CHAPTER 9

SYMMETRY

Complete Notes with Step-by-Step Solutions

Introduction to Symmetry

Look around you — you may find many objects that catch your attention. What is it that makes these objects beautiful? The answer often lies in SYMMETRY!

What is Symmetry?

A symmetry refers to a part or parts of a figure that are repeated in some definite pattern. A figure having such repetitions is called a SYMMETRICAL figure.

When a figure is made up of parts that repeat in a definite pattern, we say that the figure has symmetry.

Real-Life Examples of Symmetry

Flower	Butterfly	Rangoli	Pinwheel
6 lines of symmetry	*1 line of symmetry (vertical)*	*4 lines of symmetry + rotational*	*Has rotational symmetry (no line)*

Symmetrical vs Non-Symmetrical: Flowers, butterflies, rangoli and pinwheels are SYMMETRICAL. Clouds are NOT symmetrical because there is no definite pattern that repeats.

Symmetrical structures: Taj Mahal (reflection symmetry), Gopuram (reflection + rotational symmetry)

9.1 Line of Symmetry

Definition of Line of Symmetry

Line of Symmetry: A line that cuts a figure into two parts that exactly overlap when folded along that line. Also called the axis of symmetry.

Mirror Halves: The two parts of a figure that exactly overlap when folded along the line of symmetry.

Reflection Symmetry: A figure that has a line or lines of symmetry is said to have reflection symmetry.

The folding concept: If you fold a figure along the line of symmetry, one half covers the other half COMPLETELY. The two halves are called mirror halves.

Understanding Line of Symmetry (Folding Concept)

```
               Before Folding:           After Folding:

                ___________               __________
                  |    |    |     fold→     |《》》》》》《|
                |    |    |               |  overlap |
                |____|____|               |__________|
                                  ↑
                           Line of Symmetry
         (Two halves overlap completely = Line of Symmetry EXISTS)
```

When Folding DOES NOT work (No Line of Symmetry)

```
               Before Folding:           After Folding:

                ___________               __________
                 |\  |    /|     fold→     |\  |  /|
                 | \ |   / |               | \≠| / |
                 |__\|__/__|               |__×|/__|
                                  ↑
               (Halves do NOT overlap = No Line of Symmetry)
```

Figures with More than One Line of Symmetry

Some figures can be folded in MULTIPLE ways to create mirror halves. Such figures have MULTIPLE lines of symmetry.

Square — 4 Lines of Symmetry

A square has FOUR lines of symmetry:

- Fold 1 — Vertical fold (top to bottom midpoint)
- Fold 2 — Horizontal fold (left to right midpoint)
- Fold 3 — Diagonal fold (top-left to bottom-right corner)
- Fold 4 — Diagonal fold (top-right to bottom-left corner)

Note: There is NO other way to fold a square so that two halves overlap.

Square — 4 Lines of Symmetry

```
                  |
          A────┼────B
          │    │    │
       ──┼────+────┼──
          │    │    │
          D────┼────C
                  |
```

```
Line 1: Vertical (|)    Line 2: Horizontal (—)
Line 3: Diagonal (\)    Line 4: Diagonal (/)
```

Rectangle (Non-Square) — Only 2 Lines of Symmetry

A rectangle that is NOT a square has only 2 lines of symmetry:

- Vertical fold (through the midpoints of left and right sides)
- Horizontal fold (through the midpoints of top and bottom sides)

Important: The DIAGONAL of a rectangle (that is not a square) is NOT a line of symmetry! When you fold a non-square rectangle along its diagonal, the two parts do NOT overlap.

Reflection — Understanding Symmetry with Labels

When we fold a square ABCD along the vertical line of symmetry:

- Points B and C (on the right) get reflected to occupy the positions of A and D
- Points A and D get reflected to occupy the positions of B and C

When we reflect along the diagonal AC:

- D occupies the position of B
- B occupies the position of D
- A and C remain at the same place

When we reflect along the horizontal line of symmetry:

- D and C occupy the positions of A and B respectively
- A and B occupy the positions of D and C respectively

Generating Shapes Having Lines of Symmetry

We can CREATE symmetrical figures using fun activities:

Ink Blot Devils	Paper Folding & Cutting	Punching Game	Pattern Creation
Fold paper, spill ink on one half, press together — the fold is the line of symmetry!	Fold paper along a line, cut a shape, unfold — you get a symmetrical shape!	Fold paper, punch a hole — when unfolded, holes are symmetric about the fold line!	Fold coloured paper multiple times, cut intricate patterns for festive decorations!

Section 9.1 — Figure it Out: Questions & Solutions

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Q1. Do you see any line of symmetry in the figures at the start of the chapter? What about in the picture of the cloud?

Ans.

- Flower — 6 lines of symmetry (one through each petal)
- Butterfly — 1 line of symmetry (vertical line through the body)
- Rangoli — 4 lines of symmetry (vertical, horizontal, and 2 diagonals)

- Pinwheel — NO line of symmetry (but has rotational symmetry)
- Cloud — NO line of symmetry (irregular, no pattern)

Final Answer: Flower: 6, Butterfly: 1, Rangoli: 4, Pinwheel: 0, Cloud: 0 lines of symmetry

Q2. For each of the following figures, identify the line(s) of symmetry if it exists.

