



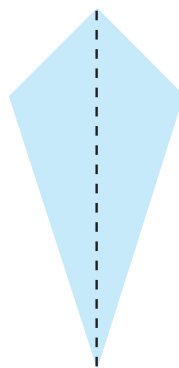
# Symmetry

By studying this lesson you will be able to

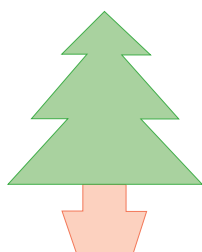
- identify plane figures with bilateral symmetry,
- draw the axes of symmetry of a bilaterally symmetric figure, and
- create bilaterally symmetric figures on square ruled paper.

## 1.1 Bilateral Symmetry

A figure of a blue quadrilateral shaped card is given here. By folding this figure along the dotted line, we obtain two parts that coincide on each other.



A few figures having two parts which coincide with each other when folded along a certain line are shown below.



Many of the objects in the environment have the property that they can be divided into two equal parts. Most creations too have this property which helps preserve their beauty. Let us learn more about plane figures and laminas with a plane figure as the boundary, that have this property.

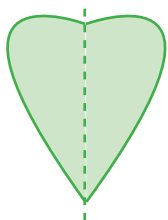


Figure 1

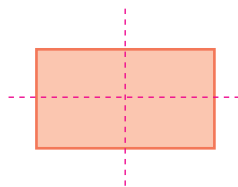


Figure 2

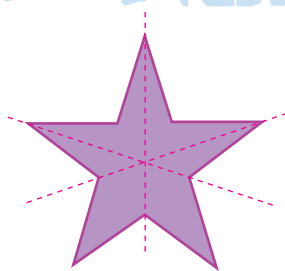


Figure 3

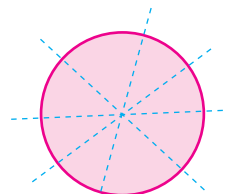


Figure 4

In figure 1, there is only one line that divides the figure into two equal parts which coincide. However, each of the figures 2, 3 and 4, has more than one line that divides the figure into two parts which coincide.



### Activity 1

**Step 1** - Trace this figure onto a paper and cut along the border of the figure.

**Step 2** - Fold the figure so that you get two equal parts which coincide as shown in figure 2.

**Step 3** - Draw a dotted line along the fold. Now paste the figure in your exercise book.

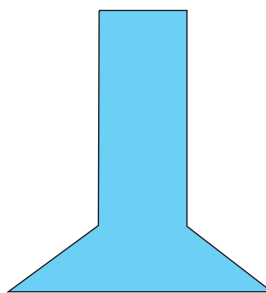


Figure 1

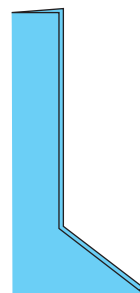
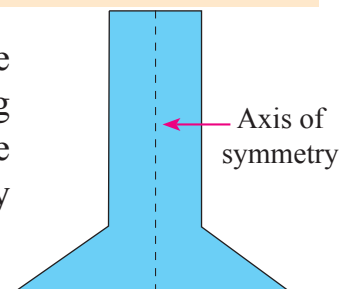


Figure 2

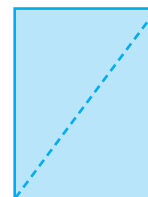
If a plane figure can be folded along a straight line so that you get two parts which coincide, then that plane figure is defined as a **bilaterally symmetric plane figure**. The line of folding is defined as an **axis of symmetry** of the figure.

In the above activity you must have drawn the dotted line shown in the figure as the line along the fold. This line is an “axis of symmetry of the figure”. This bilaterally symmetric figure has only one axis of symmetry.



In a bilaterally symmetric figure, the two parts on either side of an axis of symmetry are of the same shape and of the same area.

The figure depicts a rectangle with a dotted line drawn across it. This line divides the rectangle into two equal parts. However if we fold the rectangle along the dotted line, the two parts will not coincide. Therefore this line is not an axis of symmetry of the figure.



