9
Chapter

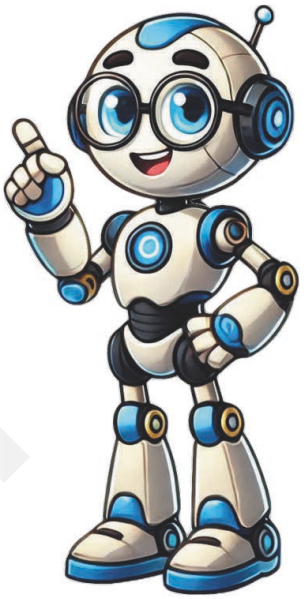
Symmetry

We'll cover the following key points:

→ Rotational symmetry of plane figures

→ Operation of rotation through the angles 90° and 180°.

→ Rotational and reflection symmetry



Hi, I'm EeeBee

Still curious? Talk to me by scanning the QR code.

Do you Remember fundamental concept in previous class.

In class 5th we learnt

→ Introduction to Symmetry

→ Rotational Symmetry

Learning Outcomes

By the end of this chapter, students will be able to:

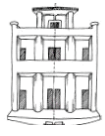
- Define symmetry and understand the concept of symmetry in geometric figures.
- Identify and distinguish between types of symmetry, including line symmetry (reflectional symmetry) and rotational symmetry.
- Recognize line of symmetry in different shapes, and draw the line(s) of symmetry for various 2D shapes.
- Understand and apply the concept of rotational symmetry, identifying the order and angle of rotation for different shapes.
- Identify symmetrical objects in real life and understand the role of symmetry in nature, art, and architecture.
- Apply symmetry to classify shapes into those with symmetry and those without symmetry, and determine the number of lines of symmetry for each shape.
- Draw figures with multiple lines of symmetry, such as squares, rectangles, and equilateral triangles, and recognize their properties.

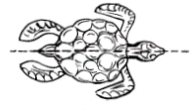
Mind Map

SYMMETRY

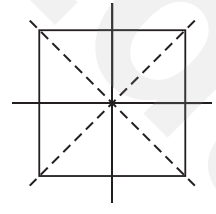
Introduction

- Line of symmetry





Line of symmetry for regular polygons

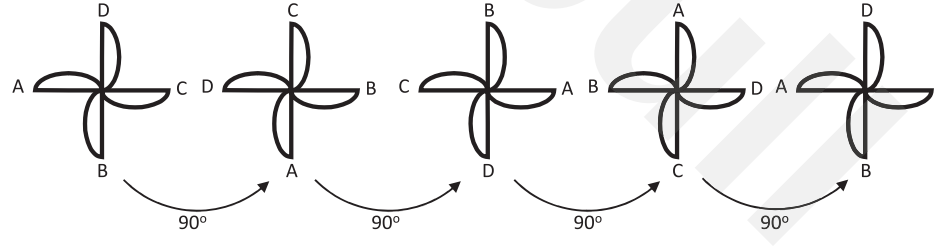


Square

Line symmetry and Rotational symmetry

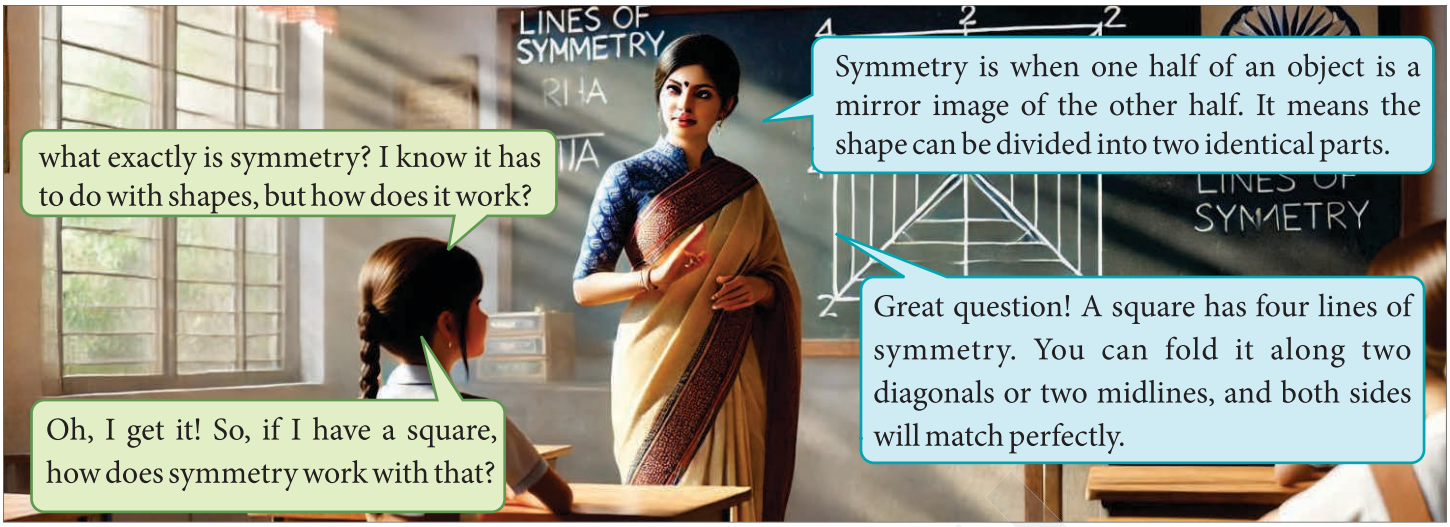
Letters	Number of line symmetry	Order of rotational symmetry
Z	0	2
H	2	2
E	1	1

Rotational symmetry



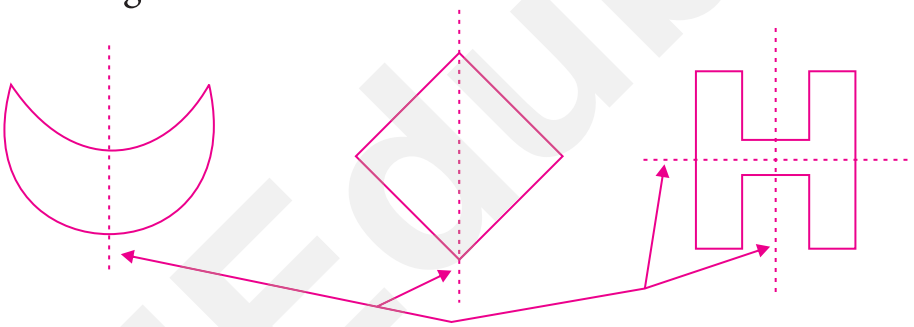
Based on NCERT*

Introduction



Symmetry : Suppose, we could fold a picture in half such that the left half and the right half match exactly, then such type of picture is called symmetrical picture and the line which divides the picture into two congruent parts is called the line or axis of symmetry.

