



Three-dimensional head models have many uses, including predicting the impact of car crashes. The original computerised head models were made using a mass of 3D points which were then moved around to change the shape of the head and features.

Objectives

In this chapter you will:

- translate, rotate, reflect and enlarge a 2D shape
- describe the translation, rotation, reflection and enlargement of a 2D shape
- combine transformations and describe the single transformation that has the same effect as a combination of transformations.

Before you start

You need to:

- be able to use coordinates in all four quadrants
- understand what it means to move (translate), flip (reflect), turn (rotate) and change the size of a 2D shape
- recognise and be able to draw lines with equations $x = a$, $y = b$, $y = \pm x$
- be able to draw scale diagrams.

17.1 Using translations

Objectives

- You know that in a translation all points of a shape move the same distance in the same direction.
- You understand that translations are described by the distance and the direction moved.
- You can use a vector to describe a translation.
- You know that when shape A is mapped to shape B by a translation, shape A and shape B are congruent.

Get Ready

1. Here is a letter square.

U	V	W	X	Y
T	S	R	Q	P
K	L	M	N	O
J	I	H	G	F
A	B	C	D	E

Start at square A, go 2 to the right, then 3 up and stop. Then go 3 down and stop. What mathematical word is this?

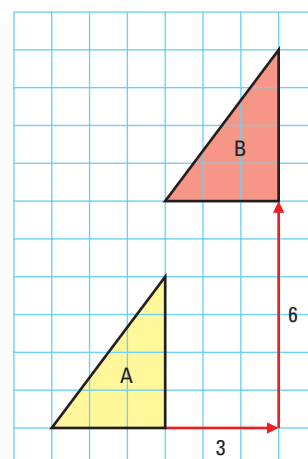
Start at square M, go 2 to the right and 2 down and stop. Then go 4 to the left and stop. Then go 3 to the right and 2 up and stop. What mathematical word is this?

Give instructions to get **a** KITE, **b** CIRCLE, **c** ADD.

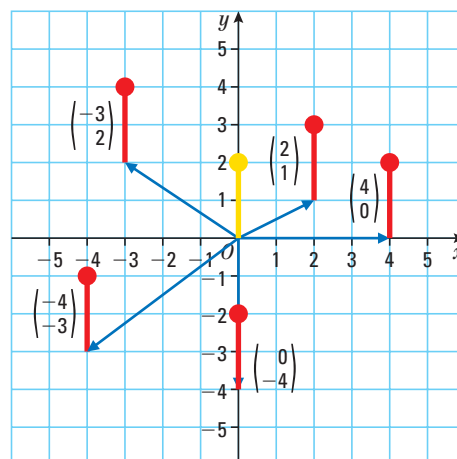
d Make up some examples of your own.

Key Points

- In the diagram, shape A has been mapped onto shape B by a **translation**.
- All points of shape A move 3 squares to the right and 6 squares up. This can be written as $\begin{pmatrix} 3 \\ 6 \end{pmatrix}$.
- In a translation, all points of the shape move the same distance in the same direction.
- In a translation:
 - the lengths of the sides of the shape do not change
 - the angles of the shape do not change
 - the shape does not turn.
- In a translation, any shape is congruent to its image because the lengths of the sides and angles of the shape are preserved by the translation.



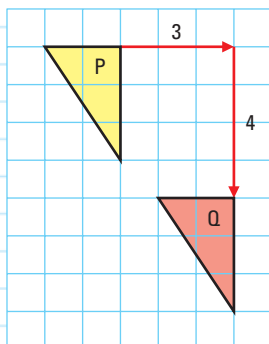
- $\begin{pmatrix} 3 \\ 6 \end{pmatrix}$ is a **vector**. Vectors can be used to describe translations. The top number shows the number of squares moved parallel to the x -axis, to the right or left. The bottom number shows the number of squares moved parallel to the y -axis, up or down. To the right and up are positive. To the left and down are negative.
- Some translations of the yellow shape to the red shape and their **column vectors** are shown on the grid.



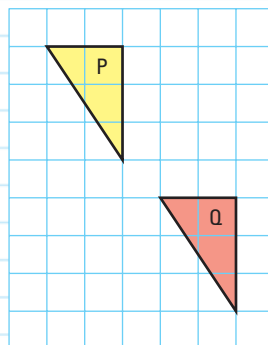
Example 1

Describe the translation that maps triangle P onto triangle Q.

Choose one corner of triangle P.



Count the number of squares to the right and the number of squares down from this corner on triangle P to the same corner on triangle Q.



The translation from triangle P to triangle Q is 3 squares to the right and 4 squares down.

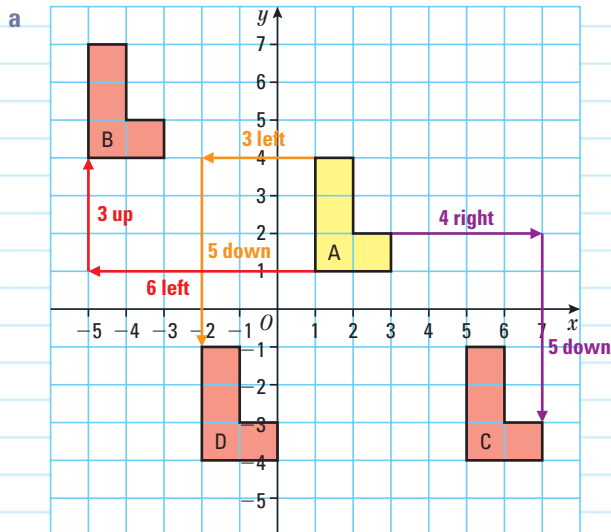
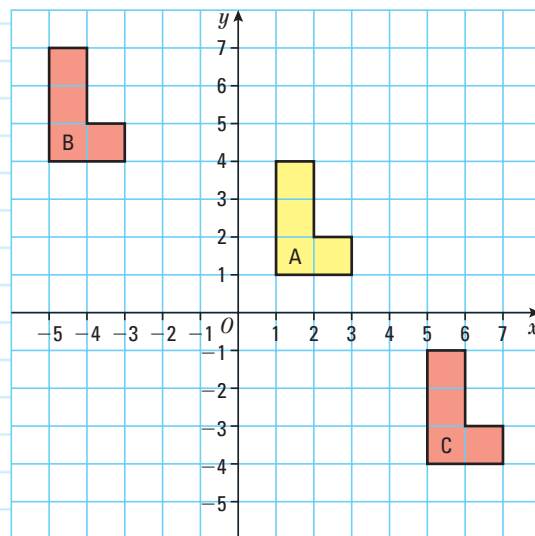
This translation can also be written as $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$.

Example 2

a Describe the transformation that maps shape A onto
i shape B ii shape C.

b Translate shape A by the vector $\begin{pmatrix} -3 \\ -5 \end{pmatrix}$.

Label this new shape D.



ResultsPlus
Examiner's Tip

The question asks for the transformation so as well as the vector, you must say it is a translation.

- i From A to B is the translation 6 to the left and 3 up, or the translation with vector $\begin{pmatrix} -6 \\ 3 \end{pmatrix}$.

Count the number of squares moved to the left (negative) and up (positive) from any corner in A to the same corner in B.

$\begin{pmatrix} -3 \\ -5 \end{pmatrix}$ means 3 to the left and 5 down.

- ii From A to C is the translation with vector $\begin{pmatrix} 4 \\ -5 \end{pmatrix}$.

- b D is marked on the diagram.

Choose one corner of shape A.
Count from this corner 3 squares to the left and then count 5 squares down to find where this corner has moved to.
The new shape is the same as shape A.
Draw the new shape and label it D.

