Cambridge IGCSE · Mathematics 0580 · Notes

Transformations

Read online at **pastopic.com/cambridge/mathematics-0580/notes/transformations**

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Read first: **Coordinate geometry**

What you need to know

By the end of this topic you should be able to recognise, describe fully and draw four transformations of a shape on a grid:

1. **Reflection** in a vertical or horizontal line, such as $x = 3$ or $y = -1$. **Extended only:** in any straight line, including sloping lines such as $y = x$, $y = -x$ or $y = x + 2$.
2. **Rotation** through a multiple of 90° (90°, 180° or 270°), clockwise or anticlockwise. On Core papers the centre is the origin, a corner of the shape or the midpoint of one of its sides. **Extended only:** about any centre.
3. **Enlargement** from a centre by a scale factor, which can be a whole number or a fraction such as $\frac{1}{2}$. **Extended only:** the scale factor can also be negative, such as -2 or $-\frac{1}{3}$.
4. **Translation** by a column vector $\begin{pmatrix} x \\ y \end{pmatrix}$. Other vector work is covered in the Vectors note.

Extended only: questions can combine transformations, for example "reflect, then rotate the image" or "describe the single transformation that maps one image onto another". Core questions use one transformation at a time. Straight edges must be drawn with a ruler.

Understand it

The shape and its image

A transformation moves a shape (the **object**) to a new position; the result is its **image**. Reflections, rotations and translations keep the shape's size and angles, so the image is **congruent** to the object. An enlargement changes the size but keeps the angles, so the image is **similar** to the object.

When you "describe fully" a transformation you give its **name** and the facts that pin it down exactly:

Transformation	What to give
Translation	the column vector
Reflection	the equation of the mirror line

Transformation	What to give
Rotation	the centre (as coordinates), the angle, the direction (clockwise or anticlockwise)
Enlargement	the centre (as coordinates), the scale factor

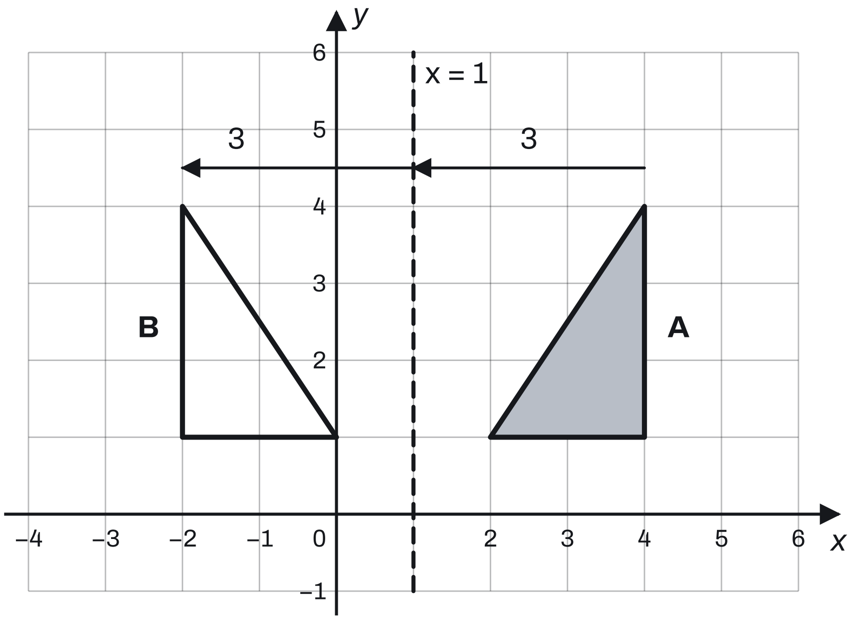
Translation

A translation slides every point the same distance in the same direction. Nothing turns or flips. The column vector $\begin{pmatrix} x \\ y \end{pmatrix}$ says how far: the **top** number is the move **across** (positive = right, negative = left) and the **bottom** number is the move **up or down** (positive = up, negative = down).

Translating the point $(2, 5)$ by $\begin{pmatrix} -3 \\ 4 \end{pmatrix}$ gives $(2 - 3,\ 5 + 4) = (-1, 9)$. To find the vector from an object to its image, choose one corner and count from it to the matching corner of the image: across first, then up or down.