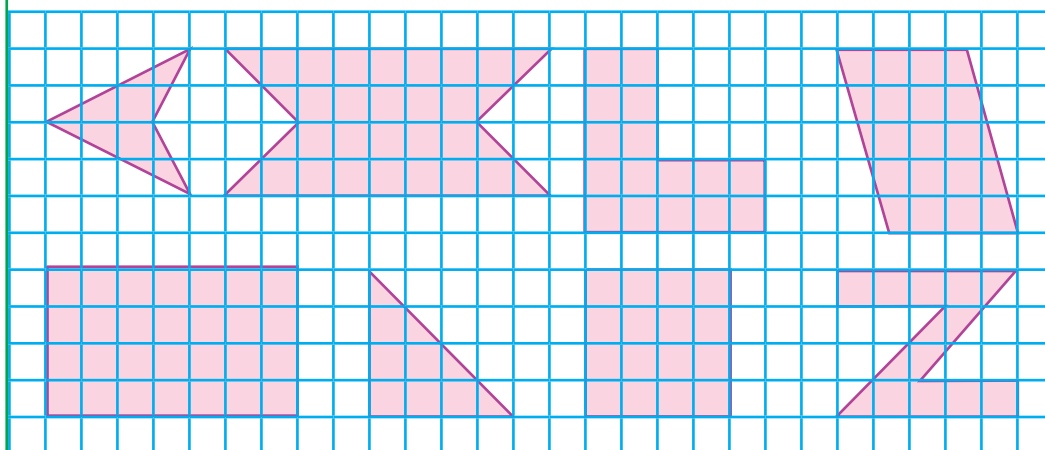
A line through a plane figure which divides it into two parts which do not coincide with each other is not an axis of symmetry of the figure.

## 1.2 Drawing axes of symmetry



### Activity 2

**Step 1** - Copy the figures given below on a piece of paper and cut out each shape.



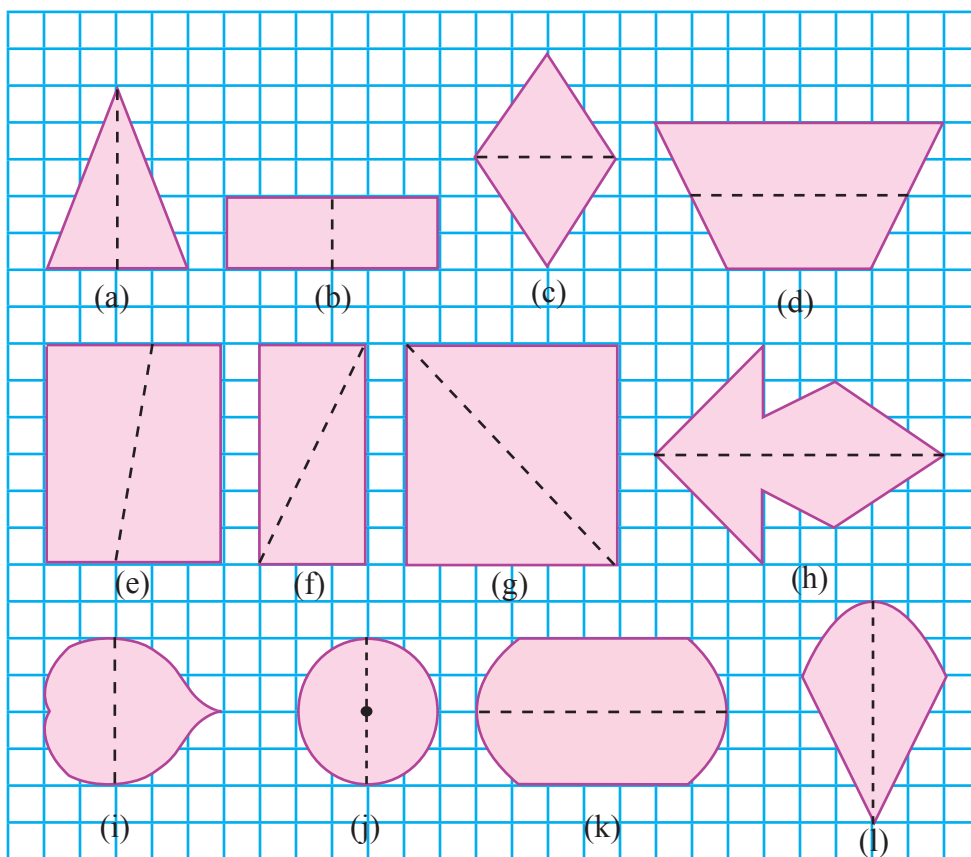
**Step 2** - Find the bilaterally symmetric figures from the figures that were cut out.