We can also see that two halves are mirror images of each other. If we place a mirror on the folding line, then the image of one side of the picture will fall exactly on the other side of the picture. This folding line is called the ***mirror line***.



Folding Line
(Line of symmetry)

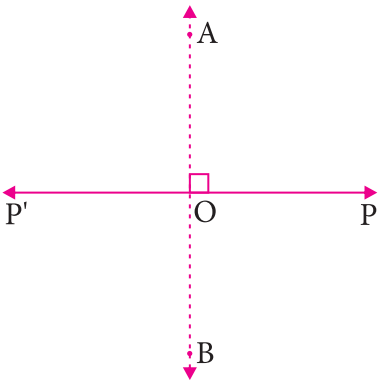
Take a Task

Watch Remedial

Reflection Symmetry

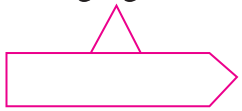
Look at the adjoining figure.

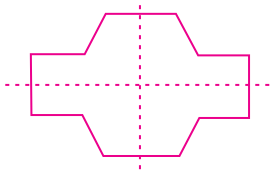
The point 'P' is called image of the point P' in a line AB, if AB is the perpendicular bisector of PP'. The line AB is called mirror line. The points of this line AB are their own images.

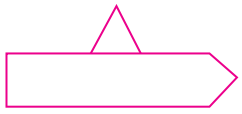


Example 1 : Draw the line of symmetry of the following figures :

(*i*) 

(*ii*) 

Solution : (*i*) 

(*ii*) 

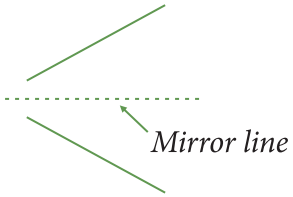
No line of symmetry

Example 2 : Reflect each of the figures given below at the mirror line (dotted line) and draw the respective image :

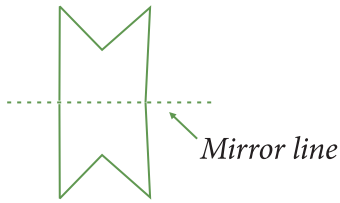
(*i*) 

(*ii*) 

Solution : (*i*)

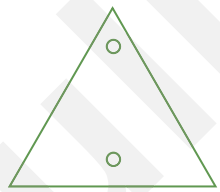


(*ii*)



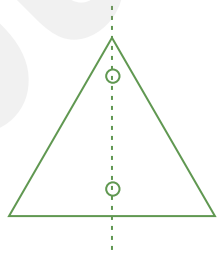
Example 3: Find the line of symmetry of the following figures with punched holes shown by small circle.

(*i*) 

(*ii*) 

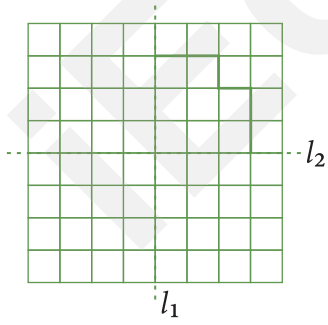
Solution : (*i*)

(*ii*)

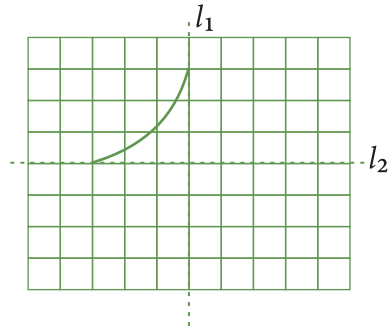


Example 4 : Complete each of the following figures to be symmetric about the mirror line :

(*i*)

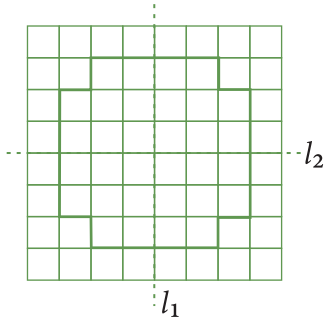


(*ii*)

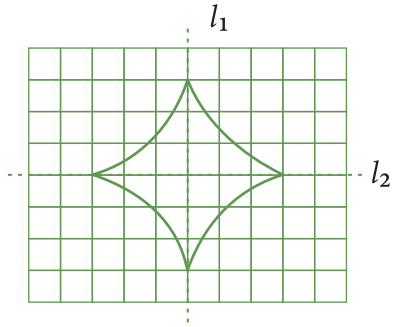


Solution : Using the concept that image is at equal distance as the object from the mirror, we get the following symmetric patterns :

(*i*)



(*ii*)



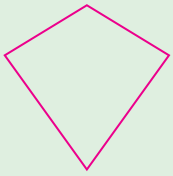
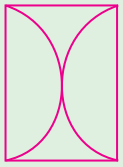
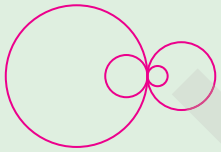
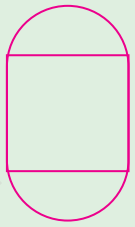
Exercise 9.1