Reflection

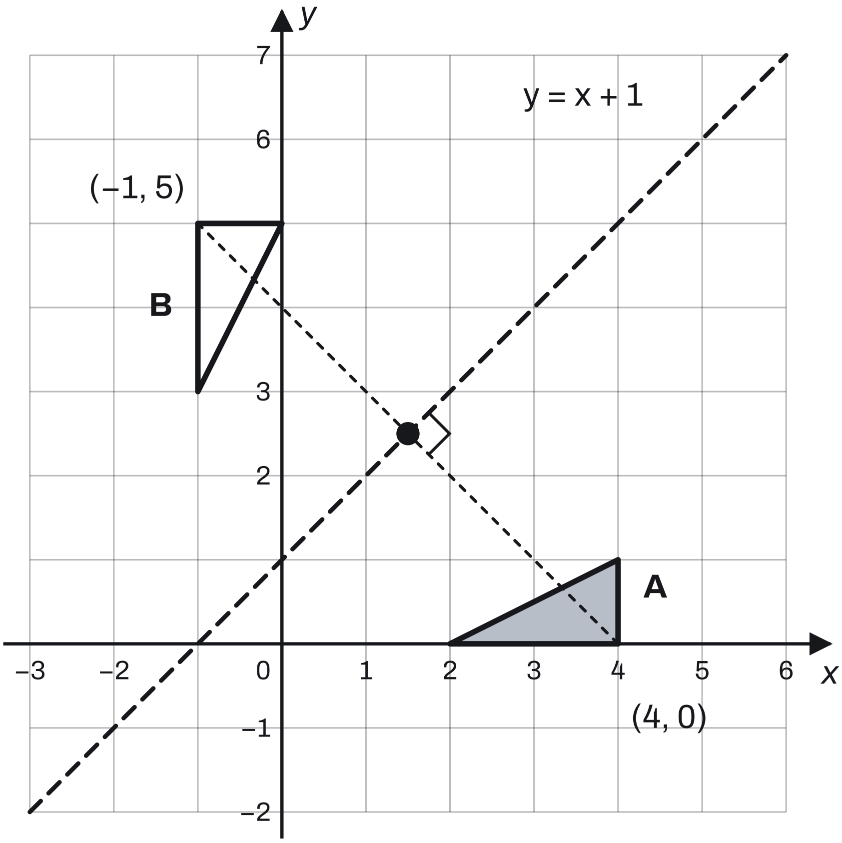
A reflection flips the shape over a mirror line. Every point of the image is the **same distance** from the mirror as the matching point of the object, on the **other side**, measured at right angles to the mirror. Points on the mirror line don't move.



Know which way the simple lines go: $x = k$ is a **vertical** line (every point on it has x-coordinate k), and $y = k$ is **horizontal**. The y-axis is $x = 0$ and the x-axis is $y = 0$.

- Reflecting in $x = k$ changes only the x-coordinate: $(x, y) \to (2k - x,\ y)$.
- Reflecting in $y = k$ changes only the y-coordinate: $(x, y) \to (x,\ 2k - y)$.

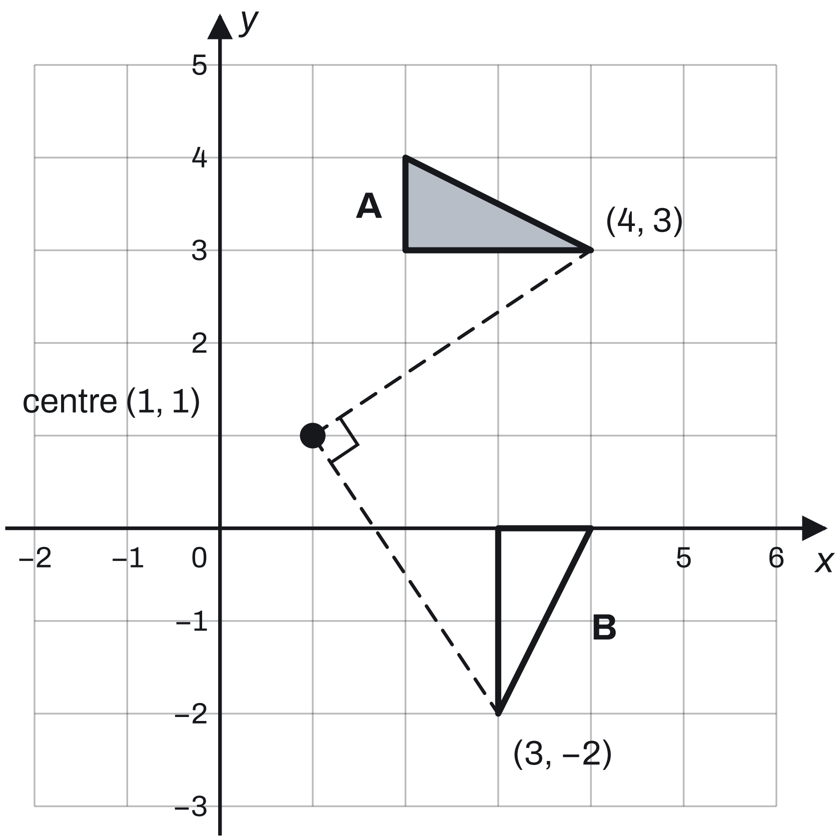
Extended only: sloping mirror lines. For a line at 45° the "at right angles" rule means you move diagonally across the grid squares. Reflecting in $y = x$ swaps the coordinates, $(x, y) \to (y, x)$; reflecting in $y = -x$ swaps them and changes both signs, $(x, y) \to (-y, -x)$. For $y = x + c$ the rule is $(x, y) \to (y - c,\ x + c)$.