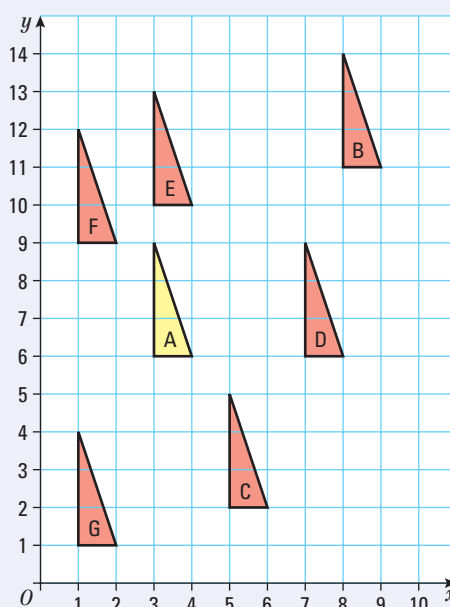


Exercise 17A

- 1 Describe, with a vector, the translation that maps triangle A onto:

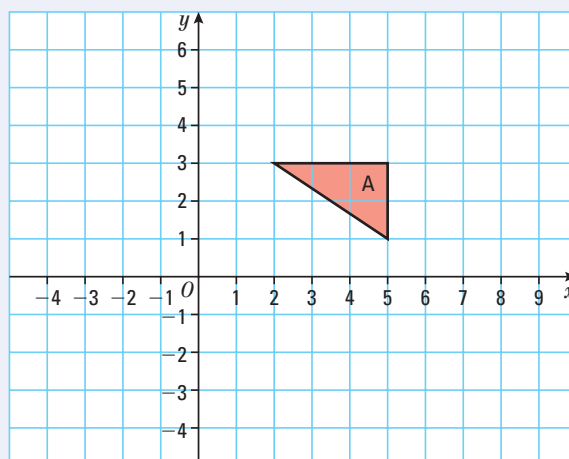
- a triangle B
- b triangle C
- c triangle D
- d triangle E
- e triangle F
- f triangle G.

Questions in this chapter are targeted at the grades indicated.



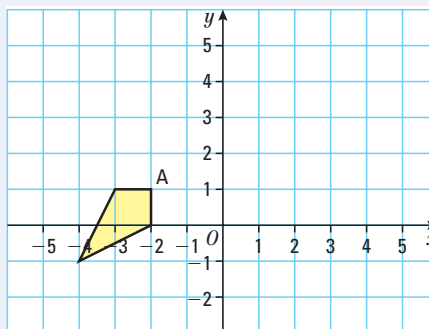
- 2 On a copy of the diagram translate triangle A:

- a 5 to the right and 4 up.
Label your new triangle B.
- b 4 to the right and 6 down.
Label your new triangle C.
- c 7 to the left. Label your new triangle D.
- d by the vector $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$.
Label your new triangle E.
- e by the vector $\begin{pmatrix} -6 \\ -4 \end{pmatrix}$.
Label your new triangle F.

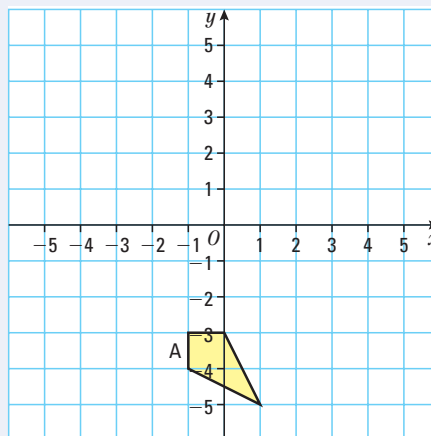


C

- 3 The coordinates of point A of this kite are $(-2, 1)$. The kite is translated so that the point A is mapped onto the point $(3, 4)$.
- On a copy of the diagram draw the image of the kite after this translation.
 - Describe this translation with a vector.



- 4 Draw the following translations on a copy of the diagram.
- Translate kite A by the vector $\begin{pmatrix} 4 \\ 7 \end{pmatrix}$. Label this new kite B.
 - Translate kite B by the vector $\begin{pmatrix} -6 \\ -3 \end{pmatrix}$. Label this new kite C.
 - Describe, with a vector, the translation that maps kite A onto kite C.
 - Describe, with a vector, the translation that maps kite C onto kite A.



17.2 Transforming shapes using reflections

Objectives

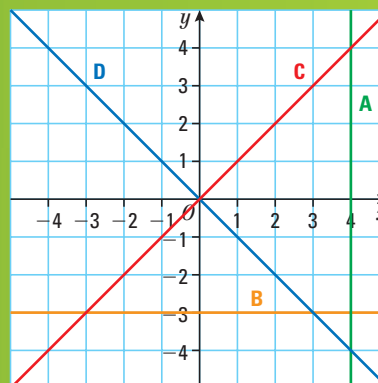
- You know that in a reflection the image is as far behind the mirror line as the object is in front of the mirror line.
- You understand that reflections are described by the mirror line.
- You can find an equation of a mirror line.
- You know that when shape A is mapped to shape B by a reflection, shape A and shape B are congruent.

Why do this?

Many interesting patterns can be produced using reflections. The patterns in a kaleidoscope are caused by light being reflected many times.

Get Ready

1. Write down the equation of each of the lines A, B, C and D.

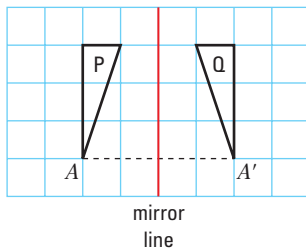


Key Points

- When you look in a mirror, you see your **reflection**.

The diagram below shows triangle P reflected in the mirror line to triangle Q.

The reflection of point A is point A' so A and A' are corresponding points.



Point A' is the same distance behind the mirror line as point A is in front.

The line joining points A and A' is perpendicular to the mirror line.

Triangle Q is the reflection of triangle P in the mirror line. Each corner of Q is the reflection in the mirror line of the corresponding corner of P.

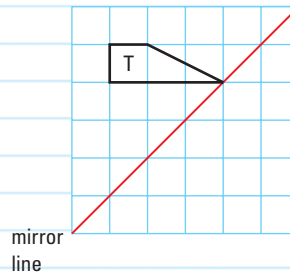
Triangle Q is as far behind the mirror line as triangle P is in front.

In mathematics all mirror lines are two-way mirrors so triangle P is also the reflection of triangle Q in the mirror line.

- To describe a reflection, give the mirror line.
- In a reflection:
 - the lengths of the sides of the shape do not change
 - the angles of the shape do not change
 - the reflection of a shape (the **image**) is as far behind the mirror line as the shape is in front.
- In a reflection, any shape is congruent to its image because the lengths of the sides and angles of the shape are preserved by the reflection.
- The mirror line is the line of symmetry.

Example 3

Reflect trapezium T in the mirror line.
Label the new trapezium U.

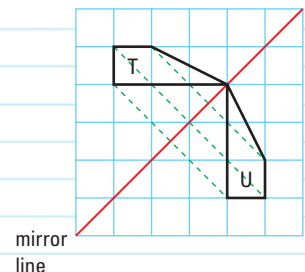


Method 1

Reflect each corner of T in the mirror line so that its reflection is the same distance behind the mirror line as the corner is in front.

Notice that:

the line joining each corner to its image is perpendicular to the mirror line
the image of the corner which is on the mirror line is also on the mirror line.

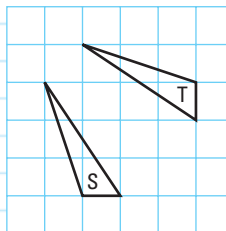


Method 2

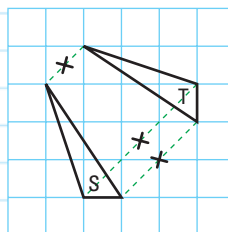
Put the edge of a sheet of tracing paper on the mirror line and make a tracing of the trapezium. Turn the tracing paper over and put the edge of the tracing paper back on the mirror line. Mark the images of the corners with a pencil or compass point. Method 2 is particularly useful when the shape is not a polygon or not drawn on a grid.

