

Translations and Column Vectors

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 (1 mark)

The point $(3, -1)$ is translated by the vector $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$

Write down the coordinates of the image.

Add the top number to the x -coordinate: $3 + (-4) = -1$

Add the bottom number to the y -coordinate: $-1 + 5 = 4$

Answer: $(-1, 4)$

2 (2 marks)

Write each translation as a column vector.

(a) 3 squares to the right and 5 squares down

Top number: across. Right is positive, so 3.

Bottom number: up or down. Down is negative, so -5 .

Answer: $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$

(b) 4 squares to the left and 2 squares up

Top number: across. Left is negative, so -4 .

Bottom number: up or down. Up is positive, so 2.

Answer: $\begin{pmatrix} -4 \\ 2 \end{pmatrix}$

Tip: Write a column vector in brackets with no line in the middle. It is not a fraction and not a coordinate.

3 (2 marks)

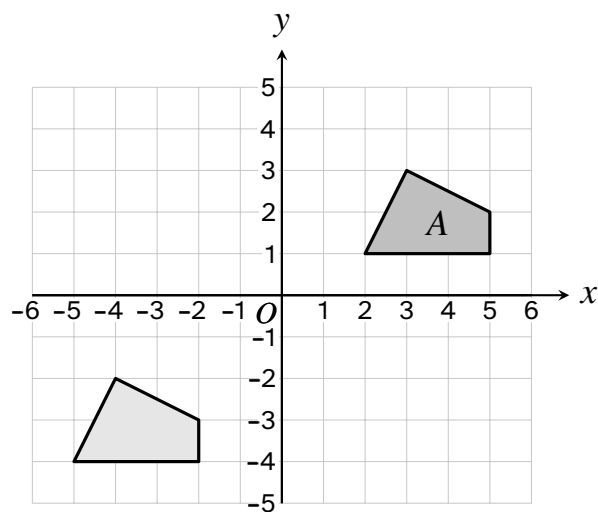
On the grid, translate shape *A* by the vector $\begin{pmatrix} -7 \\ -5 \end{pmatrix}$

The vector means 7 left and 5 down.

Move every vertex 7 squares left and 5 squares down.

For example, $(5, 1) \rightarrow (-2, -4)$

The image has vertices $(-5, -4)$, $(-2, -4)$, $(-2, -3)$, $(-4, -2)$

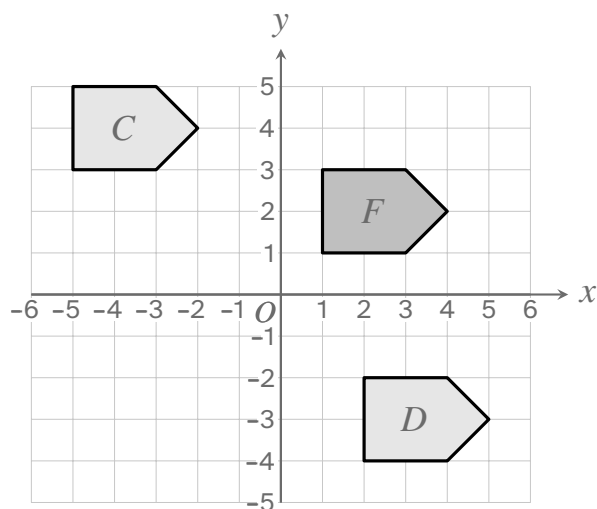


Answer: $(-5, -4)$, $(-2, -4)$, $(-2, -3)$, $(-4, -2)$

Marks: 2 marks for the correct image. 1 mark for one of the two movements correct.

4 (2 marks)

Here is shape F on a grid.



- (a) Translate shape F by the vector $\begin{pmatrix} -6 \\ 2 \end{pmatrix}$
Label the image C .

The vector means 6 left and 2 up.

Move every vertex 6 left and 2 up.

C has vertices $(-5, 3)$, $(-3, 3)$, $(-2, 4)$, $(-3, 5)$, $(-5, 5)$

Answer: $(-5, 3)$, $(-3, 3)$, $(-2, 4)$, $(-3, 5)$, $(-5, 5)$

- (b) Translate shape F by the vector $\begin{pmatrix} 1 \\ -5 \end{pmatrix}$
Label the image D .

The vector means 1 right and 5 down.

Move every vertex 1 right and 5 down.

D has vertices $(2, -4)$, $(4, -4)$, $(5, -3)$, $(4, -2)$, $(2, -2)$

Answer: $(2, -4)$, $(4, -4)$, $(5, -3)$, $(4, -2)$, $(2, -2)$

Tip: The bottom number is -5 , so the shape moves **down**. Check that the image is exactly the same size and the same way round as F .

5 (2 marks)

Here is a triangle on a grid.

The triangle is translated so that the vertex V moves to the point $(1, -4)$
On the grid, draw the image of the triangle.

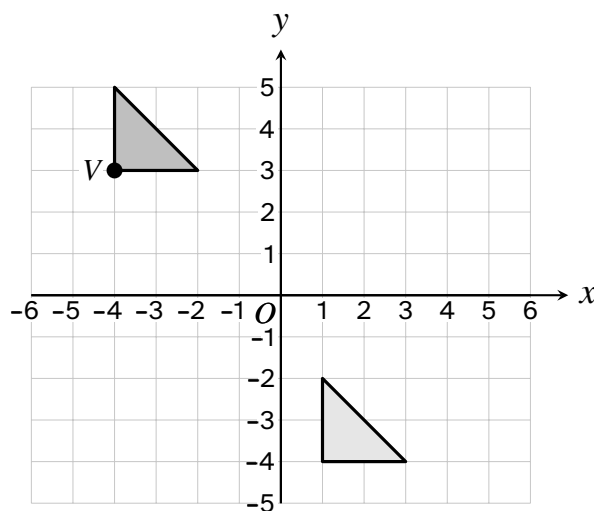
V moves from $(-4, 3)$ to $(1, -4)$.