Ans.

Analysis of each figure:

- Figure 1 (Irregular arrow-like shape): Has 1 line of symmetry — a diagonal line from one corner
- Figure 2 (Diamond/Kite shape): Has 1 line of symmetry — a vertical line through the middle
- Figure 3 (Rectangle): Has 1 line of symmetry visible (along the longer axis shown)
- Figure 4 (L-shape): Has NO line of symmetry
- Figure 5 (Scalene triangle): Has NO line of symmetry

Final Answer: See diagrams above — fold each figure mentally to check for overlap

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Q. Is there any other way to fold the square so that the two halves overlap? How many lines of symmetry does the square shape have?

Ans.

No, there is NO other way to fold the square (beyond the 4 folds already found).

Final Answer: The square shape has exactly 4 lines of symmetry.

Q. We saw that the diagonal of a square is also a line of symmetry. Let us take a rectangle that is not a square. Is its diagonal a line of symmetry?

Ans.

No! The diagonal of a rectangle (that is not a square) is NOT a line of symmetry.

Why? When you fold the rectangle along its diagonal, the two triangular parts do NOT overlap because a non-square rectangle has unequal adjacent sides. The longer triangle 'sticks out' beyond the shorter one.

Final Answer: Rectangle diagonal is NOT a line of symmetry (unless it is a square).

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Q. What if we reflect along the diagonal from A to C? Where do points A, B, C and D go? What if we reflect along the horizontal line of symmetry?

Ans.

Reflection along diagonal AC:

- A stays at A (it is on the line of symmetry)
- C stays at C (it is on the line of symmetry)

- B goes to the position of D
- D goes to the position of B

Reflection along horizontal line of symmetry:

- A occupies the position of D
- B occupies the position of C
- D occupies the position of A
- C occupies the position of B

Final Answer: AC diagonal: B↔D swap, A and C stay. Horizontal: A↔D and B↔C swap.

Page No. 223-226 — Punching Game & Paper Cutting

Q1. In each of the following figures, a hole was punched in a folded square sheet of paper and then the paper was unfolded. Identify the line along which the paper was folded. Figure (d) was created by punching a single hole. How was the paper folded?

Ans.

Identifying fold lines from hole positions:

- Figure (a): Two holes symmetrically placed left-right → Folded along VERTICAL line (left-right fold)
- Figure (b): Two holes placed diagonally at top → Folded along DIAGONAL line (from top-right to bottom-left)
- Figure (c): Two holes placed vertically (one top, one bottom) → Folded along HORIZONTAL line
- Figure (d): Four holes at corners → Paper was folded VERTICALLY, then HORIZONTALLY (or vice versa), then a single hole was punched

Final Answer: (a) Vertical fold, (b) Diagonal fold, (c) Horizontal fold, (d) Two folds: vertical then horizontal

Q2. Given the line(s) of symmetry, find the other hole(s).

Ans.

The key rule: Every hole must have a mirror image on the other side of the line of symmetry at the SAME distance from the line.

- Figure (a): Diagonal line of symmetry — the hole reflects across the diagonal to the opposite corner region
- Figure (b): Horizontal line of symmetry — the hole at bottom reflects to appear at the same position in the upper half
- Figure (c): Vertical line of symmetry (inside triangle) — the hole at the apex reflects below the peak
- Figure (d): Diagonal line of symmetry in circle — hole reflects across the diameter
- Figure (e): Diagonal line in circle — hole reflects symmetrically across the diagonal

Final Answer: Place the mirror image of each hole at the same distance on the opposite side of the symmetry line.

Q4. After each of the following cuts, predict the shape of the hole when the paper is opened. After you have made your prediction, make the cutouts and verify your answer.

Ans. — Predicting hole shapes:

Step Analysis: When paper is folded, the cut creates a shape that is MIRRORED when unfolded.

Figure (a): Vertical fold + irregular cut (arrow/star shape cut). The hole when unfolded = a STAR-LIKE or SNOWFLAKE shape (the cut shape reflected).

Figure (b): Vertical fold + triangular notch cuts on edge. The hole when unfolded = ARROW or FLAG shapes on both sides (reflections of the notch cuts).

Figure (c): Multiple folds + rectangular cuts. The hole when unfolded = REPEATED RECTANGULAR cutouts creating a castle-like or grid pattern.

Figure (d): Vertical fold + rectangular notch cut on folded edge. The hole when unfolded = H-SHAPE or I-BEAM shape (rectangle cut is doubled by the fold).

Final Answer: **(a) Star/snowflake, (b) Arrow/flag shapes, (c) Grid/castle pattern, (d) H-shape or I-beam**

Q5. Suppose you have to get each of these shapes with some folds and a single straight cut. How will you do it? (a) Hole in centre is a square (b) Hole in centre is a tilted square)

Ans.