Example 4

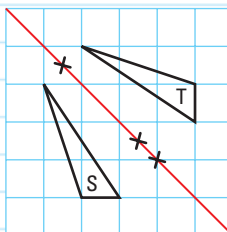
Triangle T is a reflection of triangle S.
Draw the mirror line of the reflection.



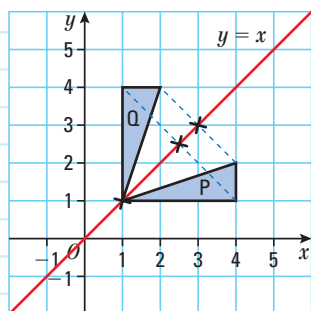
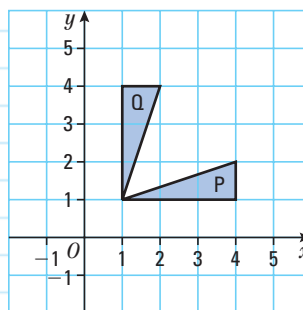
Join each corner of triangle S to its image on triangle T. The mirror line passes through the mid-points (marked with crosses) of these lines.



Draw the mirror line by joining the crosses.

**Example 5**

Describe fully the transformation which maps triangle P onto triangle Q.



The transformation is a reflection as triangle P has been 'flipped over' to triangle Q. Notice that the point on the mirror line does not move.



ResultsPlus
Examiner's Tip

Make sure that you can recognise the lines with equations $x = a$, $y = b$, $y = \pm x$

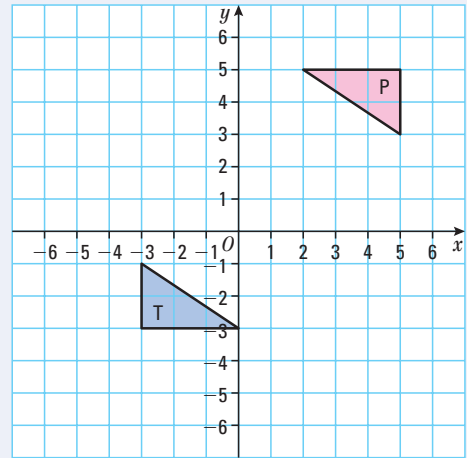
The transformation is a reflection in the line with equation $y = x$.



Exercise 17B

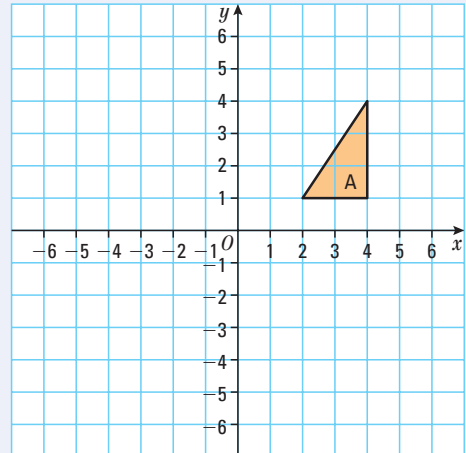
- 1 Make a copy of the diagram and complete the following reflections.

- Reflect triangle P in the line $x = 1$.
Label this new triangle Q.
- Reflect triangle P in the line $y = 2$.
Label this new triangle R.
- Describe the reflection that maps triangle Q onto triangle T.

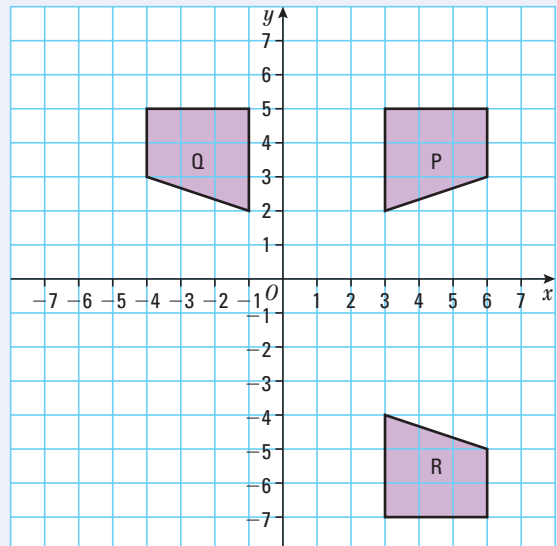


- 2 On a copy of the diagram, complete the following reflections.

- Reflect triangle A in the line $y = x$.
Label this new triangle B.
- Reflect triangle A in the line $y = -x$.
Label this new triangle C.
- Describe fully the transformation that maps triangle B onto triangle A.



- 3
- Give the equation of the mirror line of the reflection that maps:
 - shape P onto shape Q
 - shape P onto shape R.
 - Describe fully the transformation that maps shape Q onto shape P.



A03 D

A03 C

17.3 Transforming shapes using rotations

Objectives

- You know that in a rotation all points of a shape move around circles with the same centre.
- You understand that rotations are described by a centre and an angle of turn.
- You can find a centre of rotation.
- You know that when shape A is mapped to shape B by a rotation, shape A and shape B are congruent.

Why do this?

Many everyday objects turn or rotate, for example, cycle wheels and the hands of a clock. It is often necessary to describe the rotation.

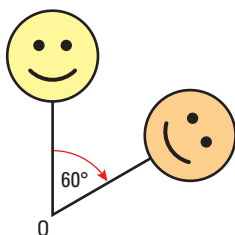
Get Ready

- Here is a clock face with only one hand. The hand is pointing to 12.
 - The hand is turned 90° anticlockwise. What number is the hand pointing to now?
 - Describe as fully as you can how the hand can turn to point to:
 - 3
 - 6
 - 5.
- Imagine that the hand is pointing to 5. Describe as fully as you can how the hand can turn to point to:
 - 8
 - 2
 - 11
 - 12.



Key Points

- To rotate means to turn. This face on a stick has rotated 60° clockwise about the point O. The size of the face has not changed.
- To describe a **rotation** you need to give:
 - the angle of turn
 - the direction of turn (clockwise or anticlockwise)
 - the point the shape turns about (the **centre of rotation**).
- In a rotation:
 - the lengths of the sides of the shape do not change
 - the angles of the shape do not change
 - the shape turns
 - the centre of rotation does not move.
- In a rotation, any shape is congruent to its image because the lengths of the sides and angles of the shape are preserved by the rotation.

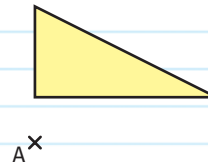
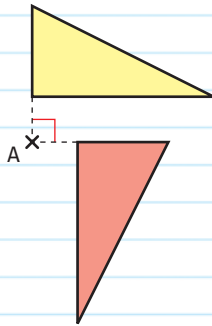


ResultsPlus Examiner's Tip

A common mistake when describing a rotation is to call it a turn instead of a rotation and forgetting to say where the centre of rotation is.

Example 6

Rotate the triangle a quarter turn clockwise about the point A.



Tracing paper can be used to rotate the shape. Trace the triangle and mark the point A.

Fix the point A with a pencil or a compass point so that the point A does not move. Turn the tracing paper about A, clockwise through a quarter turn (90°).

Now the position of the image of the triangle can be seen.

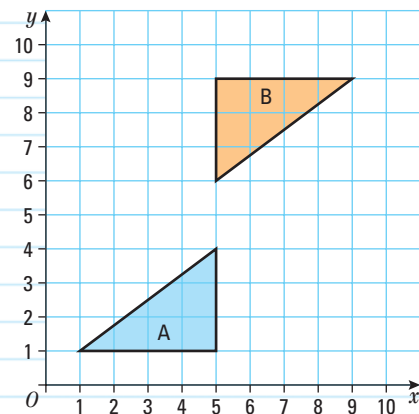
Notice that each line of the triangle has turned through a quarter turn clockwise.