For $y = x + 1$: $(4, 0) \to (0 - 1,\ 4 + 1) = (-1, 5)$. Check it: the midpoint of $(4, 0)$ and $(-1, 5)$ is $(1.5, 2.5)$, which is on the line, and the join goes diagonally, at right angles to the mirror.

Rotation

A rotation turns the shape about a fixed point, the **centre**, through an angle. The centre is the only point that doesn't move. Each point stays the same distance from the centre.



Tracing paper is allowed in the exam and is the easiest way to draw a rotation: trace the shape, hold the tracing at the centre with your pencil point, turn it a quarter turn (or half turn) and mark the new corners.

You can also count squares. Write each corner's position **from the centre**, as "across, up", then:

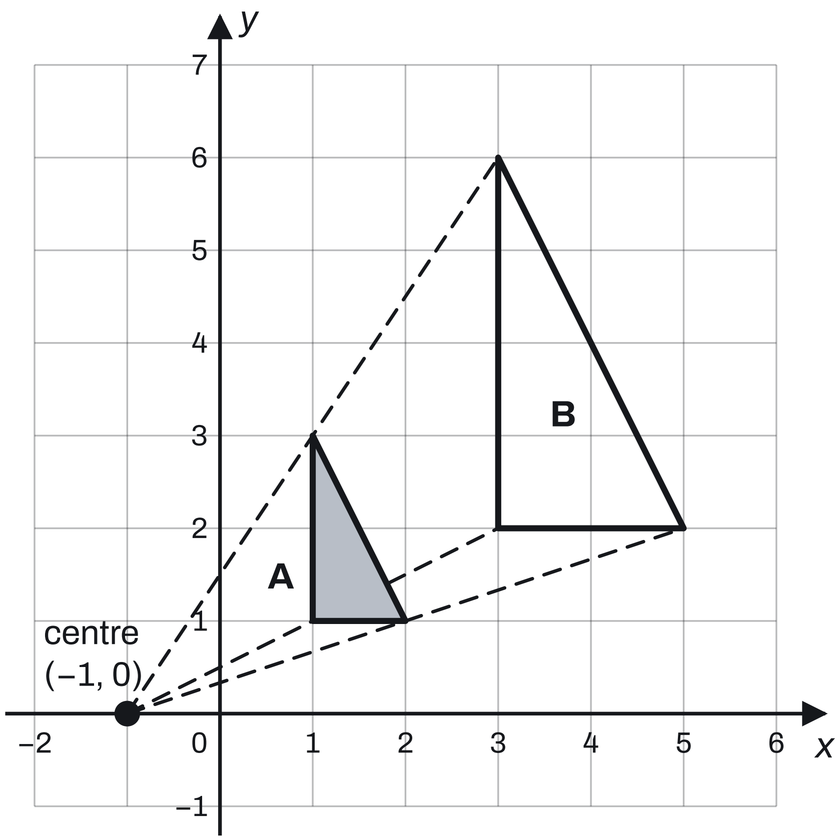
- 90° clockwise: $(\text{across}, \text{up}) \to (\text{up}, -\text{across})$;
- 90° anticlockwise: $(\text{across}, \text{up}) \to (-\text{up}, \text{across})$;
- 180°: $(\text{across}, \text{up}) \to (-\text{across}, -\text{up})$.

In the diagram, $(4, 3)$ is 3 right and 2 up from $(1, 1)$. A 90° clockwise turn makes that 2 right and 3 **down**, so the image is $(1 + 2,\ 1 - 3) = (3, -2)$.

A 90° clockwise rotation is the same as 270° anticlockwise; always use the 90° description. A 180° rotation needs no direction, because both ways end in the same place.