Part (a): Square hole (sides parallel to paper edges)

Step 1: Fold the paper horizontally (top half onto bottom half).

Step 2: Then fold vertically (left half onto right half).

Step 3: At the closed corner (where both folds meet), cut a small square notch. When unfolded, a square hole appears in the centre.

Part (b): Square hole (tilted/rotated 45° — diamond shape)

Step 1: Fold the paper horizontally, then vertically (same as above).

Step 2: At the closed corner, cut a SLANTING straight line (diagonally across the corner).

Step 3: When unfolded, the cut reveals a diamond-shaped (tilted square) hole in the centre.

Verification: Check that the resulting 4-sided figure has all equal sides and all right angles (properties of a square).

Final Answer: **(a) Two folds + straight notch cut at corner → Square hole. (b) Two folds + slanted cut at corner → Tilted square (diamond) hole.**

Q6. How many lines of symmetry do these shapes have? (a) Diamond and star shapes (b) Equilateral triangle (c) Regular hexagon

Ans.

Part (a): Diamond shape (rhombus) and 8-pointed star shape

- Diamond (rhombus/square rotated): 4 lines of symmetry — 2 diagonals and 2 lines through midpoints of opposite sides
- 8-pointed star: 8 lines of symmetry — 4 through opposite points and 4 through midpoints

Part (b): Equilateral Triangle (all sides equal, all angles equal)

Observation: An equilateral triangle has all three sides equal and all angles 60°.

There are 3 lines of symmetry — one from each vertex to the midpoint of the opposite side.

Part (c): Regular Hexagon (all sides equal, all angles equal)

Observation: A regular hexagon has 6 equal sides and 6 equal angles.

There are 6 lines of symmetry — 3 through opposite vertices and 3 through midpoints of opposite sides.

Final Answer: **Diamond: 4, Star: 8, Equilateral Triangle: 3, Regular Hexagon: 6 lines of symmetry**

Q7. Trace each figure and draw the lines of symmetry, if any.

Ans. — Lines of symmetry for each figure:

- Two diamonds stacked vertically (column): 1 line of symmetry — vertical line through both
- Three diamonds in a row: 1 line of symmetry — horizontal line through the middle
- Four diamonds (2×2 arrangement): 4 lines of symmetry — vertical, horizontal, and 2 diagonals
- Four diamonds tilted (diamond arrangement): 4 lines of symmetry

- Grid figure 1 (nested squares): 4 lines of symmetry — vertical, horizontal, and 2 diagonals
- Grid figure 2 (irregular octagon): 4 lines of symmetry
- Grid figure 3 (irregular pentagon): 1 line of symmetry — vertical line
- Grid figure 4 (irregular star): 1 line of symmetry — vertical line

Final Answer: **Draw the symmetry lines on each traced figure as described above.**

Q8. Find the lines of symmetry for the kolam below.

Ans.

Observation: The kolam is a traditional South Indian decorative pattern made of interlocking flower-star shapes arranged in a grid.

The kolam shown has the following lines of symmetry:

- 1 vertical line of symmetry (through the centre, top to bottom)
- 1 horizontal line of symmetry (through the centre, left to right)
- 2 diagonal lines of symmetry (through opposite corners)

Final Answer: **The kolam has 4 lines of symmetry: vertical, horizontal, and 2 diagonals.**

Q9. Draw the following: (a) A triangle with exactly one line of symmetry. (b) A triangle with exactly three lines of symmetry. (c) A triangle with no line of symmetry. Is it possible to draw a triangle with exactly two lines of symmetry?

Ans.

Part (a): Triangle with exactly ONE line of symmetry

Observation: This is an ISOSCELES triangle (two equal sides). The line of symmetry goes from the top vertex (between the two equal sides) straight down to the midpoint of the base.

Isosceles Triangle — 1 Line of Symmetry

```
              /\
             /  \
            /    \
     /  |    \      ← line of symmetry
          /    |     \
         /----+-----\
      Equal      Equal
      sides       sides
```

Part (b): Triangle with exactly THREE lines of symmetry

Observation: This is an EQUILATERAL triangle (all three sides equal, all angles = 60°). Each line of symmetry goes from a vertex to the midpoint of the opposite side.

Equilateral Triangle — 3 Lines of Symmetry

```
               /\
         /   /  \   \
        /   /    \   \
       /   /  L2  \   \
      /   /--------\   \
    L1   /    +     \ L3
        /__________\
```

Part (c): Triangle with NO line of symmetry

Observation: This is a SCALENE triangle (all three sides different, all angles different). No fold can create mirror halves.

Is it possible to draw a triangle with EXACTLY TWO lines of symmetry?

NO! It is not possible.

A triangle can have only 0, 1, or 3 lines of symmetry — never exactly 2.

Reason: If a triangle has 2 lines of symmetry, the mathematics forces a third one to appear automatically, making it equilateral.