Example 7

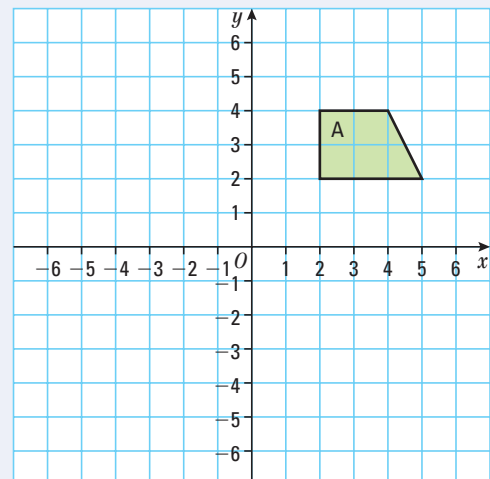
Describe the transformation that maps triangle A onto triangle B.

Triangle A is mapped onto triangle B by a rotation of 180° (a half turn) about the point (5, 5).

Tracing paper can be used to check that the transformation is a rotation of 180° with the centre of rotation the point (5, 5).

**Exercise 17C**

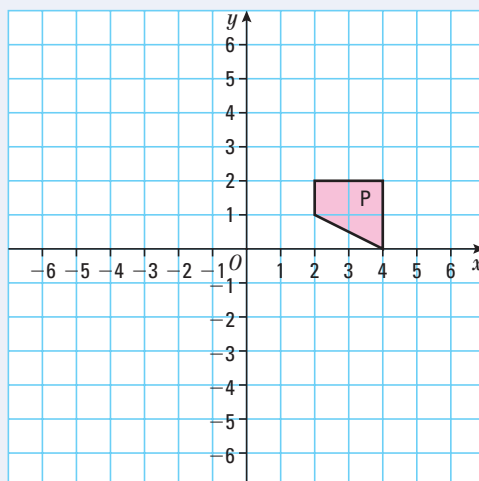
- 1 On a copy of the diagram, complete the following rotations.
 - a Rotate trapezium A a half turn about the origin O. Label the new trapezium B.
 - b Rotate trapezium A a quarter turn clockwise about the origin O. Label the new trapezium C.
 - c Rotate trapezium A a quarter turn anticlockwise about the origin O. Label the new trapezium D.



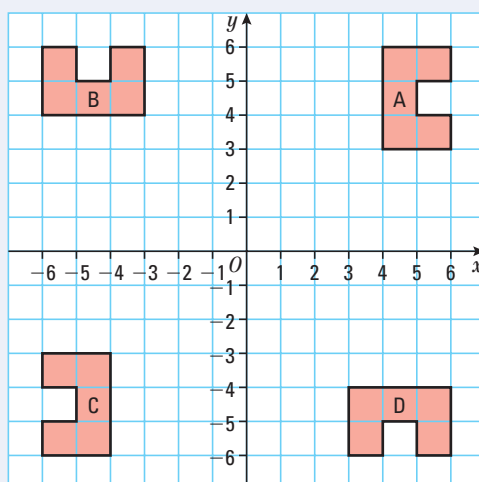
C

- 2 Make three copies of this diagram showing trapezium P.

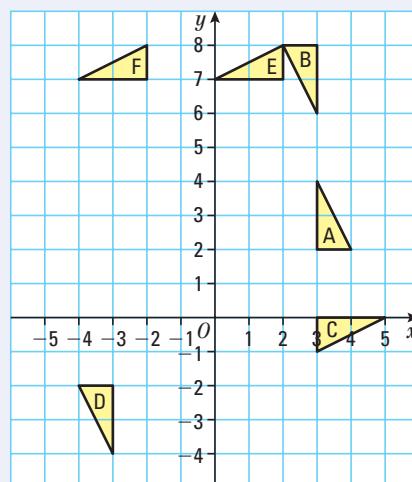
- On copy 1 of the diagram, rotate trapezium P 180° about the point $(2, 0)$. Label the new trapezium Q.
- On copy 2 of the diagram, rotate trapezium P 90° clockwise about the point $(-2, 2)$. Label the new trapezium R.
- On copy 3 of the diagram, rotate trapezium P 90° anticlockwise about the point $(-1, -1)$. Label the new trapezium S.



- 3
- Describe fully the rotation that maps shape A onto: **i** shape B **ii** shape C **iii** shape D.
 - Describe fully the rotation that maps shape B onto shape A.
 - Describe fully the rotation that maps shape B onto shape D.



- 4
- Describe fully the rotation that maps triangle A onto: **i** triangle B **ii** triangle C **iii** triangle D **iv** triangle E **v** triangle F.
 - Describe the transformation that maps triangle B onto triangle E.
 - Describe the transformation that maps: **i** triangle D onto triangle B **ii** triangle F onto triangle E.



A03

A03

17.4 Enlargements and scale factors

Objectives

- You can enlarge a shape given the scale factor.
- You know that enlargements preserve angles but change lengths.
- You understand that enlargements are described by a centre and a scale factor.
- You can find the centre of an enlargement.
- You can use positive and negative scale factors.

Why do this?

If you have holiday photos blown up for a poster, you are making an enlarged version of the original photo.

Get Ready

1. Plot the following points on graph paper and join them up.
 a (0, 1) b (1, 1) c (1, 0) d (0, 0)
2. Then plot the following points on the same graph and join them up.
 a (0, 2) b (2, 2) c (2, 0) d (0, 0)
3. What can you say about these two shapes?

Scale factors

Key Points

- Here is a photograph of a shark.



- Here is an **enlargement** of the photograph.



The sharks in the two photographs are the same but each length in the enlargement is 2 times the corresponding length in the original photograph.

For example, the length of the shark's fin in the enlargement is 2 times the length of the fin in the original photograph.

- The scale factor of an enlargement is the number of times by which each original length has been multiplied. So the larger photograph is an enlargement with scale factor 2 of the smaller photograph as

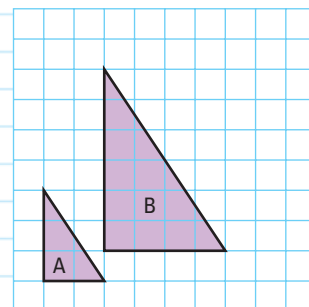
$$\text{scale factor} = \frac{\text{length of side in image}}{\text{length of corresponding side in object}}$$

- The scale factor can be found from the ratio of the lengths of two corresponding sides; in this case the ratio is 1 : 2.

- An enlargement changes the size of an object but not the shape of the object.
- Notice that each angle in the original photograph has the same size as the corresponding angle in the enlargement.
- So in an enlargement:
 - the lengths of the sides of the shape change
 - the angles of the shape do not change.

Example 8 Triangle B is an enlargement of triangle A.

- a Work out the scale factor of the enlargement that maps triangle A onto triangle B.
- b Work out the scale factor of the enlargement that maps triangle B onto triangle A.



- a Scale factor of the enlargement that maps triangle A onto triangle B = $\frac{4}{2}$.
Scale factor = 2

The base of triangle A is 2 squares. The base of triangle B is 4 squares. Notice that pairs of corresponding sides are parallel.

- b Scale factor of the enlargement that maps triangle B onto triangle A = $\frac{2}{4}$.
Scale factor = $\frac{1}{2}$

This answer means that the length of each side of triangle A is $\frac{1}{2}$ the length of the corresponding side of triangle B.

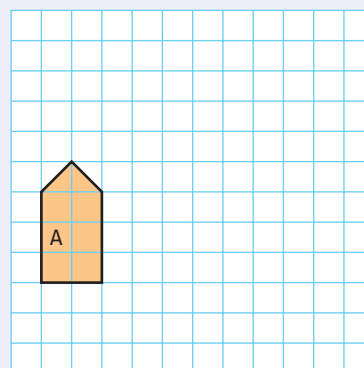


ResultsPlus
Examiner's Tip

The transformation is still called an enlargement when the scale factor is a positive fraction less than 1 so that the image is smaller than the object.