1. Identify horizontal and vertical line of symmetry:

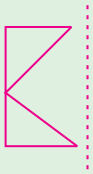
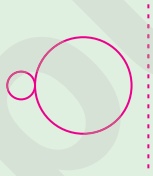
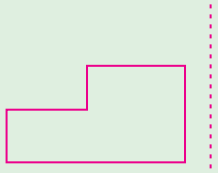
(*i*) 3 (*ii*) A (*iii*) 5 (*iv*) M

(*v*) N (*vi*) C (*vii*) T (*viii*) P

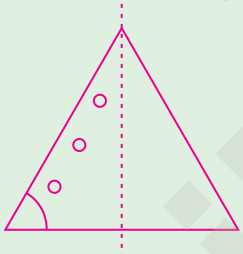
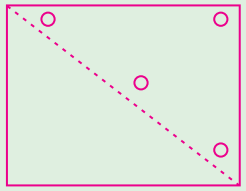
2. Draw the line / axis of symmetry of the following figures :

(*i*)  (*ii*)  (*iii*)  (*iv*) 

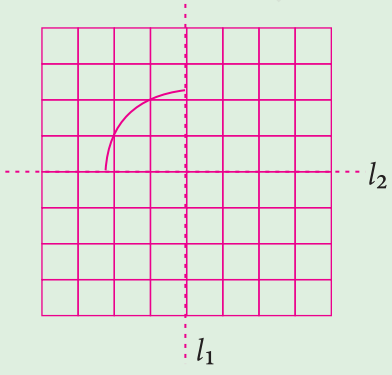
3. Draw the following images keeping the mirror on the dotted line :

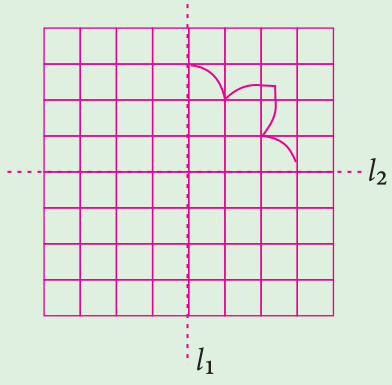
(*i*)  (*ii*)  (*iii*)  (*iv*) 

4. Given the lines of symmetry, find the other holes :

(*i*)  (*ii*) 

5. Complete each of the following figures to be symmetric about the mirror line :

(*i*) 

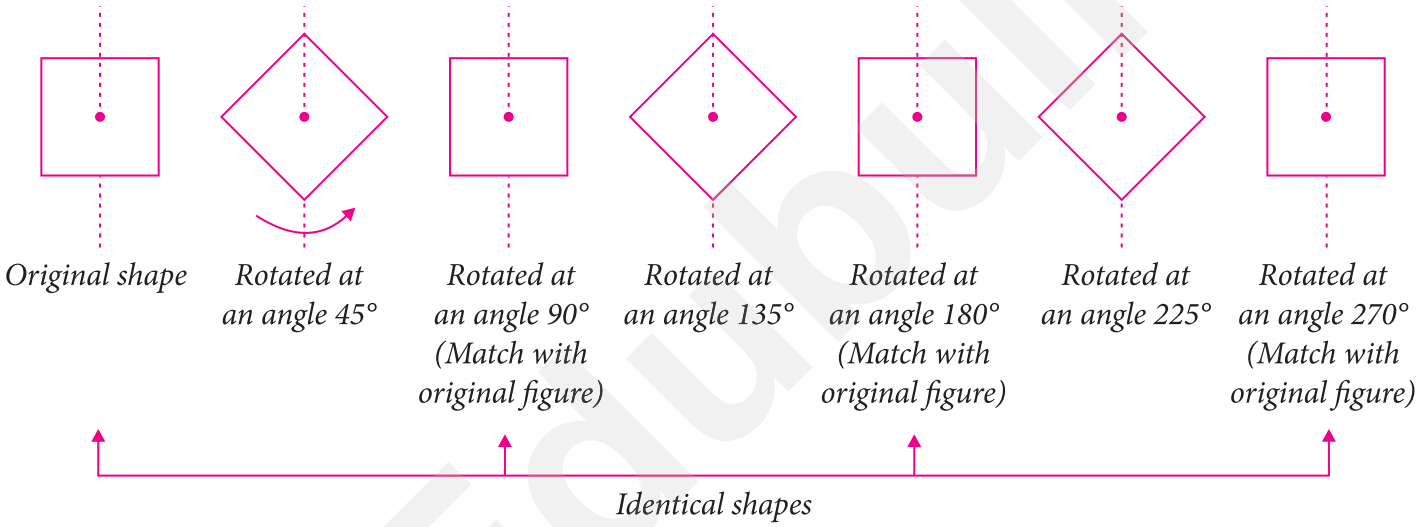
(*ii*) 

Rotational Symmetry of Plane Figures

If you can rotate (or turn) a figure around a centre point by fewer than 360° and the figure appears unchanged, then the figure has rotational symmetry. The point around which you rotate is called the **centre of rotation**, and the smallest angle you need to turn is called the **angle of rotation**.

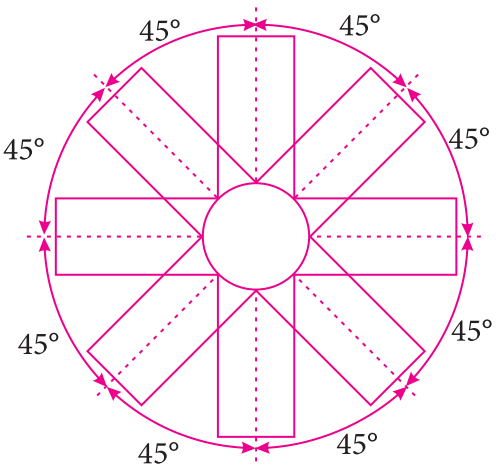
Take a Task Watch Remedial

We can easily observe that a certain picture looks identical when it is rotated about a certain point at a certain degree. For example, a square lamina, when rotated around an axis by 90°, 180° or 270°, retains its shape.