Final Answer: **(a) Isosceles triangle: 1 line, (b) Equilateral triangle: 3 lines, (c) Scalene triangle: 0 lines. A triangle with exactly 2 lines of symmetry is IMPOSSIBLE.**

Q10. Draw the following (each figure must contain at least one curved boundary): (a) Exactly one line of symmetry, (b) Exactly two lines of symmetry, (c) Exactly four lines of symmetry.

Ans.

Part (a): Exactly ONE line of symmetry (with curved boundary)

Example: A teardrop or leaf shape — or a heart shape. The vertical line through the middle is the only line of symmetry.

Part (b): Exactly TWO lines of symmetry (with curved boundary)

Example: A horizontal oval (ellipse). It has exactly 2 lines of symmetry — the major axis and the minor axis.

Part (c): Exactly FOUR lines of symmetry (with curved boundary)

Example: A circle divided into 4 curved 'petal' sections, or a figure shaped like a 4-petaled flower. Has vertical, horizontal, and 2 diagonal lines of symmetry.

Final Answer: **(a) Leaf/heart: 1 line, (b) Ellipse: 2 lines, (c) 4-petal flower: 4 lines of symmetry**

Q11. Copy the following on squared paper. Complete them so that the blue line is a line of symmetry. [Figures (a) to (f) as in textbook]

Ans. — Method for completing symmetric figures:

Observation: For each figure, the blue line is the axis of symmetry. Every point on the drawn (red) part must have a mirror image on the other side.

Step 1: Identify the axis of symmetry (blue line — vertical, horizontal, or diagonal).

Step 2: For each point on the red figure, measure its perpendicular distance from the blue line.

Step 3: Mark the mirror image point at the same distance on the other side of the blue line.

Step 4: Connect the mirror image points to complete the figure.

Hint for (c) and (f): The axis of symmetry is diagonal. Try rotating the book/paper 45° to see it as a vertical axis — this makes it easier to draw the reflection.

Final Answer: **Complete each figure by drawing the mirror reflection of the red part across the blue line.**

Q12. Copy the following drawing on squared paper. Complete each one of them so that the resulting figure has the two blue lines as lines of symmetry.

Ans. — Method for completing figures with TWO lines of symmetry:

Observation: When a figure has TWO lines of symmetry, it has MORE constraints. The figure must be symmetric about BOTH lines simultaneously.

Step 1: Take the drawn (red) part of the figure.

Step 2: Reflect it across the first blue line (e.g., vertical) to get a second part.

Step 3: Now reflect BOTH the original and the first reflection across the second blue line (e.g., horizontal).

Step 4: You now have 4 copies of the original piece, arranged symmetrically.

> **Key Insight:** With 2 lines of symmetry, the figure is divided into 4 quadrants. Whatever shape appears in one quadrant must appear (reflected) in all four.

Final Answer: **Complete by reflecting the given piece across both blue lines — creating 4 symmetric quadrants.**

Q13. Copy the following on a dot grid. For each figure draw two more lines to make a shape that has a line of symmetry.

Ans. — Strategy for adding lines to create symmetry:

Step 1: Look at the given lines. Identify what shape would make it symmetric.

Step 2: Think about where the line of symmetry could be.

Step 3: Draw 2 additional line segments that make the figure symmetric about that axis.

For example:

- Given: A line going bottom-left. Add two more lines to make a symmetric arrowhead or 'V' shape.
- Given: An L-shape. Add lines to make it a 'T' or '+' shape that has symmetry.
- Given: A partial triangle. Add lines to make the other side mirror the first.

Final Answer: **Draw the 2 additional lines so that the completed shape has at least one fold-line that creates matching mirror halves.**

9.2 Rotational Symmetry

Key Definitions — Rotational Symmetry

Rotational Symmetry: When a figure looks exactly the same after being rotated by some angle (less than 360°) about a fixed point.

Centre of Rotation: The fixed point about which the figure is rotated.

Angle of Symmetry: An angle through which a figure can be rotated to look exactly the same. Also called 'angle of rotational symmetry'.

Order of Rotational Symmetry: The total number of times a figure looks exactly the same during one complete rotation (360°).

A paper windmill looks symmetrical but has NO line of symmetry! However, it has ROTATIONAL symmetry because it looks exactly the same when rotated 90° about its centre.

Windmill — Rotational Symmetry

```
↑ (vertical reference line)
          |
     ┌────┼────┐
```

```
|      •      |      • = centre of rotation
                 └─────┼─────┘
                             |


           Rotate 90°  → looks SAME
           Rotate 180° → looks SAME
           Rotate 270° → looks SAME
    Rotate 360° → back to original (always same)

     Angles of symmetry: 90°, 180°, 270°, 360°
         Order of rotational symmetry = 4
```

Square — Rotational Symmetry

A square also has rotational symmetry! Let's see how:

Start	90°	180°	270°
Initial Position ABCD **Looks SAME ✓**	After 90° rotation B→A, C→B, D→C, A→D **Looks SAME ✓**	After 180° rotation C→A, D→B, A→C, B→D **Looks SAME ✓**	After 270° rotation D→A, A→B, B→C, C→D **Looks SAME ✓**

Square: 4 angles of symmetry = 90°, 180°, 270°, 360°

The centre of rotation for a square is at the intersection of its diagonals (the exact centre of the square).