Exercise 17D

- 1 Here is a right-angled triangle.
The triangle is enlarged with a scale factor of 4.
 - a Work out the length of each side of the enlarged triangle.
 - b Compare the perimeter of the enlarged triangle with the perimeter of the original triangle.
- 2 Copy the shape on squared paper and draw:
 - a an enlargement of shape A with scale factor 3. Label this enlargement shape B.
 - b an enlargement of shape A with scale factor $\frac{1}{2}$. Label this enlargement shape C.
 - c Shape B is an enlargement of shape C. Work out the scale factor of the enlargement.

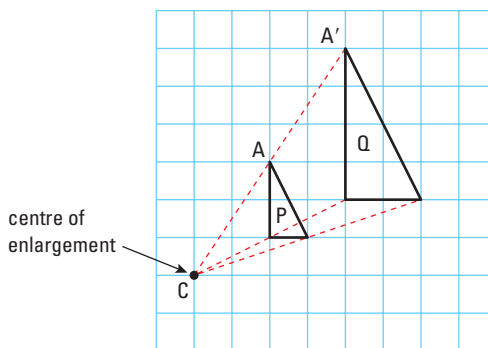


- 3 Rectangle P has a base of 4 cm and a height of 2 cm.
 Rectangle Q is an enlargement of rectangle P with a scale factor of 2.
 Rectangle R is an enlargement of rectangle P with a scale factor of 3.
- On squared paper, draw rectangles P, Q and R.
 - Find the perimeter of: i rectangle P ii rectangle Q iii rectangle R.
 - Find the area of: i rectangle P ii rectangle Q iii rectangle R.
 - Work out the value of: i $\frac{\text{Perimeter of Q}}{\text{Perimeter of P}}$ ii $\frac{\text{Perimeter of R}}{\text{Perimeter of P}}$.
 Write down anything that you notice about these values.
 - Work out the value of: i $\frac{\text{Area of Q}}{\text{Area of P}}$ ii $\frac{\text{Area of R}}{\text{Area of P}}$.
 Write down anything that you notice about these values.
 - Rectangle S is an enlargement of rectangle P with a scale factor of 8.
 What is the perimeter of rectangle S?

Centre of enlargement

Key Points

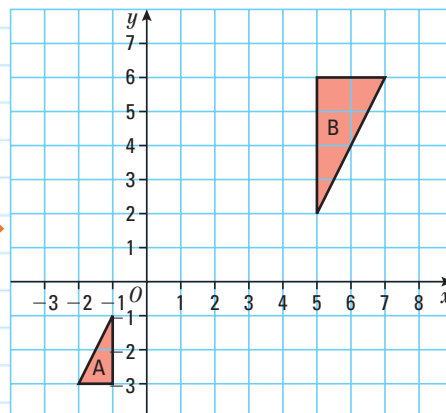
- In the diagram, triangle P has been enlarged by a scale factor of 2 to give triangle Q. The corner A of triangle P is mapped onto the corner A' of triangle Q. A line has been drawn joining A and A'. Lines have also been drawn joining the other pairs of corresponding points of triangles P and Q. The lines meet at a point C called the **centre of enlargement**.
 C to A is 2 squares across and 3 squares up.
 C to A' is 4 squares across and 6 squares up.
 So $\frac{CA'}{CA} = 2$, the scale factor of the enlargement.
- To describe an enlargement you need to give:
 - the scale factor
 - the centre of enlargement.
- In general, when shape P is mapped onto shape Q by an enlargement with centre C and scale factor k , $CA' = k \times CA$ for any point A of shape P and the corresponding point A' of shape Q.

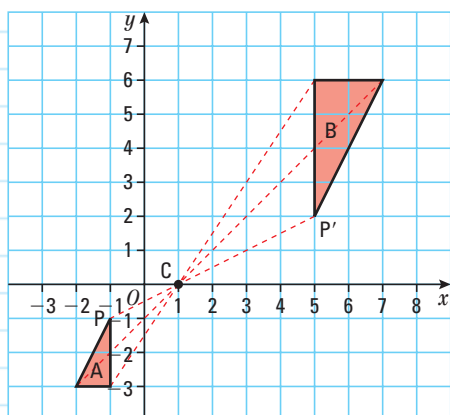


Example 9

Describe fully the transformation which maps triangle A onto triangle B.

The lengths of the sides of triangle B are twice those of triangle A.
 This means that the transformation is an enlargement.
 To find the centre of enlargement, join each corner (vertex) of triangle A to the corresponding vertex of triangle B.
 The centre of enlargement C is the point where these lines cross.





Notice that point C is between the object A and the image B. From C to P' is twice the distance from C to P but in the opposite direction. The scale factor of the enlargement is -2 .



ResultsPlus

Watch Out!

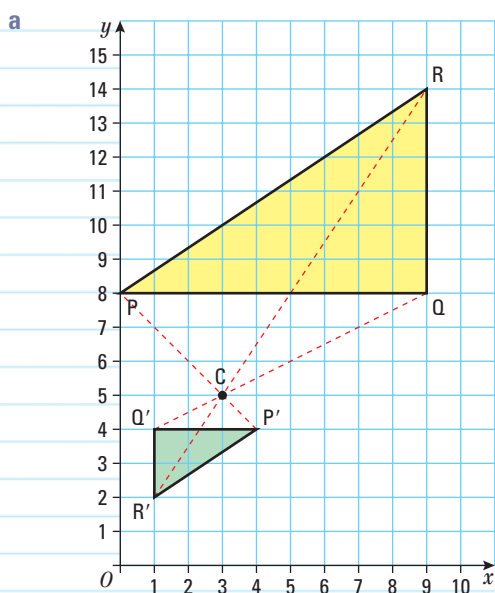
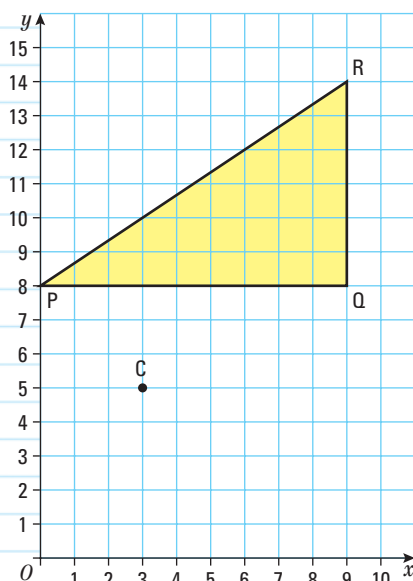
When a shape is enlarged by a negative scale factor, the image is on the opposite side of the centre of enlargement to the object.

The transformation is an enlargement with scale factor -2 , centre $(1, 0)$.



Example 10

- Enlarge triangle PQR by a scale factor of $-\frac{1}{3}$ with centre of enlargement C $(3, 5)$.
- Describe fully the transformation that maps triangle P'Q'R' onto triangle PQR.



From C to P is 3 squares to the left and 3 squares up. So from C to P' is $-\frac{1}{3} \times 3 = -1$ square to the left, or 1 square to the right, and $-\frac{1}{3} \times 3 = -1$ square up, or 1 square down.

In the same way, from C to Q' is 2 squares to the left and 1 square down, from C to R' is 2 squares to the left and 3 squares down.

- b The transformation that maps triangle $P'Q'R'$ onto triangle PQR is an enlargement with scale factor -3 , centre $(3, 5)$.

The lengths of the sides of triangle PQR are 3 times those of triangle $P'Q'R'$ and the centre of enlargement is between the two triangles.


ResultsPlus
Examiner's Tip

The word 'enlargement' is used even when the new shape is smaller than the original shape.

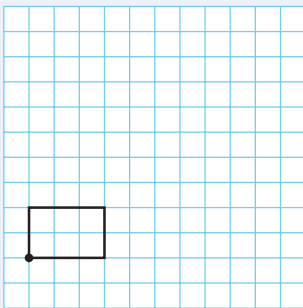

ResultsPlus
Examiner's Tip

In an enlargement, corresponding sides in the object and the image are parallel.