Let us take another example of wheel of 8 spokes.

It can easily be observed that when it is rotated by 45° about its central point, it regains its original position.



Therefore, the square lamina and wheel are said to have turn symmetry or rotational symmetry.

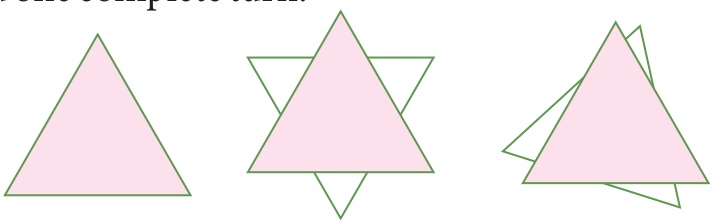
Hence, the square lamina shown above has $\frac{1}{4}$ turn symmetry or 90° symmetry and the wheel has $\frac{1}{8}$ turn symmetry or 45° symmetry.

Now, we can say that Rotational symmetry exists when a figure can be rotated by less than 360° about a central point called point of rotation and be made to match or coincide with the original figure.

Order of Rotational Symmetry

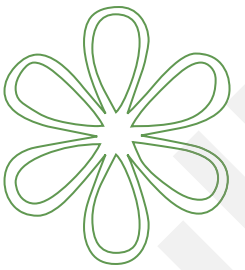
An image has rotational symmetry, if there is a central point around which the object is turned into a certain number of degrees and the object still looks the same i.e., it matches itself a number of times while it is being rotated one complete turn.

Since the triangle shown at right will match itself 3 times as it is rotated, it is said to have rotational symmetry of Order 3.



The flower shown at right has rotational symmetry of Order 5, since it matches itself 5 times.

Also, the pizza shown at right has rotational symmetry of Order 6, since all the toppings are placed so evenly.



Flower

Pizza

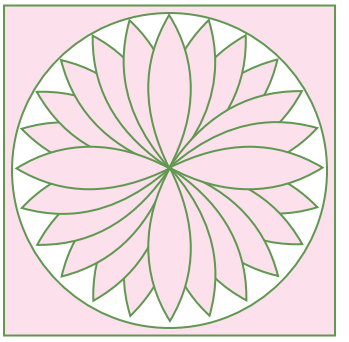
REMEMBER

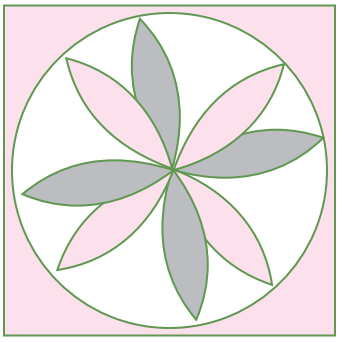
1. If an object only matches itself once, it is NOT considered to have rotational symmetry.
2. If any object has rotational symmetry of Order 1, it is NOT considered to have rotational symmetry.
3. Order of rotational symmetry = $\frac{360°}{\text{Angle of rotation}}$

Rotational Symmetry : A Challenge

Through an activity using only paper, a compass, a ruler and pencils, create designs that have rotational symmetry of different orders.

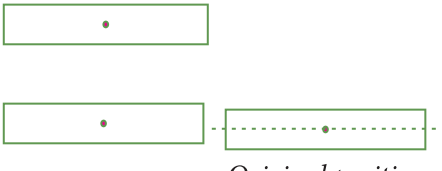
See if you can make such figures of different orders.



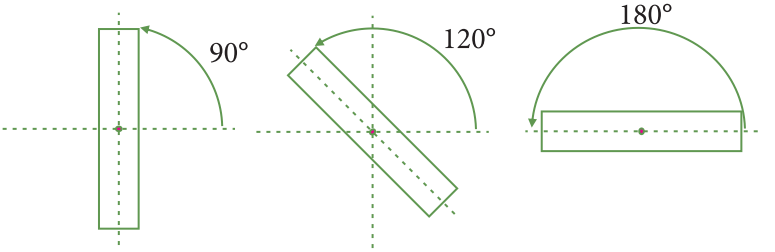


Example 5 : Rotate the following figure about its central point at an angle 90°, 120°, 180° :

Solution :



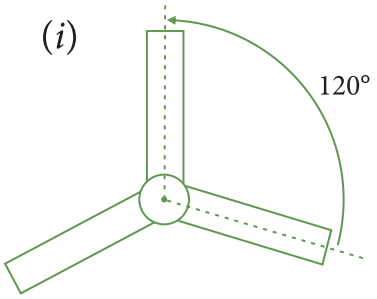
Original position



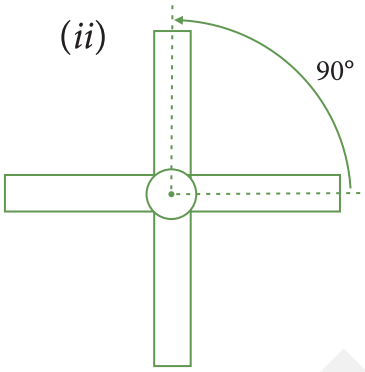
Since at 180°, the figure becomes identical with its original position, therefore the figure (*i.e.*, rectangle) shows rotational symmetry at 180°.

Example 6 : At what angle will a fan of 3-blades, 4-blades and 5-blades show rotational symmetry ? Also, find the order of its rotational symmetry .

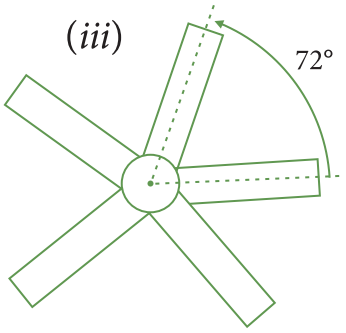
Solution : (*i*)



(*ii*)



(*iii*)



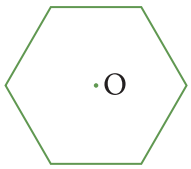
In figure (*i*), it can easily be imagined that when a 3-blade fan is rotated about its central point at an angle of 120°, each blade of the fan taken the position of the next blade and the fan as a whole looks similar to its previous position.