Across: $1 - (-4) = 5$, so 5 right.

Down: $-4 - 3 = -7$, so 7 down.

Move the other two vertices 5 right and 7 down as well.

The image has vertices $(1, -4)$, $(3, -4)$, $(1, -2)$



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

Tip: Only V goes to $(1, -4)$. Work out how far V moved, then move the other vertices by the same amount.

Marks: 2 marks for the correct image. 1 mark for a triangle the right size and way round with one vertex correct, or for a move of 5 right or 7 down.

6 (4 marks)

$$\mathbf{a} = \begin{pmatrix} 4 \\ -1 \end{pmatrix} \quad \mathbf{b} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$$

Write as a column vector

(a) $3\mathbf{a}$

Multiply both numbers by 3.

$$3 \times 4 = 12$$

$$3 \times (-1) = -3$$

Answer: $\begin{pmatrix} 12 \\ -3 \end{pmatrix}$

(b) $\mathbf{a} - \mathbf{b}$

Subtract the top numbers: $4 - (-2) = 4 + 2 = 6$

Subtract the bottom numbers: $-1 - 3 = -4$

Answer: $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$

(c) $\mathbf{a} + 2\mathbf{b}$

First work out $2\mathbf{b}$ by doubling both numbers:

$$2\mathbf{b} = \begin{pmatrix} -4 \\ 6 \end{pmatrix}$$

Now add $\mathbf{a}$:

$$\text{Top: } 4 + (-4) = 0$$

Bottom: $-1 + 6 = 5$

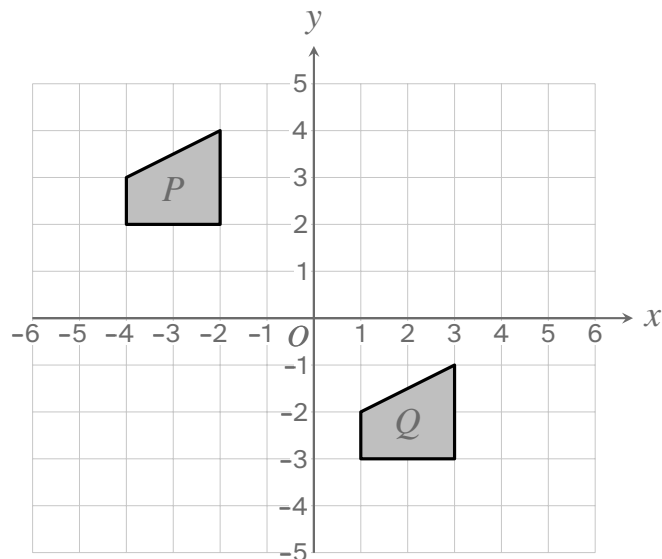
Answer: $\begin{pmatrix} 0 \\ 5 \end{pmatrix}$

Tip: Double **both** numbers in **b** before you add. Doubling only one of them is a common slip.

Marks: 1 mark for $2\mathbf{b} = \begin{pmatrix} -4 \\ 6 \end{pmatrix}$. 1 mark for the correct answer.

7 (3 marks)

Here are two shapes, P and Q , on a grid.



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

Q is the same size, shape and way round as P , so it is a translation.

Follow one vertex: $(-4, 2)$ on P moves to $(1, -3)$ on Q .

That is 5 right and 5 down.

Write this as a column vector.

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

Tip: Use the word “translation” (not “shift” or “move”), and give a column vector, not words like “5 right and 5 down”.

Marks: 1 mark for the word translation. 1 mark for the vector $\begin{pmatrix} 5 \\ -5 \end{pmatrix}$. No marks if you give more than one transformation.

- (b) Write down the column vector for the translation that maps shape Q onto shape P .

Going back from Q to P reverses both movements.

So it is 5 left and 5 up.

Change the sign of both numbers.

Answer: $\begin{pmatrix} -5 \\ 5 \end{pmatrix}$

8 (2 marks)

P is the point $(2, -3)$ and Q is the point $(-4, 1)$

Write down the column vector for the translation that maps P onto Q .

Find the change in each coordinate: end point minus start point.

Across: $-4 - 2 = -6$

Up: $1 - (-3) = 1 + 3 = 4$

Answer: $\begin{pmatrix} -6 \\ 4 \end{pmatrix}$

Tip: Work out “ Q minus P ”, not “ P minus Q ”. Going the wrong way gives the right numbers with the wrong signs.

Marks: 1 mark for each correct number in the vector.

9 (2 marks)

Shape S is translated by the vector $\begin{pmatrix} 2 \\ 5 \end{pmatrix}$ to give shape T .

Shape T is then translated by the vector $\begin{pmatrix} -6 \\ -1 \end{pmatrix}$ to give shape U .

Write down the column vector for the single translation that maps shape S onto shape U .

One translation followed by another is the same as adding the vectors.

Top: $2 + (-6) = -4$

Bottom: $5 + (-1) = 4$

Answer: $\begin{pmatrix} -4 \\ 4 \end{pmatrix}$

Marks: 1 mark for each correct number in the vector.