Enlargement

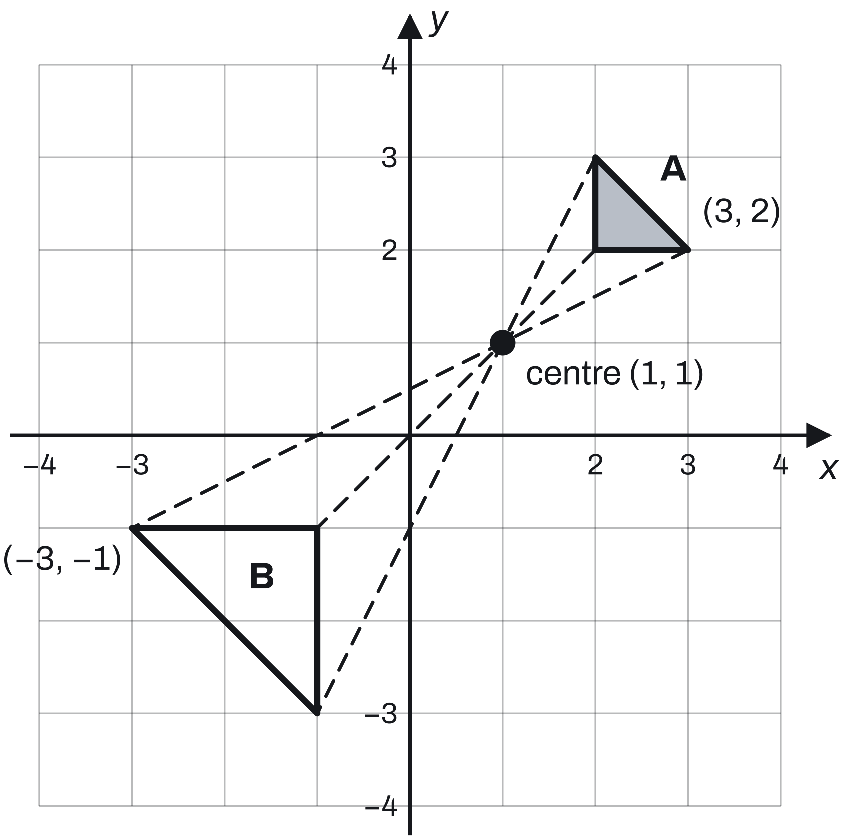
An enlargement changes the size. The **scale factor** k says how many times longer every side becomes, and every point moves along a straight line (a **ray**) from the **centre of enlargement**, ending k times as far from the centre as it started.



In the diagram, $(2, 1)$ is 3 right and 1 up from the centre $(-1, 0)$. Scale factor 2 doubles that to 6 right and 2 up, so its image is $(-1 + 6,\ 0 + 2) = (5, 2)$.

- A scale factor **bigger than 1** makes the shape bigger and further from the centre.
- A **fractional** scale factor between 0 and 1, such as $\frac{1}{2}$, makes the shape **smaller** and closer to the centre. It is still called an enlargement. Going back from B to A in the diagram is an enlargement with scale factor $\frac{1}{2}$, centre $(-1, 0)$.

Extended only: negative scale factors. A negative scale factor puts the image on the **other side** of the centre, and upside down. Each ray goes from the corner **through** the centre and out the other side. With scale factor -2, a corner 2 right and 1 up from the centre goes to 4 left and 2 down.



A scale factor of -1 gives an image of the same size turned upside down: it is the same as a rotation of 180° about the centre.

Because every length is multiplied by k, every **area** is multiplied by k^2. Enlarging by scale factor 3 makes the area 9 times as big.

Combined transformations

Extended only. Doing one transformation and then another often gives a result that a **single** transformation could have done. Track one or two corners to see which. For example, reflecting in the x-axis and then in the y-axis sends $(x, y) \to (x, -y) \to (-x, -y)$, which is a rotation of 180° about the origin. Reflecting in two parallel mirror lines gives a translation.

Key facts and formulas

None of these are in the 0580 list of formulas. "Learn it" means you must remember it.

Formula	Status
Translation by $\begin{pmatrix} a \\ b \end{pmatrix}$: $(x, y) \to (x + a,\ y + b)$	Learn it
Reflection in $x = k$: $(x, y) \to (2k - x,\ y)$; in $y = k$: $(x, y) \to (x,\ 2k - y)$	Learn it

Formula	Status
Extended only: reflection in $y = x$: $(x, y) \rightarrow (y, x)$; in $y = -x$: $(x, y) \rightarrow (-y, -x)$; in $y = x + c$: $(x, y) \rightarrow (y - c,\ x + c)$	Learn it
Rotation about the origin: 90° clockwise $(x, y) \rightarrow (y, -x)$; 90° anticlockwise $(x, y) \rightarrow (-y, x)$; 180° $(x, y) \rightarrow (-x, -y)$	Learn it
Enlargement, scale factor k, centre C: image $= C + k \times (\text{point} - C)$	Learn it
Scale factor $= \dfrac{\text{length on image}}{\text{matching length on object}}$	Learn it
Area of image $= k^2 \times$ area of object	Learn it
Centre of a 180° rotation = midpoint of any corner and its image	Learn it

The rotation rules work about any centre if you use positions measured from the centre instead of from the origin.

