1 Reflection and rotation symmetry

This work will help you
• recognise reflection symmetry and rotation symmetry in a shape
• complete a shape with given reflection or rotation symmetry
• name types of triangle and quadrilateral, and recognise symmetrical and regular polygons

You need sheets F1–1, F1–2, F1–3 and F1–4.

A Reflection symmetry  level 4

A shape with reflection symmetry has one or more mirror lines that reflect one half of the shape exactly on to the other half. These mirror lines are called lines of symmetry.

A1 How many lines of symmetry has each of these shapes?

(a)  (b)  (c)  (d)  (e)

A2 This question is on sheet F1–1.

A3 This question is on sheet F1–2.

A4 Copy each diagram and follow the instruction below it.

(a)  (b)  (c)  (d)

Shade two more squares to make a pattern with 2 lines of symmetry.
Shade two more squares to make a pattern with 1 line of symmetry.
Shade three more squares to make a pattern with 4 lines of symmetry.
Shade two more squares to make a pattern with 1 line of symmetry.
B Rotation symmetry

A shape with rotation (or rotational) symmetry can be rotated round its centre so that it fits on top of itself more than one way. The order of rotation symmetry is the number of different positions a shape fits on top of itself.

We say that a shape with no rotation symmetry has order 1 as it fits on top of itself in only one way.

B1 What is the order of rotation symmetry of each of these?

(a) ![Diagram of a shape with rotation symmetry of order 2.]
(b) ![Diagram of a shape with no rotation symmetry.]
(c) ![Diagram of a shape with rotation symmetry of order 4.]
(d) ![Diagram of a shape with rotation symmetry of order 1.]

B2 This question is on sheet F1–3.

B3 Copy each diagram and complete it as stated.

(a) ![Diagram with instruction to add two more squares so that the final shape has rotation symmetry of order 2.]
(b) ![Diagram with instruction to add three more squares so that the final shape has rotation symmetry of order 4.]
(c) ![Diagram with instruction to add three more squares so that the final shape has no rotation symmetry.]

B4 Copy this diagram and shade two more squares so that it has rotation symmetry of order 4.
C Both types of symmetry

A shape can have reflection symmetry and rotation symmetry

This shape has reflection symmetry but no rotation symmetry.

This shape has rotation symmetry but no reflection symmetry.

This shape has both reflection and rotation symmetry.

• How many lines of symmetry does it have?
• What is its order of rotation symmetry?
• Describe the symmetry of this shape.

C1 For each design below
(i) write down how many lines of symmetry it has
(ii) write down the order of rotation symmetry

(a)  
(b)  
(c)  
(d)  

(e)  
(f)  
(g)  
(h)  

C2 This question is on sheet F1–4.
A mosaic pattern is made by joining the centres of regular hexagons. This is part of the pattern with some shapes shaded.

- What kind of triangle is shape A?
- Name each of the shaded quadrilaterals.
- How many lines of symmetry has each shape?
- What is the order of rotation symmetry of each shape?

**D1** This diagram shows a regular hexagon split into four triangles. How many of these triangles are isosceles?

**D2** Here is another way to split up a regular hexagon. What is the name of the quadrilateral in this hexagon?

**D3** Show how to split up a regular hexagon into

- (a) a rectangle and two isosceles triangles
- (b) two trapeziums
- (c) three rhombuses
- (d) an equilateral triangle and three isosceles triangles

**D4** Draw an isosceles triangle. Show clearly any lines of symmetry.

**D5** (a) Draw a rectangle and show any lines of symmetry it has.
    (b) What order of rotation symmetry does a rectangle have?

**D6** Describe the symmetry of a square.

**D7** Draw a trapezium that has no reflection symmetry.
Lines that join corners across a shape are called its **diagonals**.

**D8** Identify each quadrilateral by the given information.

(a) I have rotation symmetry of order 2. My diagonals cross at right angles.

(b) My diagonals are the same length. I have rotation symmetry of order 4.

(c) I have reflection symmetry but no rotation symmetry. My diagonals cross at right angles.

(d) My diagonals are the same length. I have rotation symmetry of order 2.

(e) I have no reflection symmetry. I have two pairs of parallel sides.

**E Symmetrical and regular polygons**

A **polygon** is a shape with straight edges. Some polygons that have special names are shown in this table.

<table>
<thead>
<tr>
<th>Number of sides</th>
<th>Name of polygon</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>triangle</td>
</tr>
<tr>
<td>4</td>
<td>quadrilateral</td>
</tr>
<tr>
<td>5</td>
<td>pentagon</td>
</tr>
<tr>
<td>6</td>
<td>hexagon</td>
</tr>
<tr>
<td>8</td>
<td>octagon</td>
</tr>
<tr>
<td>10</td>
<td>decagon</td>
</tr>
</tbody>
</table>

**E1** All these shapes are hexagons. Which hexagon has

(a) only one line of symmetry

(b) rotation symmetry but no reflection symmetry

(c) rotation symmetry of order 3 and 3 lines of symmetry

(d) no reflection or rotation symmetry
Here are some regular polygons.

(a) Copy and complete this table.

<table>
<thead>
<tr>
<th>Polygon</th>
<th>Number of sides</th>
<th>Lines of symmetry</th>
<th>Order of rotation symmetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equilateral triangle</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Square</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Regular pentagon</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Regular hexagon</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Regular nonagon</td>
<td>7</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

(b) An icosagon is a polygon with 20 sides. What symmetry does a regular icosagon have?
Using coordinates

F1 Each shape in this diagram is one half of a quadrilateral. Each quadrilateral has line M as a line of symmetry.

(a) Copy the diagram.

(b) Draw a reflection of each shape in line M.

(c) Write down the coordinates of each corner of the rhombus.

(d) Write down the name of the other quadrilateral.

F2 The shape in this diagram is part of a hexagon. The x-axis is a line of symmetry of the hexagon.

(a) Copy the diagram and complete the hexagon.

(b) Write down the coordinates of each corner of the hexagon.

(c) How many lines of symmetry does the hexagon have?

F3 This diagram shows half a quadrilateral. The quadrilateral has rotation symmetry of order 2.

(a) (i) Copy the diagram and complete the quadrilateral.

(ii) What are the coordinates of the fourth corner of the quadrilateral?

(b) What is the name of this quadrilateral?

(c) How many lines of symmetry does the quadrilateral have?

F4 Draw a grid going from −4 to 4 on both axes.

(a) Draw a straight line from (2, 0) to (2, 3). Then draw a straight line from (2, 3) to (−2, 0).

(b) (i) Add another point to make a quadrilateral with rotation symmetry of order 2.

(ii) What are the coordinates of this point?
Test yourself

T1 Here are four road signs.

![Road signs A, B, C, D](image)

Two of these road signs have one line of symmetry.

(a) Write down the letters of each of these two road signs.

Only one of these four road signs has rotational symmetry.

(b) (i) Write down the letter of this road sign.

(ii) Write down its order of rotational symmetry.

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T2 Judith has lots of tiles, all like this one.

![Tile](image)

(a) Judith makes these patterns.

For each pattern, write down the number of lines of symmetry it has.

If the pattern does not have reflection symmetry, write 0.

(i) (ii) (iii) (iv) (v)

(b) Copy and complete this tiling pattern so that it has rotation symmetry of order 4.

OCR

T3 This design is made from a regular hexagon and four equilateral triangles.

(a) What is its order of rotation symmetry?

(b) Write down the number of lines of symmetry it has.