Exercise 17E

- 1 Copy the shape on squared paper and draw the enlargement of the shape with the given scale factor and centre of enlargement marked with a dot (\bullet).

- a Scale factor 3.

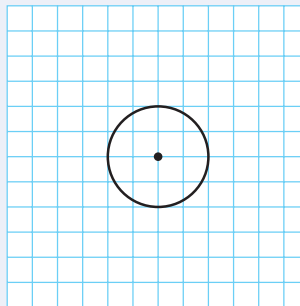


- b i Scale factor 3.

- ii Scale factor 2.

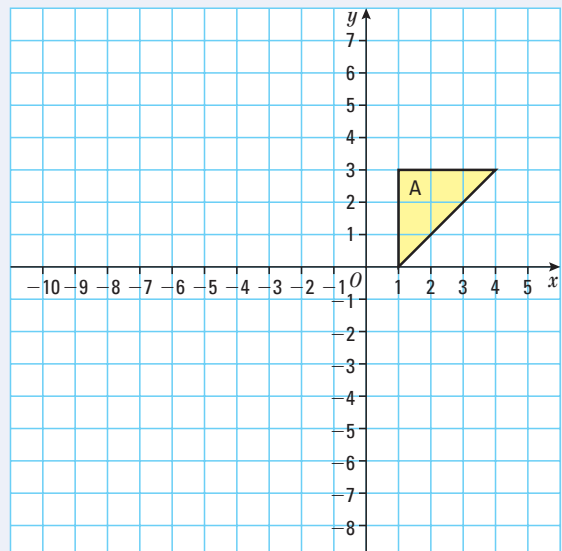
- iii Scale factor $\frac{1}{2}$.

Draw all three enlargements on the same diagram.

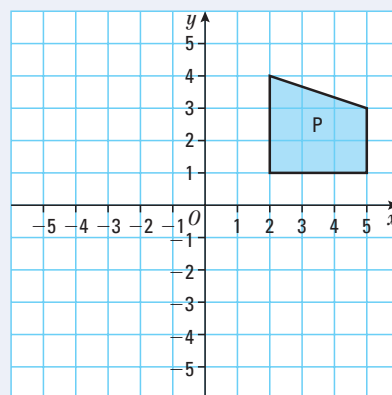


- 2 On a copy of the diagram complete the following enlargements.

- a Enlarge triangle A with a scale factor of -2 , centre $(0, 0)$. Label this new triangle B.
 b Enlarge triangle A with a scale factor of $-\frac{1}{3}$, centre $(1, 6)$. Label this new triangle C.
 c Find the scale factor of the enlargement that maps triangle C onto triangle B.



- 3 a On a copy of the diagram, enlarge shape P with a scale factor of -1 , centre $(1, 2)$. Label this new shape Q.
The mapping of shape P onto shape Q is also a rotation.
- b Describe fully the rotation that maps shape P onto shape Q.



17.5 Combinations of transformations

Objectives

- You can transform a shape using combined translations, rotations, reflections or enlargements.
- You can find a single transformation which has the same effect as a combination of transformations.

Why do this?

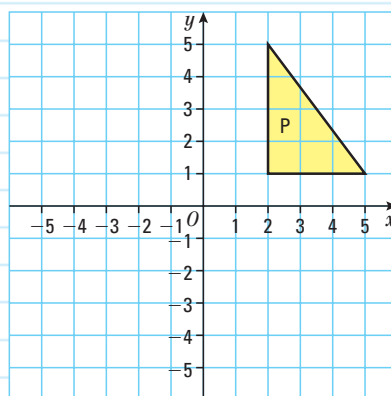
Many designs for wallpaper and fabric are based on combinations of transformations.

Key Points

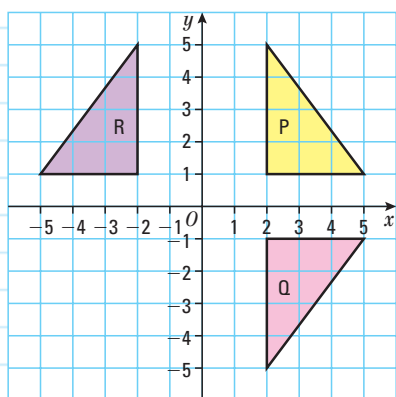
- A combination of transformations is when shape P is transformed to shape Q and then shape Q is transformed to shape R. It may be possible to find a single transformation which maps shape P onto shape R.
For example, a reflection in the y -axis has the same effect as a reflection in the x -axis followed by a rotation of 180° about the origin.

Example 11

- a Reflect triangle P in the x -axis. Label the new triangle Q.
- b Rotate triangle Q 180° about the origin O. Label the new triangle R.
- c Describe fully the single transformation which maps triangle P onto triangle R.



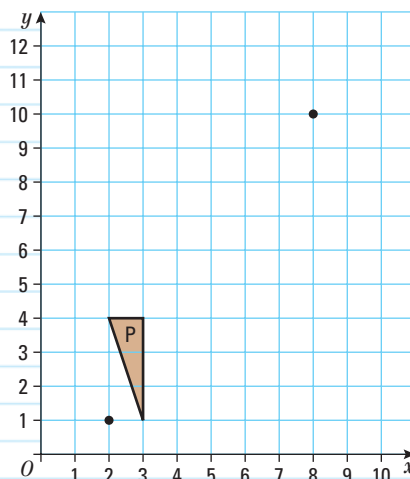
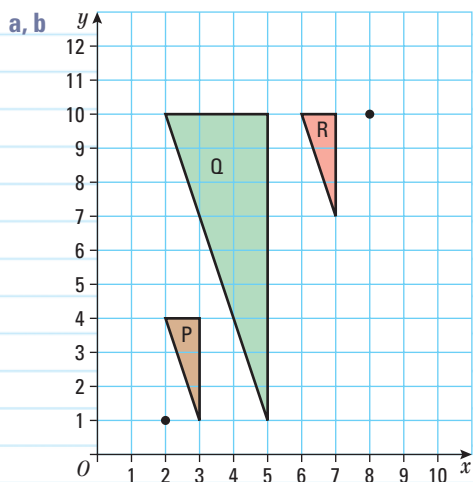
a, b



- c The single transformation which maps triangle P onto triangle R is a reflection in the y -axis.

Example 12

- a** Enlarge triangle P with scale factor 3 and centre of enlargement (2, 1).
Label the new triangle Q.
- b** Enlarge triangle Q with scale factor $\frac{1}{3}$ and centre of enlargement (8, 10).
Label the new triangle R.
- c** Describe fully the single transformation which maps triangle P onto triangle R.



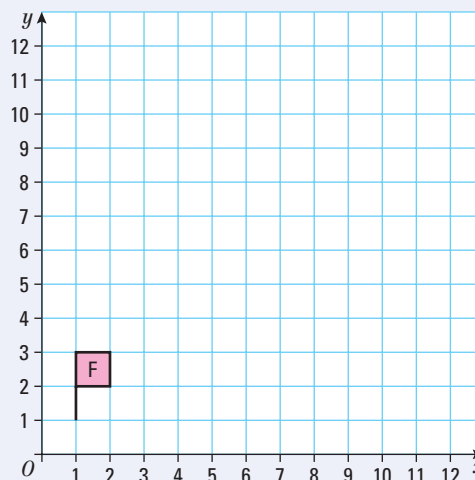
- c** From P to R is 4 to the right and 6 up.

The single transformation which maps triangle P onto triangle R is the translation with vector $\begin{pmatrix} 4 \\ 6 \end{pmatrix}$.

**Exercise 17F**

For each question, make a copy of the diagram.

