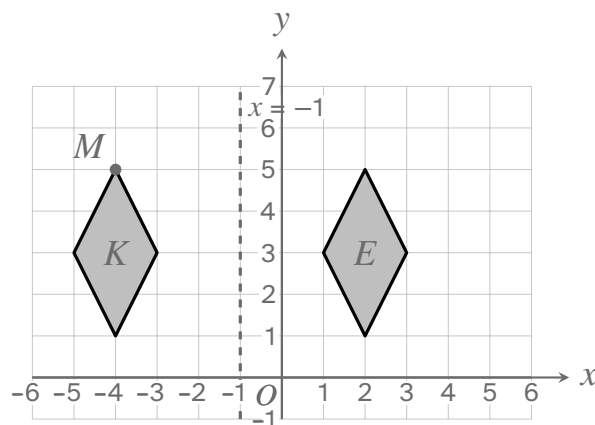
Answer: Rotation, 180° , about $(0, 0)$

Marks: 2 marks for rotation, 180° and centre $(0, 0)$. 1 mark for two of these.

2 (2 marks)

Kite E is a reflection of kite K .

M is a vertex of kite K .



- (a) Write down the coordinates of the image of point M .

M is at $(-4, 5)$. Its image is the matching vertex of E (the top vertex).

The top vertex of E is at $(2, 5)$.

Answer: $(2, 5)$

- (b) Write down an equation of the mirror line.

The mirror line is halfway between matching points.

$M(-4, 5)$ and its image $(2, 5)$: halfway is $\frac{-4+2}{2} = -1$

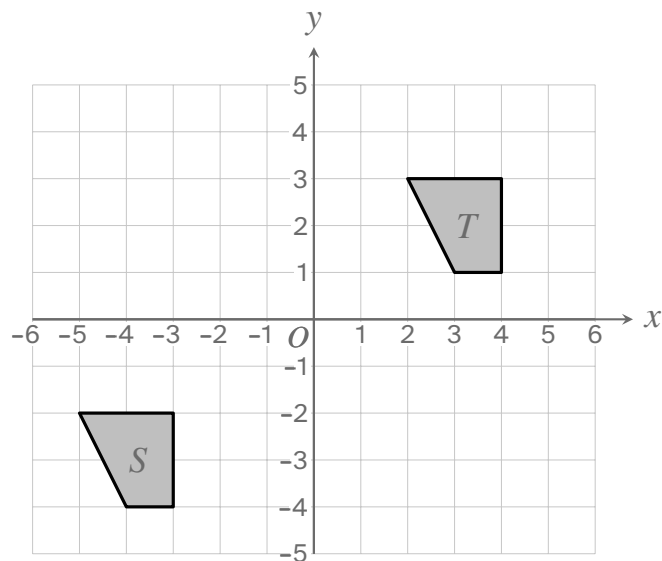
The line is vertical, so its equation is $x = \dots$

Answer: $x = -1$

Tip: A vertical line has equation $x = \dots$. Take care with the negative: halfway between -4 and 2 is -1 .

3 (2 marks)

Describe fully the single transformation that maps shape S onto shape T .



T is the same size and the same way round as S , so it is a translation.

Follow one vertex: $(-5, -2)$ on S moves to $(2, 3)$ on T .

Across: $2 - (-5) = 7$, so 7 right.

Up: $3 - (-2) = 5$, so 5 up.

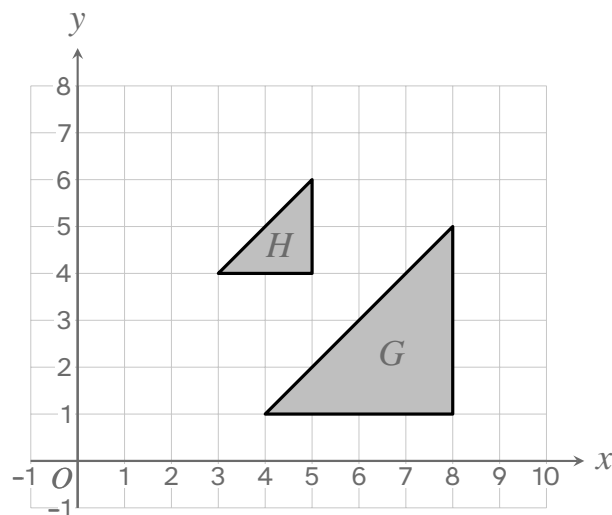
Answer: Translation by $\begin{pmatrix} 7 \\ 5 \end{pmatrix}$

Tip: Give the vector as a column vector, not as a coordinate or in words. Words like “shift” or “move” do not count as “translation”.