Worked Example: Strip without Rotational Symmetry

Example: Find the angles of symmetry of a parallelogram-shaped strip (trapezoid with one line of symmetry being the centre only).

Given: A strip shape (parallelogram / asymmetric trapezoid) rotated about its centre.

To Find: All angles of symmetry.

Step 1: Place the strip in its initial position.

Step 2: Rotate it 180° clockwise. Observe the result.

Observation: After 180° rotation, the figure looks DIFFERENT from the original (the slant direction is reversed). The 180° rotation does NOT bring it back to the same appearance.

Step 3: Continue rotating. Only after a full 360° does it return to its original position.

Conclusion: This figure comes back to itself ONLY after one complete rotation (360°). So 360° is its only angle of symmetry.

Final Answer: This strip does NOT have rotational symmetry (since 360° is always an angle of symmetry for every figure, we need an angle STRICTLY between 0° and 360° for rotational symmetry).

Rotational Symmetry of Figures with Radial Arms

Figures with multiple radial arms arranged evenly can have beautiful rotational symmetry. The key formula is:

Smallest Angle of Symmetry = 360° ÷ Number of Arms

Number of Arms	Smallest Angle	All Angles of Symmetry	Example
2	**180°**	180°, 360°	*Straight line through centre*
3	**120°**	120°, 240°, 360°	*Triskelion, Y-shape*
4	**90°**	90°, 180°, 270°, 360°	*Plus sign, square, windmill*
5	**72°**	72°, 144°, 216°, 288°, 360°	*5-pointed star, pentagon*
6	**60°**	60°, 120°, 180°, 240°, 300°, 360°	*Hexagon, snowflake*
7	**51 3/7°°**	51 3/7°, ..., 360°	*Not a whole number angle!*

Key Pattern: Multiples of the Smallest Angle

In every case, ALL the angles of symmetry are multiples of the SMALLEST angle of symmetry.

- If smallest is 90°: angles are 90°, 180°, 270°, 360° (multiples of 90°)
- If smallest is 120°: angles are 120°, 240°, 360° (multiples of 120°)
- If smallest is 72°: angles are 72°, 144°, 216°, 288°, 360° (multiples of 72°)

True or False — Answers:

- 'Every figure will have 360° as an angle of symmetry' → TRUE (any figure returns to itself after a full turn)
- 'If smallest angle is a natural number, it is a factor of 360' → TRUE

Symmetries of a Circle — The Most Symmetric Shape

Circle: Infinite Symmetry!

- Rotational Symmetry: A circle looks EXACTLY the same when rotated by ANY angle about its centre. So every angle (1°, 2°, 45°, 90°... any angle) is an angle of symmetry!
- Lines of Symmetry: EVERY diameter of a circle is a line of symmetry. Since there are infinitely many diameters, a circle has INFINITE lines of symmetry.

Why the circle is special: For most figures, there IS a smallest angle of symmetry. But for a circle, there is no smallest — you can always find a smaller angle that also works!

Objects around us with rotational symmetry: Fan (3 blades: 120°), Flower (petals: varies), Wheel (spokes: depends on count), Rangoli patterns, Ashoka Chakra (24 spokes: 15°).

Section 9.2 — Figure it Out: Questions & Solutions

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Q. Can you draw a figure with radial arms that has (a) exactly 5 angles of symmetry, (b) 6 angles of symmetry? Also find the angles of symmetry in each case.

Ans.

Part (a): 5 Angles of Symmetry — Use 5 radial arms

Step 1: Use 5 radial arms arranged evenly around a centre point.

Step 2: Angle between adjacent arms = 360° ÷ 5 = 72°

Angles of symmetry: 72°, 144°, 216°, 288°, 360°

Part (b): 6 Angles of Symmetry — Use 6 radial arms

Step 1: Use 6 radial arms arranged evenly (like a snowflake).

Step 2: Angle between adjacent arms = 360° ÷ 6 = 60°

Angles of symmetry: 60°, 120°, 180°, 240°, 300°, 360°

Final Answer: (a) 5 arms: angles = 72°, 144°, 216°, 288°, 360° | (b) 6 arms: angles = 60°, 120°, 180°, 240°, 300°, 360°

Q. Consider a figure with radial arms having exactly 7 angles of symmetry. What will be its smallest angle of symmetry? Is the number of degrees a whole number in this case? If not, express it as a mixed fraction.

Ans.

Step 1: For 7 angles of symmetry, we need 7 radial arms.

Step 2: Smallest angle = 360° ÷ 7

360 ÷ 7 = 51 with remainder 3

$$360° \div 7 = 51\tfrac{3}{7}°$$

The number of degrees is NOT a whole number — it is a mixed fraction: $51\frac{3}{7}$ degrees.