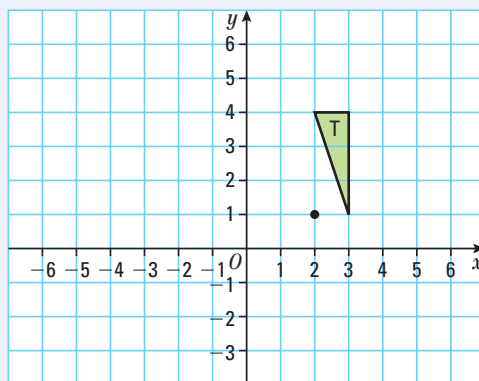
- 1** Complete the following translations.
- a** Translate flag F by the vector $\begin{pmatrix} 3 \\ 8 \end{pmatrix}$.
Label the new flag G.
- b** Translate flag G by the vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$.
Label the new flag H.
- c** Describe fully the single transformation which maps flag F onto flag H.
- d** Describe fully the single transformation which maps flag H onto flag F.



B

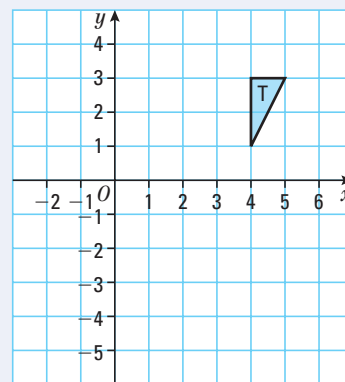
2 Complete the following transformations.

- Rotate triangle T 180° about (2, 1).
Label the new triangle U.
- Translate triangle U by the vector $\begin{pmatrix} 4 \\ 4 \end{pmatrix}$.
Label the new triangle V.
- Describe fully the single transformation which maps triangle T onto triangle V.

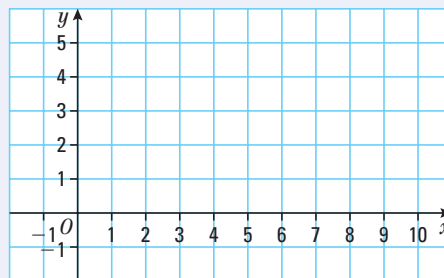


3 Complete the following transformations.

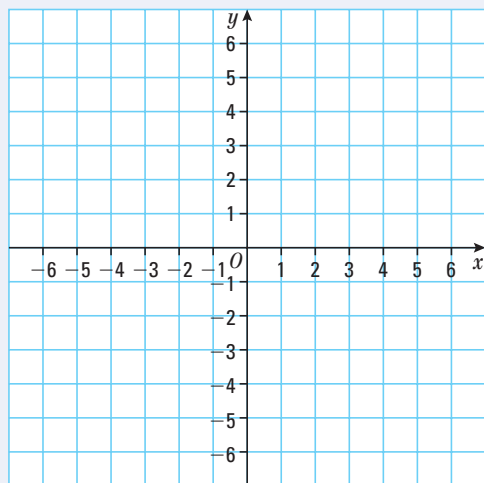
- Rotate triangle T 90° clockwise about the origin O.
Label the new triangle U.
- Reflect triangle U in the line $y = -x$. Label the new triangle V.
- Describe fully the single transformation which has the same effect as a rotation of 90° clockwise about the origin O followed by a reflection in the line $y = -x$.



- * 4 Use your copy of the graph paper to find and describe fully the single transformation which has the same effect as a translation with vector $\begin{pmatrix} 4 \\ 0 \end{pmatrix}$ followed by a reflection in the line $x = 7$.



* 5



Use your copy of the graph paper to find and describe fully the single transformation which has the same effect as a rotation of 180° about (0, 0) followed by a reflection in the y -axis.

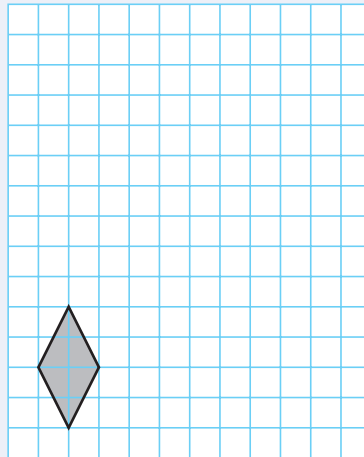
Chapter review

- In a **translation**, all points of the shape move the same distance in the same direction.
- In a translation
 - the lengths of the sides of the shape do not change
 - the angles of the shape do not change
 - the shape does not turn.
- In a translation, any shape is congruent to its image because the lengths of the sides and angles of the shape are preserved by the translation.
- **Vectors** can be used to describe translations.
- The top number shows the number of squares moved parallel to the x -axis, to the right or left.
- The bottom number shows the number of squares moved parallel to the y -axis, up or down.
- To the right and up are positive.
- To the left and down are negative.
- In a **reflection**:
 - the lengths of the sides of the shape do not change
 - the angles of the shape do not change
 - the **image** is as far behind the mirror line as the shape is in front.
- To describe a reflection, give the mirror line. The mirror line is the line of symmetry.
- In a reflection, any shape is congruent to its image because the lengths of the sides and angles of the shape are preserved by the reflection.
- To describe a **rotation**, give:
 - the angle of turn
 - the direction of turn (clockwise or anticlockwise)
 - the point the shape turns about (the **centre of rotation**).
- In a rotation:
 - the lengths of the sides of the shape do not change
 - the angles of the shape do not change
 - the shape turns
 - the centre of rotation does not move.
- In a rotation, any shape is congruent to its image because the lengths of the sides and angles of the shape are preserved by the rotation.
- In an **enlargement**:
 - the lengths of the sides of the shape change
 - the angles of the shape do not change.
- To describe an enlargement, give:
 - the scale factor
 - the centre of enlargement.
- If each vertex of shape P is joined to the corresponding vertex of shape Q, the joining lines intersect at the **centre of enlargement**.
- In general, when shape P is mapped onto shape Q by an enlargement with centre C and scale factor k , $CA' = k \times CA$ for any point A of shape P and the corresponding point A' of shape Q.
- A combination of transformations is when shape P is transformed to shape Q and then shape Q is transformed to shape R. It may be possible to find a single transformation which maps shape P onto shape R.



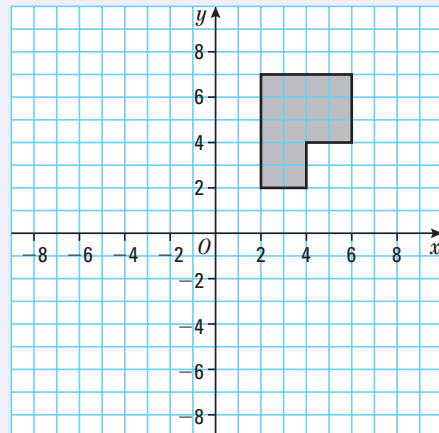
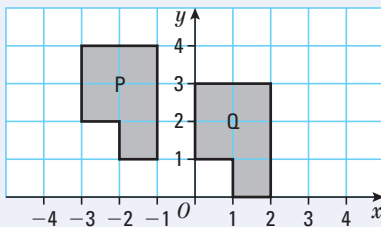
Review exercise

- 1 On a copy of the grid, draw an enlargement of the shaded shape with a scale factor of 3.



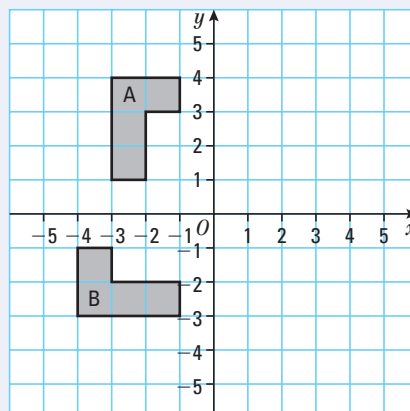
Nov 2006

- 2 a On a copy of the grid, rotate the shaded shape 90° clockwise about the point O .
b Describe fully the single transformation that will map shape P onto shape Q.