Marks: 1 mark for translation. 1 mark for the vector $\begin{pmatrix} 7 \\ 5 \end{pmatrix}$.

4 (2 marks)

Describe fully the single transformation that maps triangle G onto triangle H .



H is the same shape as G but smaller, so it is an enlargement.

The base of H is 2 squares and the base of G is 4 squares.

$$\text{Scale factor} = \text{new} \div \text{old} = 2 \div 4 = \frac{1}{2}$$

Join matching vertices and extend the lines: (4, 1) to (3, 4), and (8, 5) to (5, 6).

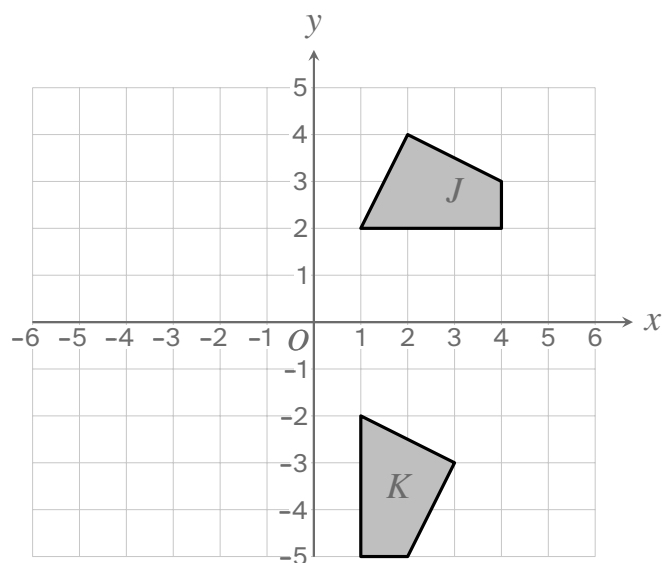
The lines meet at $(2, 7)$, the centre.

Answer: Enlargement, scale factor $\frac{1}{2}$, centre $(2, 7)$

Marks: 2 marks for enlargement, scale factor $\frac{1}{2}$ and centre $(2, 7)$. 1 mark for two of these. No marks if you give more than one transformation.

5 (2 marks)

Describe fully the single transformation that maps shape J onto shape K .



K is the same size as J but turned a quarter turn clockwise, so it is a rotation of 90° clockwise.

Use tracing paper to find the centre. Try points until one works.

Turning about $(-1, 0)$ takes $(1, 2)$ to $(1, -2)$ and $(4, 2)$ to $(1, -5)$ ✓

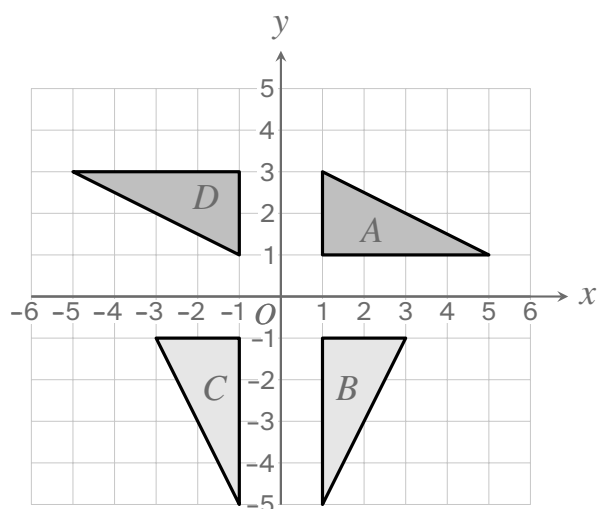
Answer: Rotation, 90° clockwise, about $(-1, 0)$

Tip: Write the centre with x first: $(-1, 0)$, not $(0, -1)$.