The order of rotational symmetry of this blade $= \frac{\cancel{360^\circ}^{3}}{\cancel{120^\circ}} = 3.$

Similarly, in figure (*ii*), a 4-blade fan shown the rotational symmetry at an angle of 90° and the order of rotational symmetry $= \frac{\cancel{360^\circ}^{4}}{\cancel{90^\circ}} = 4.$

In figure (*iii*), a 5-blade fan shows the rotational symmetry at an angle 72° and the order of the rotational symmetry $= \frac{\cancel{360^\circ}^{5}}{\cancel{72^\circ}} = 5.$

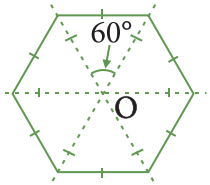
Example 7 : Find the order of rotational symmetry of the adjoining figure about 'O'.



Solution : Here, the angle of rotation = 60°

The order of rotational symmetry $= \frac{360^\circ}{\text{Angle of rotation}}$

$= \frac{\cancel{360^\circ}}{\cancel{60^\circ}} = 6$

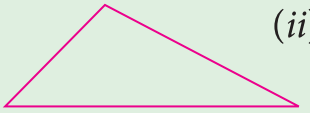
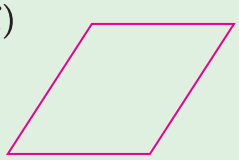
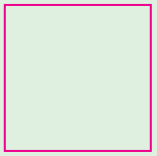
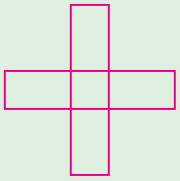


Exercise 9.2

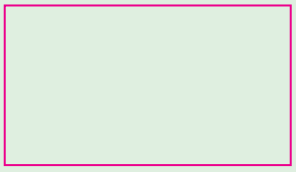
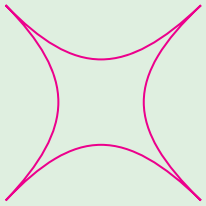
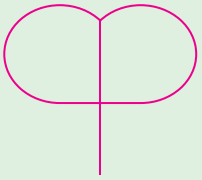
1. What is the order of rotational symmetry in the following letters :

(*i*) A (*ii*) Z (*iii*) C (*iv*) O

2. Which of the following figures does not have rotational symmetry ?

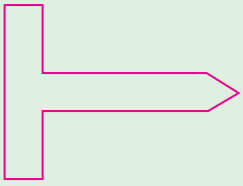
(*i*)  (*ii*)  (*iii*)  (*iv*) 

3. What is the angle at which each of the following figures shows rotational symmetry:

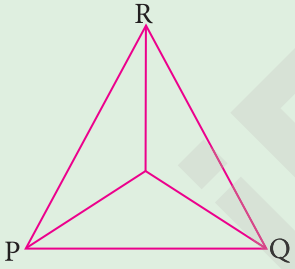
(*i*)  (*ii*)  (*iii*) 

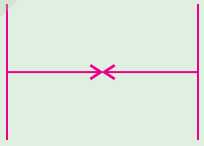
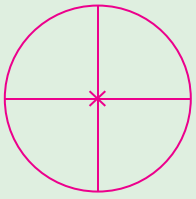
4. Trace the letter in the word SHAPE which shows the rotational symmetry .

5. Rotate the following figures at angles 90°, 120° and 180° about point P and comment over its rotational symmetry on these angles :

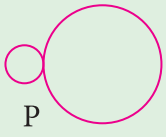
(*i*)  (*ii*) 

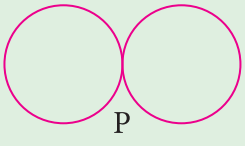
6. Find the rotational symmetry of the following figures. Also, find the order of symmetry.

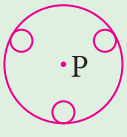
(*i*) 

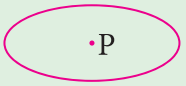
(*ii*)  (*iii*) 

7. Discuss the rotational symmetry of the following figures, when each one is rotated about at point P. Also, find the order of rotational symmetry.

(*i*) 

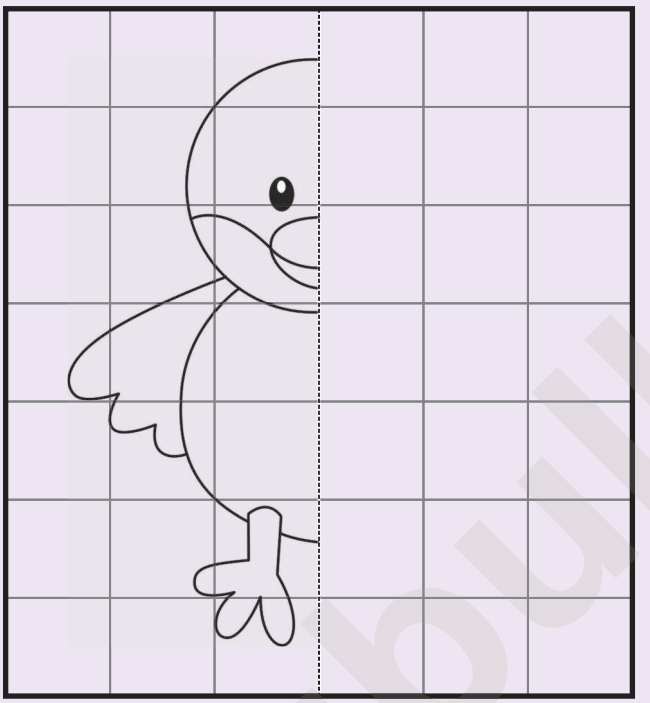
(*ii*) 

(*iii*) 

(*iv*) 

Project

Complete this figure using reflection:

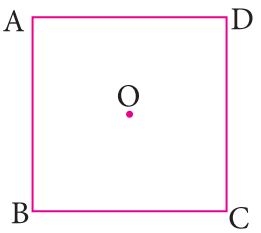


Operation of Rotation Through the Angles 90° and 180°

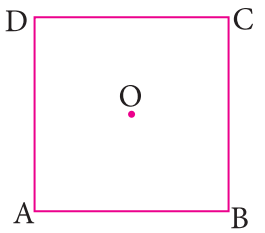
A figure can be rotated about various points and its point of rotation decides its position and nature. Suppose a figure shows the rotational symmetry about a particular point, then the same figure would not show that rotational symmetry about any other point .