How to do it

In the questions we have tagged for this topic (62 questions, 2021–2025, Papers 1 to 4), the types came up this often. Most questions have several parts, so 53 of the 62 mix two or more types and the counts add up to more than 62.

Question type	Questions
Describe fully the single transformation	59
Draw a reflection	34
Draw a translation	23
Draw a rotation	15
Draw an enlargement	12
Coordinates and calculations from a transformation	6

1. Describe fully the single transformation (59 questions)

1. **Name it.** Compare the object and the image:
    - same size, same way up and facing the same way: **translation**;
    - same size, but a mirror image (flipped over): **reflection**;
    - same size, turned: **rotation**;

   - a different size: **enlargement** (upside down and on the other side of some point: a negative scale factor, Extended only).
2. **Find the facts** for that transformation:
   - **Translation:** count from one corner to its image. Write the vector with the across move on top: $\begin{pmatrix} 2 \\ -8 \end{pmatrix}$ means 2 right, 8 down.
   - **Reflection:** join a corner to its image and find the midpoint; do this for two corners. The mirror line passes through the midpoints. Write its equation: $x = \ldots, y = \ldots$ or (Extended) $y = x, y = -x, y = x + c$.
   - **Rotation:** the angle is how far the shape has turned (90° or 180°), and the direction comes from which way a side has turned. For the centre, try a likely point with tracing paper, or check that it is the same distance from a corner and its image, with a right angle between the two joins for 90°. For a 180° turn the centre is the midpoint of a corner and its image: $(1, 2)$ and $(5, 0)$ give centre $(3, 1)$.
   - **Enlargement:** scale factor $=$ image length $\div$ object length (make it negative if the image is upside down on the other side of the centre). For the centre, draw straight lines through at least two pairs of matching corners (corner to its image) and extend them; the centre is where they cross.
3. **Write one transformation**, with its name and every fact: for example "Rotation, 90° clockwise, centre $(1, 4)$".

Variations you will meet:

- **The image is smaller.** It is still an **enlargement**, with a fractional scale factor such as $\frac{1}{2}$ or $\frac{1}{3}$.
- **Mapping one image onto another** (Extended), such as "the shape P onto the shape Q", where both were made from a third shape earlier in the question. Ignore how they were made; compare P and Q directly.
- **"Explain why this description is wrong"**, for example a translation vector with the wrong sign: count the move again and say which part is wrong ("it moves 1 down, not 1 up").

2. Draw a reflection (34 questions)

1. **Draw the mirror line** on the grid first (lightly, long enough to see). Remember $x = k$ is vertical and $y = k$ is horizontal.
2. For each corner, count the squares to the mirror at right angles, and count the same number on the other side. Use $(x, y) \to (2k - x,\ y)$ for $x = k$ or $(x, y) \to (x,\ 2k - y)$ for $y = k$ to check.
3. Join the new corners with a ruler and check that the image is the same size and a mirror image.

For example, $(4, 5)$ reflected in $y = -1$: it is 6 above the line, so the image is 6 below: $(4, -7)$. The rule gives $2(-1) - 5 = -7$.

Variations you will meet:

- **Extended only: sloping lines** $y = x, y = -x, y = x + c$ or $x + y = c$. Move diagonally across the squares, or use the rules in the table. $x + y = 6$ is the line $y = -x + 6$, and its rule is $(x, y) \to (6 - y,\ 6 - x)$. A corner that lies on the mirror stays where it is.

- **A mirror line through the shape.** Parts of the object and image overlap; reflect each corner as usual.
- **Flags and other shapes with a pole or a line.** Reflect both ends of every line, not just the outline.

3. Draw a translation (23 questions)

1. Read the vector: top number across, bottom number up (negative: left or down).
2. Move **every** corner by that amount, then join them.
3. Check the image is the same way up and facing the same way.

Variations you will meet:

- **Translate a single point**: add the vector to the coordinates, $(4, -3)$ by $\begin{pmatrix} -20 \\ 12 \end{pmatrix}$ gives $(-16, 9)$.
- **A large vector** that takes the image off the part of the grid you usually use: it still fits; count carefully.

4. Draw a rotation (15 questions)

1. Mark the centre. On Core papers it is the origin, a corner or the midpoint of a side of the shape.
2. Use tracing paper: trace the shape, pin the tracing at the centre with your pencil, turn it through the angle in the right direction, and mark where the corners land.
3. Or count: for each corner, find its position from the centre (across, up) and turn it with the rules in "Understand it". Then add the centre back on.
4. Join the new corners and check the image is the same size.