Final Answer: Smallest angle = $51\frac{3}{7}$° (not a whole number — expressed as a mixed fraction)

Q1. Find the angles of symmetry for the given figures about the point marked •. [(a) Plus/cross shape, (b) Asymmetric cross shape with small rectangles, (c) Horizontal bar/line]

Ans.

Figure (a): Plus/cross shape with 4 equal arms

Observation: This is a symmetric plus shape with 4 equal radial arms. It looks the same every 90°.

Final Answer: Angles of symmetry = 90°, 180°, 270°, 360° [Order = 4]

Figure (b): Cross shape with small rectangles at ends (only 2-fold symmetry)

Observation: The small rectangles at the ends make the figure NOT look the same at 90° or 270° — only at 360°.

Final Answer: Angle of symmetry = 360° only [No rotational symmetry strictly speaking]

Figure (c): Horizontal bar (line segment with a centre point)

Observation: A horizontal bar looks the same when rotated 180° (it flips to look identical) and also at 360°.

Final Answer: Angles of symmetry = 180°, 360° [Order = 2]

Q2. Which of the following figures have more than one angle of symmetry?

Ans. — Figures with MORE THAN ONE angle of symmetry:

- Circle with 4 lines through centre (cross): Has multiple — 90°, 180°, 270°, 360°
- Circle with 3 equal sectors (Y shape inside): Has multiple — 120°, 240°, 360°
- 4-petal flower/fan shape: Has multiple — 90°, 180°, 270°, 360°
- X shape (two crossing lines): Has multiple — 180°, 360° (or 90° if lines perpendicular)
- 5-pointed star: Has multiple — 72°, 144°, 216°, 288°, 360°

Figures with only ONE angle of symmetry (= 360° only): Inverted triangle (scalene), D-shape (semicircle)

Final Answer: Figures with more than one angle: Circle+cross, Y-shape, 4-petal fan, X-shape, and 5-pointed star.

Q3. Give the order of rotational symmetry for each figure: [(a) Arrow, (b) X-shape, (c) 6-pointed star, (d) Person doing cartwheels, (e) Plus shape, (f) Pentagon]

Ans. — Orders of Rotational Symmetry:

Figure Description	Order of Rotational Symmetry
Figure	Order of Symmetry
(a) Arrow/boomerang shape	Order = 1 (only 360°)
(b) X-shape (two crossing lines)	Order = 2 (180°, 360°)
(c) 6-pointed star	Order = 6 (60°, 120°, 180°, 240°, 300°, 360°)
(d) Person cartwheel figure	Order = 3 (120°, 240°, 360°)
(e) Plus/cross shape	Order = 4 (90°, 180°, 270°, 360°)
(f) Regular pentagon	Order = 5 (72°, 144°, 216°, 288°, 360°)

Final Answer: **(a)=1, (b)=2, (c)=6, (d)=3, (e)=4, (f)=5**

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Q. In each case, the angles are multiples of the smallest angle. Will this always happen?

Ans.

Yes, the angles of symmetry are ALWAYS multiples of the smallest angle of symmetry.

Why this is always true:

If a figure looks the same after rotating by angle θ (smallest angle), then rotating AGAIN by θ brings it back to 'same' state too. So 2θ is also an angle of symmetry. Similarly, 3θ, 4θ, etc. are all angles of symmetry. This continues until we reach 360°.

Final Answer: **True — angles of symmetry are always multiples of the smallest angle of symmetry.**

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Q1. Colour the sectors of the circle so that the figure has (i) 3 angles of symmetry, (ii) 4 angles of symmetry. (iii) What are the possible numbers of angles of symmetry obtainable?

Ans.

The circle has 12 sectors (like a clock).

Part (i): 3 angles of symmetry (120°, 240°, 360°)

Colour every 4th sector the same colour (groups of 4). The pattern repeats every 4 sectors = every 120°. Example: Colour sectors 1,2 pink; sectors 5,6 pink; sectors 9,10 pink — and leave the rest white.

Part (ii): 4 angles of symmetry (90°, 180°, 270°, 360°)

Colour every 3rd sector the same. The pattern repeats every 3 sectors = every 90°. Example: Colour sectors 1, 4, 7, 10 pink; rest white.

Part (iii): Possible numbers of angles of symmetry

The number of possible angles of symmetry = divisors of 12 = 1, 2, 3, 4, 6, 12. So you can get 1, 2, 3, 4, 6, or 12 angles of symmetry by colouring sectors differently.

Final Answer: **(i) Colour in groups of 4: 3 angles of symmetry. (ii) Colour in groups of 3: 4 angles of symmetry. (iii) Possible: 1, 2, 3, 4, 6, or 12 angles.**

Q2. Draw two figures other than a circle and a square that have both reflection symmetry and rotational symmetry.

Ans.

Figure 1: Regular Hexagon

- Lines of symmetry: 6 (3 through opposite vertices + 3 through midpoints of opposite sides)
- Order of rotational symmetry: 6 (angles: 60°, 120°, 180°, 240°, 300°, 360°)

Figure 2: 4-petal flower shape (or plus shape with rounded ends)

- Lines of symmetry: 4 (vertical, horizontal, and 2 diagonals)
- Order of rotational symmetry: 4 (angles: 90°, 180°, 270°, 360°)

Final Answer: Hexagon: 6 lines & order 6. Four-petal flower: 4 lines & order 4. Both have reflection AND rotational symmetry.