Let us take an example of a square lamina.

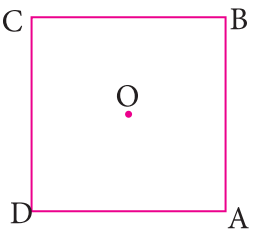
Case 1 : When it is rotated about its middle point O.



Original position



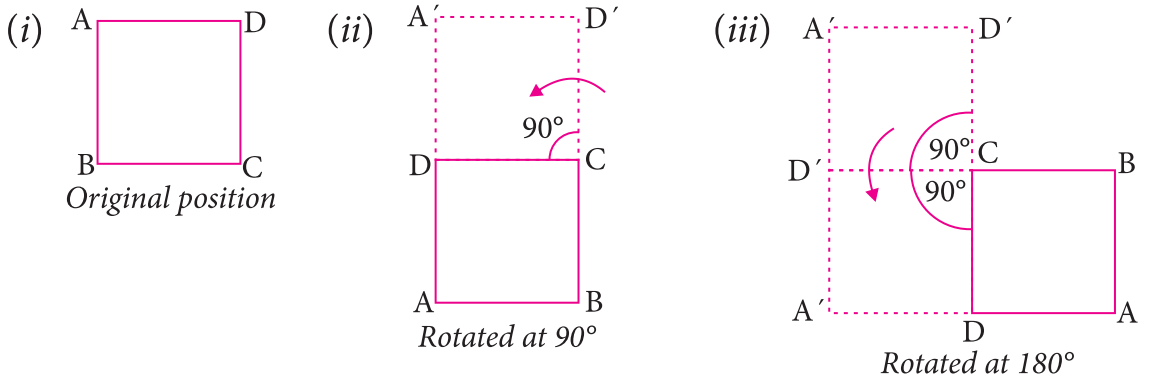
Rotated at an angle 90°



Rotated at an angle 180°

Observe that all three figures look similar.

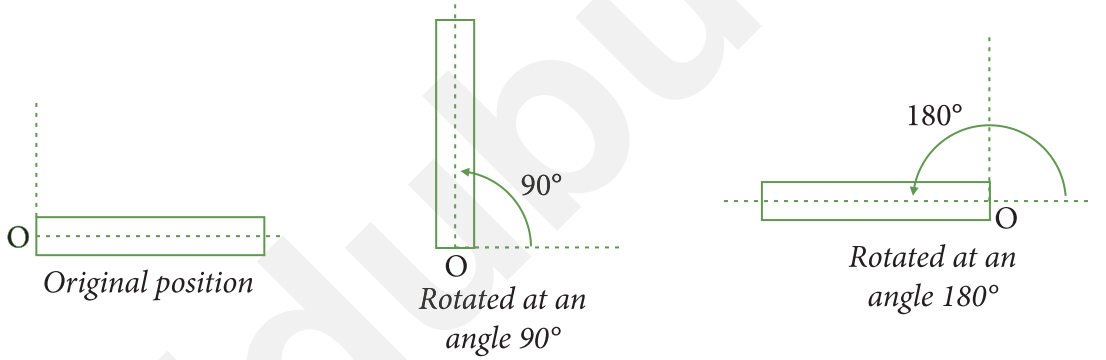
Case II : When the square lamina is rotated about its corner point, say at C.



Thus, in this case, we observe that the square lamina does not show the rotational symmetry about point C.

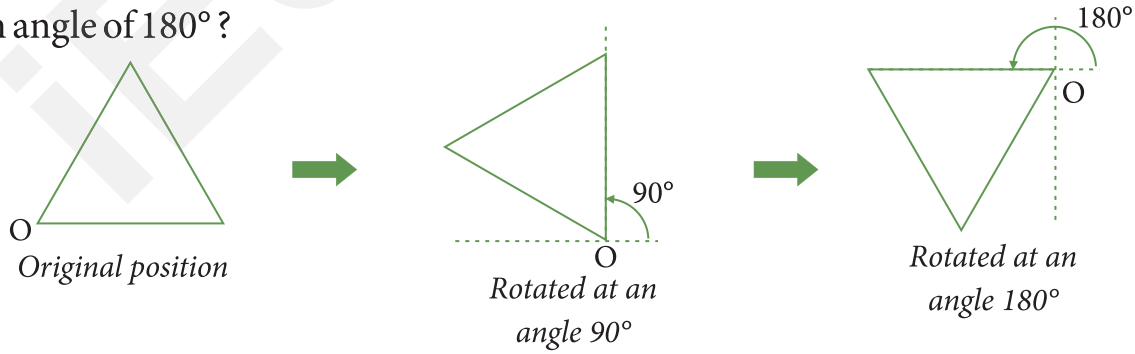
Example 8: Rotate the figure given below about the given point O at an angle of 90° and 180°.

Solution :



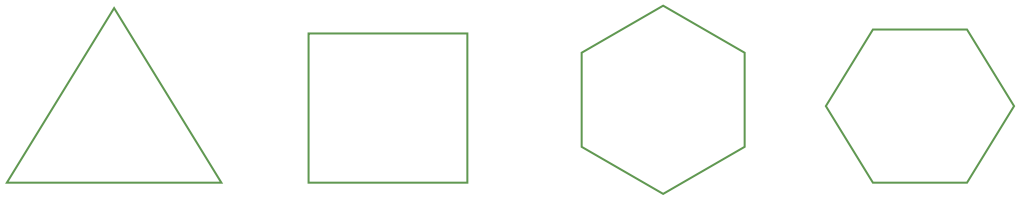
Example 9 : Which figure will be obtained when the given figure rotates about the point 'O' at an angle of 180° ?