For example, the corner $(4, 1)$ rotated 90° clockwise about $(1, -2)$: from the centre it is 3 right, 3 up; turned clockwise it is 3 right, 3 down, so the image is $(4, -5)$.

Variations you will meet:

- 180° **about a point:** each image corner is directly opposite, the same distance through the centre: $(x, y) \to (2a - x,\ 2b - y)$ for centre (a, b).
- **"Clockwise" vs "anticlockwise"** is the most common slip; after drawing, check which way a side has turned.

5. Draw an enlargement (12 questions)

1. Mark the centre C.
2. For each corner, count its position from C (across, up), multiply **both** numbers by the scale factor, and count that far from C.
3. Join the new corners. Check each side is k times as long as before and the angles look the same.

Variations you will meet:

- **Fractional scale factor**, such as $\frac{1}{2}$: halve each distance from the centre. The image is smaller and closer to the centre.

- **Extended only: negative scale factor**, such as -2 or $-\frac{1}{2}$: multiply by the number, sign and all, so every "across, up" changes sign as well as size. The image is on the opposite side of the centre and upside down. Draw rays from each corner through the centre to check.
- **The image of one point**: the same method for a single corner, for example $(6, 3)$ enlarged by scale factor 2 from $(2, 1)$ is 4 right and 2 up, doubled to 8 right and 4 up, so $(10, 5)$.

6. Coordinates and calculations from a transformation (6 questions)

These parts use a transformation you have just drawn or described:

- **A general point**: (a, b) reflected in $y = k$ goes to $(a,\ 2k - b)$; reflected in $x = k$ it goes to $(2k - a,\ b)$.
- **How far a translation moves each point**: by Pythagoras, the distance for $\begin{pmatrix} x \\ y \end{pmatrix}$ is $\sqrt{x^2 + y^2}$. For $\begin{pmatrix} 6 \\ -8 \end{pmatrix}$ it is $\sqrt{36 + 64} = 10$ units.
- **Area after an enlargement**: multiply by the scale factor squared. A shape of area 20 cm² enlarged by scale factor 1.5 has area $20 \times 1.5^2 = 45$ cm².
- **Rectangles rotated about a corner**: a quarter turn swaps a rectangle's "across" and "up" lengths, so use the side lengths from known corners to find the others.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **B1** mark for a correct result on its own, with no method needed.

Example 1

Triangle P has vertices $(1, 1)$, $(3, 1)$ and $(1, 4)$.

(a) Draw the image of triangle P after a reflection in the line $y = -1$. **[2]**

(b) Draw the image of triangle P after a translation by the vector $\begin{pmatrix} -5 \\ 2 \end{pmatrix}$. **[2]**

(c) Triangle Q has vertices $(-1, 1)$, $(-1, 3)$ and $(-4, 1)$. Describe fully the single transformation that maps triangle P onto triangle Q. **[3]**

(a) $y = -1$ is horizontal. $(1, 1)$ is 2 above it, so its image is 2 below: $(1, -3)$. Likewise $(3, 1) \to (3, -3)$ and $(1, 4) \to (1, -6)$. Triangle drawn at $(1, -3)$, $(3, -3)$, $(1, -6)$. **B2** (**B1** for a correct reflection in a different horizontal line)

(b) 5 left and 2 up: $(1, 1) \to (-4, 3)$, $(3, 1) \to (-2, 3)$, $(1, 4) \to (-4, 6)$. **B2** (**B1** for the right move in one direction only)

(c) Same size, turned: a rotation. **B1**

The side from $(1, 1)$ to $(3, 1)$ pointed right; its image, $(-1, 1)$ to $(-1, 3)$, points up. That is a quarter turn anticlockwise. Test the origin as the centre with $(x, y) \to (-y, x)$: $(1, 1) \to (-1, 1)$, $(3, 1) \to (-1, 3)$, $(1, 4) \to (-4, 1)$. All three match.

Rotation, 90° anticlockwise, centre $(0, 0)$. **B1** for 90° anticlockwise, **B1** for the centre.

Example 2

Triangle A has vertices $(2, 1)$, $(4, 1)$ and $(2, 2)$. Triangle B has vertices $(4, 3)$, $(10, 3)$ and $(4, 6)$.