May 2009

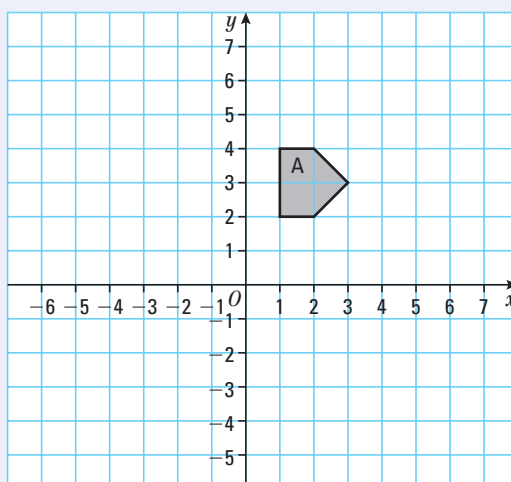
3



- a On a copy of the grid, reflect shape A in the y -axis.
b Describe fully the **single** transformation which takes shape A to shape B.

Nov 2008

4



On a copy of the grid:

- a reflect shape A in the y -axis. Label your new shape B.
- b translate shape A by 3 squares right and 2 squares down. Label your new shape C.

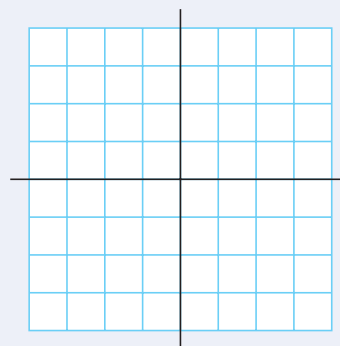
Nov 2007

5

You have been asked to design a bathroom tile with reflective symmetry.

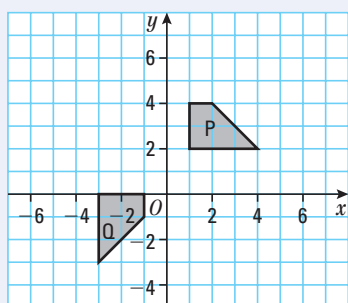
Draw a design in the top left 4 by 4 corner.

Then reflect your design in the vertical and horizontal lines to create the full pattern.



6

Describe fully the single transformation that will map shape P onto shape Q.



ResultsPlus
Exam Question Report

61% of students answered this question poorly.

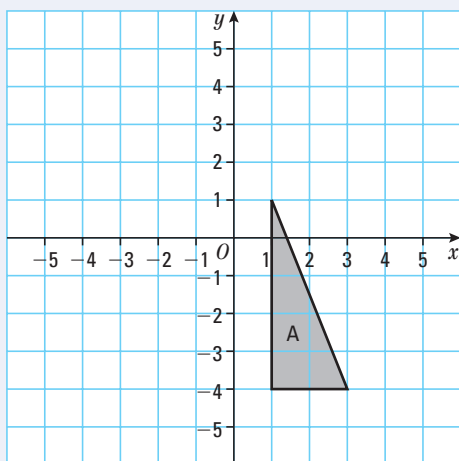
Nov 2007

D

A03 C

C

7

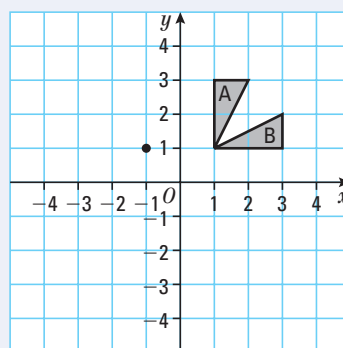


On a copy of the grid, enlarge triangle A by scale factor $-\frac{1}{2}$, centre $(-1, -2)$.
Label your triangle B.

Nov 2005

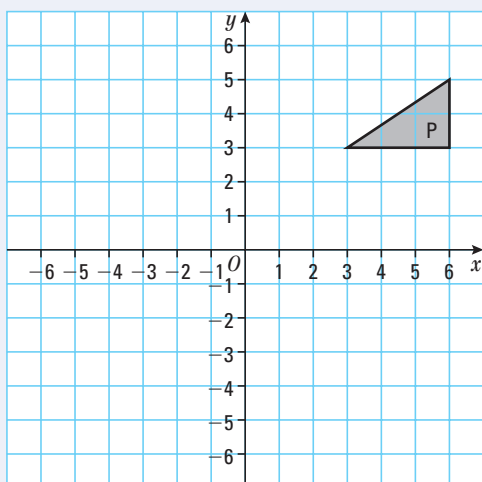
8

- a Describe fully the single transformation that maps triangle A onto triangle B.
- b On a copy of the grid, rotate triangle A 90° anticlockwise about the point $(-1, 1)$. Label your new triangle C.

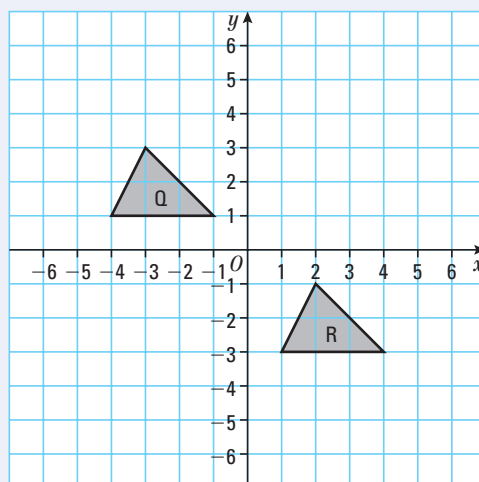


Nov 2006

9



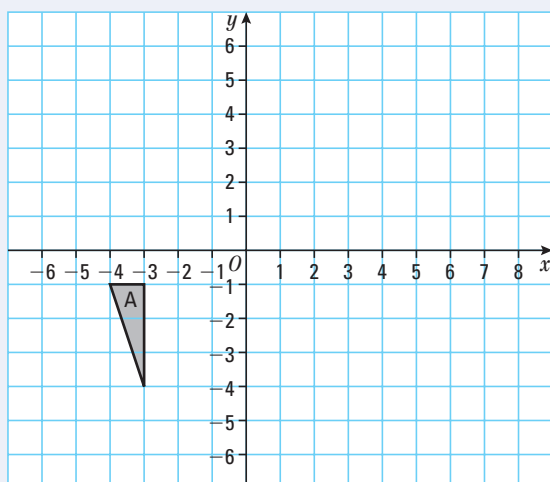
- a On a copy of the grid, reflect triangle P in the line $x = 2$.



- b Describe fully the **single** transformation that takes triangle Q to triangle R.

Nov 2006

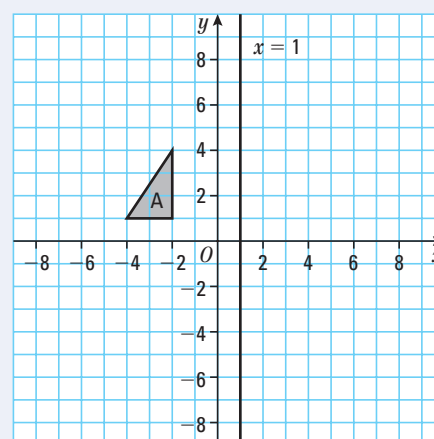
10



On a copy of the grid, enlarge triangle A by scale factor -2 , centre $(0, -1)$.

* 11

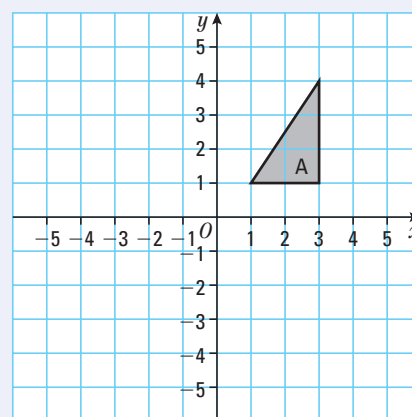
Triangle A is reflected in the x -axis to give triangle B. Triangle B is reflected in the line $x = 1$ to give triangle C. Describe the **single** transformation that takes triangle A to triangle C.



June 2008

* 12

Triangle A is reflected in the y -axis to give triangle B. Triangle B is then reflected in the x -axis to give triangle C. Describe the single transformation that takes triangle A to triangle C.



June 2006

C

A03 B

A03