Solution :



Rotational and Reflection Symmetry

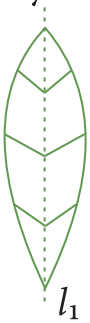
Figures Showing Both Rotational and Reflection Symmetry:



All these figures are regular polygons, which show reflection symmetry and rotational symmetry at the same time .

Example 10 : Draw two figures which show only reflection symmetry, but not the rotational symmetry. Also, draw the line (axis) of symmetry.

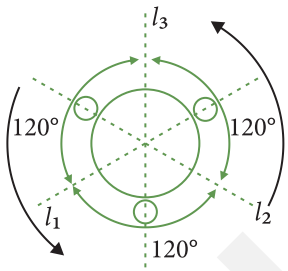
Solution :



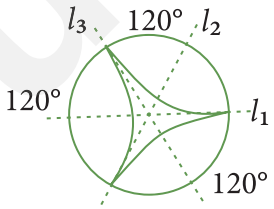
Example 11 : Draw two simple figures which show both reflection as well as rotational symmetry (rotation of symmetry should be 120°).

Also, draw the line (axis) of symmetry.

Solution : (*i*)

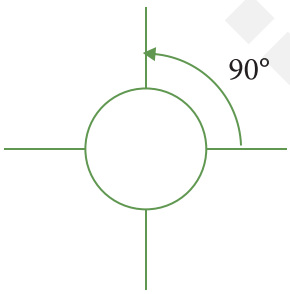


(*ii*)



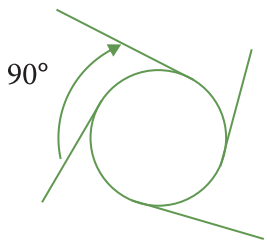
Here, l_1 l_2 and l_3 are the lines of symmetry and both the figures show rotational symmetry at an angle 120°.

Figures Showing only Rotational Symmetry But not Reflection Symmetry



This figure shows both the reflection symmetry and rotational symmetry: rotation angle = 90°

After twisting its line



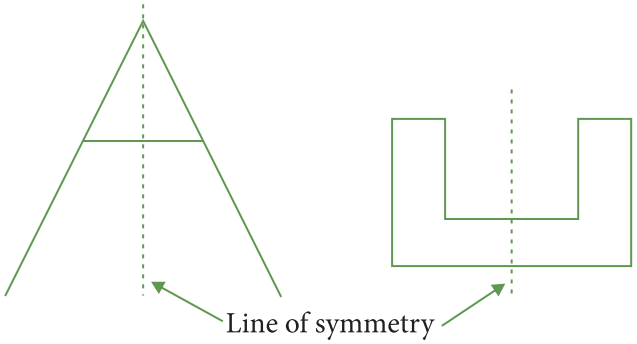
This figure only shows rotational symmetry but not reflection symmetry: rotation angle = 90°

Take a Task

Watch Remedial

Figures Showing Only the Reflection Symmetry But not the Rotational Symmetry

Let us discuss about the following figures :

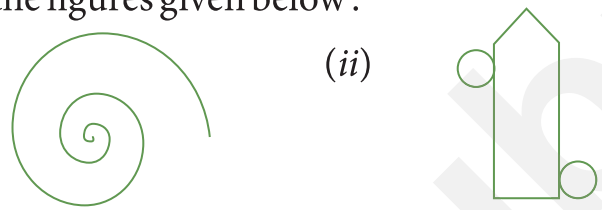


It can easily be seen that each of the above figures fit onto itself in one complete turn which means, it needs to be rotated by 360°. So, the angle of rotation cannot be 360°. Therefore, both the figures show only the reflection symmetry, but not the rotational symmetry.

Figures Showing Neither The Reflection Symmetry Nor The Rotational Symmetry

Let us consider the figures given below .

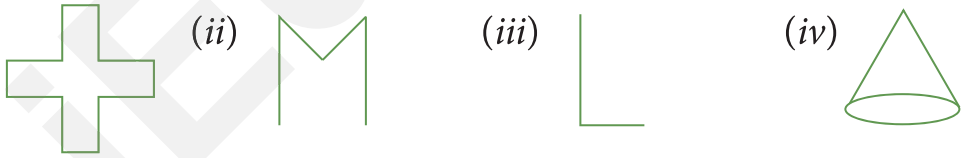
(*i*) (*ii*)



Here, both the figures do not show either rotational or reflection symmetry.

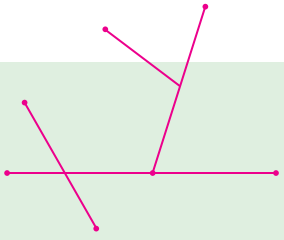
Example 12 : Which of the following figures show either the reflection or the rotation symmetry or both?

(*i*) (*ii*) (*iii*) (*iv*)



Solution : (*i*) By observing all the options, it is obvious that options (*i*), (*ii*) and (*iv*) have either reflection or rotational symmetry. But only option (*iii*) does not show either the reflection or rotation symmetry. So, the option (*iii*) is correct.

Exercise 9.3



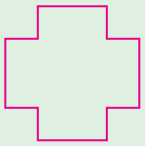
1. Answer the following question:

(*i*) Write any alphabets that show

(*a*) line symmetry only. (*b*) both line and rotational symmetry.

(*ii*) Find the value of rotation angle in the given figure alongside :

2. In the following figures, draw the line of symmetry and specify at what angle it shows rotational symmetry:

(*i*)  (*ii*) 

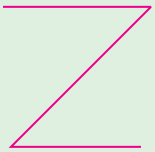
3. Rotate each of the following figures about the given point O at an angle of 90° and 180° :

(*i*) 

(*ii*) 

(*iii*) 

4. Do the following figures show rotational symmetry ? Find the value of angle of rotation:

(*i*)  (*ii*)  (*iii*) 

5. Draw three figures which do not show either the reflection or the rotation symmetry.

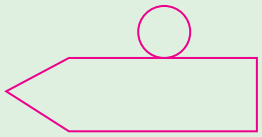
Chapter-end Exercise

Gap Analyzer™

A. Multiple Choice Questions (MCQs)

Tick (✓) the correct option.