Marks: 2 marks for rotation, 90° clockwise and centre $(-1, 0)$. 1 mark for two of these.

6 (5 marks)

The grid shows triangle *A* and triangle *D*.



- (a) Rotate triangle *A* 90° clockwise about $(0, 0)$
Label the image *B*.

$(5, 1)$ is 5 right and 1 up from the origin.

A quarter turn clockwise takes it to 1 right and 5 down: $(1, -5)$

$(1, 3)$ goes to 3 right and 1 down: $(3, -1)$

B has vertices $(1, -1)$, $(1, -5)$, $(3, -1)$

Answer: $(1, -1)$, $(1, -5)$, $(3, -1)$

Marks: 2 marks for the correct image. 1 mark for the right shape and way round in the wrong position.

- (b) Reflect triangle *B* in the *y*-axis.
Label the image *C*.

The *y*-axis is the line $x = 0$.

Each vertex moves to the same distance on the other side: $(x, y) \rightarrow (-x, y)$

C has vertices $(-1, -1)$, $(-1, -5)$, $(-3, -1)$

Answer: $(-1, -1)$, $(-1, -5)$, $(-3, -1)$

- (c) Describe fully the single transformation that maps triangle A onto triangle D .

D is the same size as A but upside down: a half turn, so it is a rotation of 180° .

For a half turn, the centre is halfway between a vertex and its image.

$(1, 1)$ on A matches $(-1, 3)$ on D . Halfway: $\left(\frac{1+(-1)}{2}, \frac{1+3}{2}\right) = (0, 2)$

Check: $(5, 1)$ matches $(-5, 3)$, and halfway between them is also $(0, 2)$ ✓

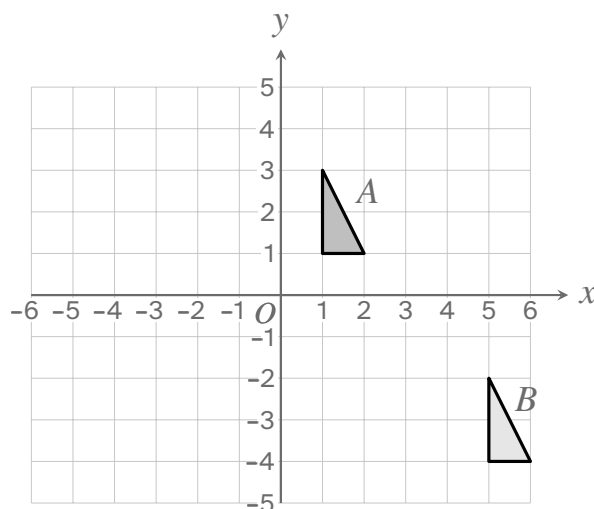
Answer: Rotation, 180° , about $(0, 2)$

Tip: A half turn does not need a direction, but it does need a centre. The centre is not always the origin.

Marks: 2 marks for rotation, 180° and centre $(0, 2)$. 1 mark for two of these.

7 (3 marks)

Here is shape A on a grid.



- (a) Translate shape A by the vector $\begin{pmatrix} 4 \\ -5 \end{pmatrix}$
Label the image B .

The top number, 4, means 4 squares right. The bottom number, -5 , means 5 squares down.

Move every vertex 4 right and 5 down: $(1, 1) \rightarrow (5, -4)$, $(2, 1) \rightarrow (6, -4)$,
 $(1, 3) \rightarrow (5, -2)$

B has vertices $(5, -4)$, $(6, -4)$, $(5, -2)$

Answer: $(5, -4)$, $(6, -4)$, $(5, -2)$

Tip: A negative bottom number means move **down**.

- (b) Describe fully the single transformation that maps shape B onto shape A .

A is the same size and the same way round as B , so it is a translation.

This undoes the move in part (a): $(5, -4)$ on B goes back to $(1, 1)$ on A .

That is 4 left and 5 up.

Answer: Translation by $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$

Tip: Going back the other way reverses both signs. $\begin{pmatrix} 4 \\ -5 \end{pmatrix}$ is the translation from A to B , not from B to A .

Marks: 1 mark for translation. 1 mark for the vector $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$.