(a) Describe fully the single transformation that maps triangle A onto triangle B. **[3]**

(b) Describe fully the single transformation that maps triangle B onto triangle A. **[3]**

(c) The area of triangle A is 1 cm². Find the area of triangle B. **[1]**

(a) B is bigger, so it is an enlargement. **B1**

The bottom side of A is $4 - 2 = 2$ long; on B it is $10 - 4 = 6$ long. Scale factor $= 6 \div 2 = 3$. **B1**

Centre: the line through $(2, 1)$ and $(4, 3)$ is $y = x - 1$, and the line through $(2, 2)$ and $(4, 6)$ is $y = 2x - 2$. They cross where $x - 1 = 2x - 2$, so $x = 1$, $y = 0$. (On a grid, just draw the lines and read where they meet.)

Enlargement, scale factor 3, centre $(1, 0)$. **B1** for the centre.

Check with the rule: $(2, 2)$ is 1 right and 2 up from $(1, 0)$; times 3 gives 3 right and 6 up, so $(4, 6)$. ✓

(b) Going back undoes the enlargement: Enlargement, scale factor $\frac{1}{3}$, centre $(1, 0)$. **B3**

(c) Area factor $= 3^2 = 9$, so the area of B is 9 cm². **B1**

Example 3

Extended. Triangle T has vertices $(2, 1)$, $(6, 1)$ and $(6, 3)$.

(a) Draw the image of triangle T after an enlargement with scale factor $-\frac{1}{2}$, centre $(0, -1)$. **[2]**

(b) Draw the image of triangle T after a reflection in the line $y = x - 1$. **[3]**

(c) Triangle U has vertices $(-2, 3)$, $(-2, -1)$ and $(0, -1)$. Describe fully the single transformation that maps triangle T onto triangle U. **[3]**

(a) Positions from the centre $(0, -1)$, then times $-\frac{1}{2}$:

Corner	From centre	$\times \left(-\frac{1}{2}\right)$	Image
$(2, 1)$	2 right, 2 up	1 left, 1 down	$(-1, -2)$
$(6, 1)$	6 right, 2 up	3 left, 1 down	$(-3, -2)$

Corner	From centre	$\times\left(-\frac{1}{2}\right)$	Image
$(6,3)$	6 right, 4 up	3 left, 2 down	$(-3,-3)$

Triangle drawn at $(-1,-2)$, $(-3,-2)$, $(-3,-3)$: half the size, on the other side of the centre, upside down. **B2** (**B1** for the right size and way round in the wrong place)

(b) Draw the line $y=x-1$ (through $(0,-1)$ and $(1,0)$). **B1** if nothing else is right.

The rule for $y=x+c$ with $c=-1$ is $(x,y)\to(y+1,\ x-1)$:

- $(2,1)\to(2,1)$: this corner is on the mirror, so it stays;
- $(6,1)\to(2,5)$;
- $(6,3)\to(4,5)$.

Triangle drawn at $(2,1)$, $(2,5)$, $(4,5)$. **B3** (**B2** for the right size and way round in the wrong place)

(c) Same size, turned: rotation. **B1**

T's side from $(2,1)$ to $(6,1)$ points right; on U the matching side, from $(-2,3)$ to $(-2,-1)$, points down. A quarter turn clockwise: 90° clockwise. **B1**

The centre is the same distance from $(2,1)$ and from its image $(-2,3)$, so it is on the perpendicular bisector of the join: midpoint $(0,2)$, and the join has gradient $\frac{2}{-4}=-\frac{1}{2}$, so the bisector is $y=2x+2$. Likewise $(6,1)$ and $(-2,-1)$ have midpoint $(2,0)$ and bisector $y=-4x+8$. These cross where $2x+2=-4x+8$, so $x=1$ and $y=4$.

Check: $(6,3)$ is 5 right and 1 down from $(1,4)$; turned 90° clockwise that is 1 left and 5 down, giving $(0,-1)$. ✓

Rotation, 90° clockwise, centre $(1,4)$. **B1** for the centre. With tracing paper you can find the same centre by trying points until the tracing lands on U.

Common mistakes

- **Giving two transformations.** "Enlargement then translation" or "rotation and translation" scores **nothing** when the question asks for a single transformation. When a question asks for a single transformation, one always exists.
- **Using the wrong word.** Move, shift, slide, turn, flip, mirror, transition, translocation and transformation all fail. Write **translation**, **reflection**, **rotation** or **enlargement**, spelt correctly.
- **Leaving out a fact.** The centre of a rotation is the fact most often missing; the direction of a 90° turn is next. An enlargement needs both the scale factor and the centre.
- **Writing the centre as a vector.** A centre is a point: $(2,4)$, not $\begin{pmatrix}2\\4\end{pmatrix}$. A translation is the reverse: a column vector, not coordinates, and never a fraction.
- **Getting the vector wrong.** The top number is across, the bottom is up; swapping them, or getting a sign wrong, is common. Count from a corner to **its own** image.