Q3. Draw, wherever possible, a rough sketch of: (a) Triangle with ≥2 lines and ≥2 angles of symmetry, (b) Triangle with only 1 line, no rotational symmetry, (c) Quadrilateral with rotational but no reflection symmetry, (d) Quadrilateral with reflection but no rotational symmetry.

Ans.

Part (a): Equilateral triangle

- 3 lines of symmetry and 3 angles of symmetry (120°, 240°, 360°) ✓

Part (b): Isosceles triangle (non-equilateral)

- Exactly 1 line of symmetry (vertical through apex)
- NO rotational symmetry (only 360° is an angle of symmetry)

Part (c): Parallelogram (non-rectangle)

- Has rotational symmetry of order 2 (180°, 360°)
- Has NO lines of symmetry ✓

Part (d): Kite shape (or isosceles trapezoid)

- Kite: Has exactly 1 line of symmetry
- Kite: Has NO rotational symmetry ✓

Final Answer: (a) Equilateral △, (b) Isosceles △, (c) Parallelogram, (d) Kite shape

Q4. In a figure, 60° is the smallest angle of symmetry. What are the other angles of symmetry of this figure?

Given: Smallest angle of symmetry = 60°

To Find: All other angles of symmetry.

Concept Used: All angles of symmetry are multiples of the smallest angle.

Step 1: Smallest angle = 60°

Step 2: Next angles = 2×60° = 120°, 3×60° = 180°, 4×60° = 240°, 5×60° = 300°, 6×60° = 360°

Final Answer: Other angles of symmetry: 120°, 180°, 240°, 300°, 360° [Total: 6 angles of symmetry, Order = 6]

Q5. In a figure, 60° is an angle of symmetry. The figure has two angles of symmetry less than 60°. What is its smallest angle of symmetry?

Given: 60° is an angle of symmetry, and there are 2 angles LESS THAN 60°.

To Find: The smallest angle of symmetry.

Concept Used: All angles are multiples of the smallest angle. If 60° is an angle and there are 2 smaller ones, then 60° must be the 3rd multiple.

Step 1: Let the smallest angle = x°

Step 2: There are 2 angles less than 60°: these are x° and 2x°

Step 3: So 60° is the 3rd angle = 3x°

Step 4: Therefore: 3x = 60 → x = 20°

Final Answer: Smallest angle of symmetry = 20°

Q6. Can we have a figure with rotational symmetry whose smallest angle of symmetry is: (a) 45°? (b) 17°?

Ans.

Part (a): Smallest angle = 45°

Check: Is 360° a multiple of 45°?

360° ÷ 45° = 8 exactly. YES, 360 is a multiple of 45.

YES, possible! A figure with 8 radial arms evenly spaced would have smallest angle 45°.

Part (b): Smallest angle = 17°

Check: Is 360° a multiple of 17°?

360° ÷ 17° = 21.17... (not a whole number). NO, 360 is not exactly divisible by 17.

NO, not possible! Since the smallest angle must be a factor of 360°, and 17 is not a factor of 360, we cannot have a figure with 17° as smallest angle.

Final Answer: (a) 45° → YES (45 is a factor of 360) | (b) 17° → NO (17 is not a factor of 360)

Q7. This is a picture of the new Parliament Building in Delhi. (a) Does the outer boundary have reflection symmetry? How many lines? (b) Does it have rotational symmetry? Find the angles.

Ans. Observation: The new Parliament Building has a triangular outer boundary (like a rounded triangle / circular triangle shape).

Part (a): Reflection Symmetry

Yes, the outer boundary HAS reflection symmetry.

There are 3 lines of symmetry — one through each vertex (corner) of the triangular shape, going to the midpoint of the opposite curved side.

Part (b): Rotational Symmetry

Yes, the outer boundary HAS rotational symmetry.

Smallest angle = 360° ÷ 3 = 120°

Angles of rotational symmetry: 120°, 240°, 360°

Final Answer: (a) YES — 3 lines of symmetry | (b) YES — angles of rotational symmetry: 120°, 240°, 360°

Q8. How many lines of symmetry do the Regular Polygons have? What number sequence do you get?

Ans.

Regular Polygon	Number of Sides	Lines of Symmetry
Equilateral Triangle	3	3
Square	4	4
Regular Pentagon	5	5
Regular Hexagon	6	6
Regular Heptagon	7	7
Regular Octagon	8	8
Regular Nonagon	9	9
Regular Decagon	10	10

Pattern: A regular polygon with n sides has EXACTLY n lines of symmetry. The sequence is 3, 4, 5, 6, 7, 8, 9, 10... — the counting numbers starting from 3 (natural numbers ≥ 3).

Final Answer: Regular n-gon has n lines of symmetry. Sequence: 3, 4, 5, 6, 7, 8, 9, 10 ...