1. In the given figure:



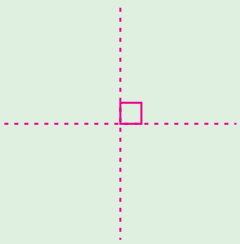
(*a*) 3 lines of symmetry can be found. ☐

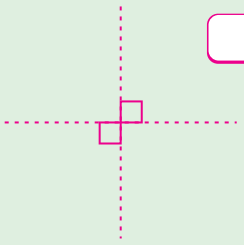
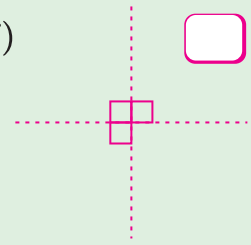
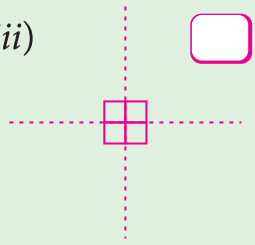
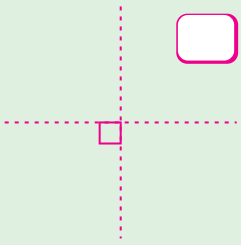
(*b*) 2 lines of symmetry can be found. ☐

(*c*) no line of symmetry can be found. ☐

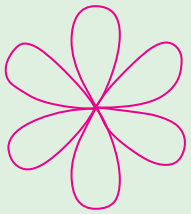
(*d*) 1 line of symmetry can be found. ☐

2. Complete the figure given at right to be symmetric about the mirror line.



(*i*)  ☐ (*ii*)  ☐ (*iii*)  ☐ (*iv*)  ☐

2. The flower shown at right has a rotational symmetry of order:



(*a*) 1 ☐ (*b*) 5 ☐

(*c*) 10 ☐ (*d*) 3 ☐

3. An object is not considered to have rotational symmetry, if it has rotational symmetry of order:

(*a*) 2 ☐ (*b*) 3 ☐ (*c*) 5 ☐ (*d*) 1 ☐

5. The angle at which a 5- blade fan shows the rotational symmetry is:

(*a*) 60° ☐ (*b*) 72° ☐ (*c*) 36° ☐ (*d*) 90° ☐

Knowledge Application

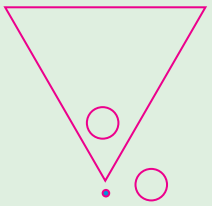
B. Fill in the Blanks:

1. An _____ triangle has same number of lines of symmetry and the order of symmetry.
2. A scalene triangle has _____ line of symmetry.
3. The number of lines of symmetry in a regular pentagon is _____.
4. The English alphabet 'O' has _____ lines of symmetry.
5. The order or rotational symmetry of the English alphabet 'K' is _____.

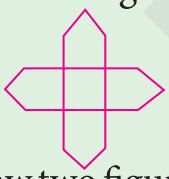
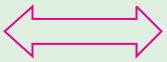
Knowledge Application

C. Answer the following questions :

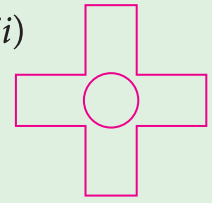
1. Rotate the following figure (anti- clockwise) about the point O at angles 60°, 120° and 180°.



2. In the letter "ADVANCE", which letter shows rotational symmetry ?
3. Find the angle of rotation, if any, for the following figures :

(*i*)  (*ii*)  (*iii*) 

4. Draw two figures which neither exhibit the rotational nor the reflection symmetry.
5. Draw the dotted line to indicate the line of symmetry of the following figures :

(*i*)  (*ii*)  (*iii*) 

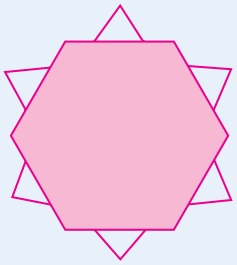
6. List three letters in English alphabet which exhibit only line symmetry.
7. List two letters in English alphabet which exhibit both line as well as rotational symmetry.

Mental Maths

Knowledge Application

1. Does the given figure show the rotational symmetry ? If yes, find the angle of rotation.

2. In the following figure, find the angle of rotation and order of rotation.



3. Draw two letters of English alphabet which show the line symmetry, but not the rotational symmetry.

HOTS (Higher Order Thinking Skills)

Critical Thinking

1. Draw a figure which shows the rotational symmetry but not the line symmetry.
2. What is the order of rotation of a rectangular lamina ?
3. Draw two English alphabets having both the line as well as rotational symmetry.

Assertion and Reason

Experiential Learning

In each of the following questions, an Assertion (A) and a corresponding Reason (R) supporting it is given.
Study both the statements and state which of the following is correct:
(*a*) Both A and R are true and R is the correct explanation of A.
(*b*) Both A and R are true but R is not the correct explanation of A.
(*c*) A is true but R is false.
(*d*) A is false but R is true.

1. **Assertion (A) :** An isosceles triangle has two lines of symmetry.
   Reason (R) : A rectangle has two lines of symmetry.
2. **Assertion (A) :** The English alphabet O has many lines of symmetry.
   Reason (R) : The English alphabet B has no rotational symmetry.
3. **Assertion (A) :** The order of rotational symmetry of a square is 4.
   Reason (R) : A half tern means rotation by 180°.
4. **Assertion (A) :** The angle turned during rotation is called the angle of rotation.
   Reason (R) : A scalene triangle has no line of symmetry.
5. **Assertion (A) :** The number of lines of symmetry in a circle is 3.
   Reason (R) : Every shape has rotational symmetry of the order 1.