- **Mixing up $x = k$ and $y = k$.** $x = -2$ is a vertical line. Reflecting in the wrong one of these costs a mark.
- **Wrong direction or wrong centre for a rotation.** Many images are the right shape turned the right amount, but anticlockwise instead of clockwise, or about the wrong point. Pin the tracing paper at the given centre.
- **Negative scale factors.** Drawing the enlargement on the same side of the centre (a positive scale factor), or giving $\frac{1}{2}$ when the answer is $-\frac{1}{2}$. If the image is upside down on the far side, the scale factor is negative.
- **Calling a smaller image a reduction.** It is still an enlargement, with a fractional scale factor.
- **Images that aren't congruent.** After a reflection, rotation or translation, check the image is exactly the same size and shape. Use a ruler for every edge.

How to get the marks

- **"Describe fully"**: a rotation or enlargement is usually worth **3** marks, one for the name and one for each fact. A translation or reflection is worth **2**: the name and the vector or the mirror line. Each part scores on its own, so write the name even if you can't find the centre.
- **"Single"** is in bold on the paper for a reason. One name only.
- **Drawing questions** usually give **2** marks for the correct image, and **1** for a nearly right image: a reflection in a different line of the same kind, a rotation about the wrong centre or the wrong way, a translation right in one direction only, or an enlargement of the right size in the wrong place. So draw something, even if unsure.
- **Draw accurately**: corners on grid points, straight edges with a ruler. Label the image if the question gives it a name.
- **Angles**: write 90° clockwise or 90° anticlockwise (not 270°), and just 180° for a half turn.
- **Scale factors**: a fraction such as $\frac{1}{3}$ or $-\frac{1}{2}$ is fine; don't write a ratio.
- **"Explain why … is incorrect"**: say exactly what is wrong, for example which component of the vector has the wrong sign.
- **Check** your answer by moving one corner with the transformation you have described. If it doesn't land on its image, something is wrong.

Quick check

1. (a) Translate the point $(3, -2)$ by the vector $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$. (b) Find the vector of the translation that maps $(2, 7)$ onto $(-3, 4)$.
2. Triangle A has vertices $(1, 2)$, $(3, 2)$ and $(3, 5)$. Find the vertices of its image after a reflection in the line $x = -1$.
3. Triangle B has vertices $(3, 3)$, $(5, 3)$ and $(5, 4)$. Find the vertices of its image after a rotation of 90° anticlockwise about $(2, 3)$.
4. *Extended.* Triangle C has vertices $(4, 4)$, $(6, 4)$ and $(6, 8)$. Triangle D has vertices $(1, 1)$, $(0, 1)$ and $(0, -1)$. Describe fully the single transformation that maps C onto D.

5. *Extended.* A shape is reflected in the line $x = 1$, and then the image is reflected in the line $x = 4$. Describe fully the single transformation that has the same effect.

Answers

1. (a) $(3-4,\ -2+5)=(-1,3)$. (b) 5 left and 3 down: $\begin{pmatrix}-5\\-3\end{pmatrix}$.
2. $(x,y)\to(-2-x,\ y)$: $(-3,2)$, $(-5,2)$, $(-5,5)$.
3. From the centre the corners are $(1,0)$, $(3,0)$ and $(3,1)$ (across, up). Anticlockwise, $(\text{across},\text{up})\to(-\text{up},\text{across})$: $(0,1)$, $(0,3)$, $(-1,3)$. Adding the centre back: $(2,4)$, $(2,6)$, $(1,6)$.
4. D is smaller and upside down: an enlargement with a negative scale factor. The side from $(4,4)$ to $(6,4)$ (2 long) matches $(1,1)$ to $(0,1)$ (1 long, reversed), so the scale factor is $-\frac{1}{2}$. The centre is where the lines joining $(4,4)$ to $(1,1)$ and $(6,8)$ to $(0,-1)$ cross: $y=x$ and $y=\frac{3}{2}x-1$ meet at $(2,2)$. Enlargement, scale factor $-\frac{1}{2}$, centre $(2,2)$.
5. $(x,y)\to(2-x,\ y)\to(8-(2-x),\ y)=(x+6,\ y)$. Translation by $\begin{pmatrix}6\\0\end{pmatrix}$.

Past questions to try

- **0580/31/M/J/22 Q5**: describing and drawing translations and reflections on a Core paper.
- **0580/42/O/N/22 Q4**: describing three transformations, then a reflection in a sloping line.
- **0580/22/M/J/23 Q10**: a rotation about a point that isn't the origin and an enlargement with a negative scale factor.
- **0580/42/F/M/23 Q4**: drawing an enlargement, a rotation and a reflection in $x+y=6$, then describing the single transformation between two images.