Q9. How many angles of symmetry do the Regular Polygons have? What number sequence do you get?

Ans.
A regular polygon with n sides has EXACTLY n angles of symmetry (smallest = 360°/n, then multiples up to 360°).

The sequence of orders of rotational symmetry = 3, 4, 5, 6, 7, 8, 9, 10 ...

This is the same as the number of lines of symmetry — both equal the number of sides!

Final Answer: Order of rotational symmetry of regular n-gon = n. Sequence: 3, 4, 5, 6, 7, 8, 9, 10 ... (same as lines of symmetry)

Q10. How many lines of symmetry do the shapes in the Koch Snowflake sequence have? How many angles of symmetry?

Ans. The Koch Snowflake sequence starts from an equilateral triangle and adds triangles on each side repeatedly.

- First shape (equilateral triangle): 3 lines of symmetry, 3 angles of symmetry
- Subsequent Koch Snowflake shapes: 6 lines of symmetry, 6 angles of symmetry (the 3-fold symmetry gets doubled to 6-fold as spikes are added equally)

Number of lines: 3, 6, 6, 6, 6 ...

Number of angles: 3, 6, 6, 6, 6 ...

Final Answer: Koch Snowflake sequence: 3 lines of symmetry for first shape, then 6 lines and 6 angles for all subsequent shapes.

Q11. How many lines of symmetry and angles of symmetry does the Ashoka Chakra have?

Ans.

Observation: The Ashoka Chakra (on the Indian flag) has 24 spokes equally spaced, with the hub in the centre.

Step 1: Number of spokes = 24

Step 2: Lines of symmetry: Each spoke and the gap between spokes can serve as lines. Lines of symmetry = 24

Step 3: Angles of symmetry: Smallest angle = 360° ÷ 24 = 15°. Total angles = 24 (multiples of 15° up to 360°)

Final Answer: **Ashoka Chakra: 24 lines of symmetry and 24 angles of symmetry. Smallest angle = 15°**

Chapter Summary

KEY CONCEPTS AT A GLANCE

1. Symmetry

A figure has symmetry when it is made up of parts that repeat in a definite pattern. Such figures are called symmetrical.

2. Line of Symmetry (Axis of Symmetry)

A line that cuts a figure into two parts that exactly overlap when folded along that line. A figure may have multiple lines of symmetry.

- Square: 4 lines of symmetry
- Rectangle (non-square): 2 lines of symmetry
- Equilateral triangle: 3 lines of symmetry
- Regular n-gon: n lines of symmetry
- Circle: Infinite lines of symmetry (every diameter)

3. Reflection Symmetry

A figure that has one or more lines of symmetry is said to have reflection symmetry.

4. Rotational Symmetry

A figure has rotational symmetry if it looks exactly the same after being rotated by some angle strictly between 0° and 360°.

Centre of rotation: The fixed point about which the figure is rotated

Angle of symmetry: An angle of rotation that makes the figure look identical

Order of rotational symmetry: Total number of angles of symmetry (including 360°)

Smallest angle formula: 360° ÷ number of radial arms (or sides for regular polygons)

5. Circle — Special Case

A circle has infinite lines of symmetry and infinite angles of symmetry (every angle is an angle of symmetry).

6. Important Rules

- Every figure has 360° as an angle of symmetry (trivially)
- If smallest angle of symmetry is a natural number, it is a factor of 360
- All angles of symmetry are multiples of the smallest angle
- A regular n-gon has n lines of symmetry AND n angles of symmetry

Line Symmetry vs. Rotational Symmetry — Comparison

LINE SYMMETRY	ROTATIONAL SYMMETRY
Definition	A fold line makes two identical halves
Produces	Mirror image of the figure
Key test	Can the figure be folded onto itself?
Example: Square	4 lines of symmetry
Example: Windmill	0 lines of symmetry
Circle	Infinite lines (every diameter)
Equilateral Triangle	3 lines of symmetry
Parallelogram	0 lines of symmetry
Scalene Triangle	0 lines of symmetry

LINE SYMMETRY	ROTATIONAL SYMMETRY
Definition	Rotation by angle < 360° gives same figure
Produces	Same figure in different orientation
Key test	Does it look the same during rotation?
Example: Square	Order 4 (90°, 180°, 270°, 360°)
Example: Windmill	Order 4 (90°, 180°, 270°, 360°)
Circle	Infinite angles (every angle works)
Equilateral Triangle	Order 3 (120°, 240°, 360°)
Parallelogram	Order 2 (180°, 360°)
Scalene Triangle	Order 1 (only 360°)

Mixed Symmetry Cases

- BOTH line and rotational symmetry: Circle, square, equilateral triangle, regular hexagon, regular polygons
- ONLY line symmetry (no rotational): Isosceles triangle, kite, isosceles trapezoid
- ONLY rotational symmetry (no lines): Windmill (4-bladed), parallelogram, letter 'S' or 'Z'
- NEITHER: Scalene triangle, cloud, random irregular shapes