**Step 3** - Draw all the axes of symmetry of the figures with bilateral symmetry.

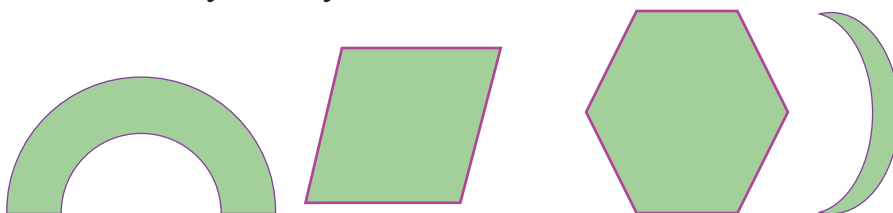
**Step 4** - Paste all the figures having axes of symmetry in your exercise book. Near each figure, write its number of axes of symmetry.

## Exercise 1.1

- (1) From the following, choose the bilaterally symmetric figures with a correctly drawn axis of symmetry and write down the corresponding letters.



- (2) (i) Cut out laminas of the following shapes using paper. Draw all the axes of symmetry of each of them.

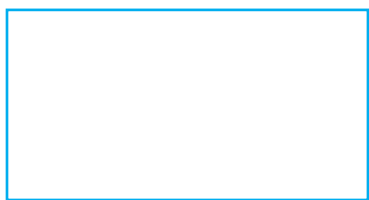


- (ii) Paste all the figures having axes of symmetry in your exercise book.

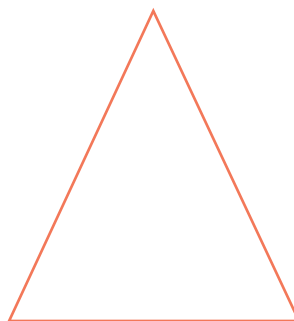
- (3) (i) Cut laminas of the following shapes using paper. Draw all the axes of symmetry of each of them.

*A* - Rectangular shape

*B* - Triangular shape with two sides of equal length



*A*



*B*

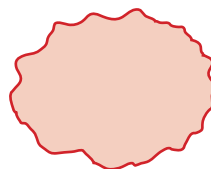
- (ii) Write the number of axes of symmetry in each of the above figures.
- (iii) Create another symmetric figure by joining two figures of the shapes given in *A* and *B* above and paste it in your exercise book.
- (4) Write the statements below in your exercise book. Mark a ✓ in front of the correct sentences and a ✕ in front of the incorrect ones.
- (i) In a bilaterally symmetric figure, the two parts on either side of an axis of symmetry are equal in shape and in area.
  - (ii) There are bilaterally symmetric figures having more than one axis of symmetry.
  - (iii) The number of axes of symmetry in a circular lamina is greater than the number of axes of symmetry in a square.
  - (iv) The maximum number of axes of symmetry in a bilaterally symmetric figure is one.
  - (v) If a bilaterally symmetric figure which has at least two axes of symmetry is cut along one axis and divided into two equal parts, then each of these parts too will be bilaterally symmetric.

### 1.3 Creating plane figures having bilateral symmetry



#### Activity 3

**Step 1** - Get a piece of paper of any shape and a pair of scissors.



**Step 2** - Fold the paper into two.



**Step 3** - Draw any figure of your choice such that it contains a part of the line of folding and is limited to the area where the two portions overlap (see diagram).



**Step 4** - Cut out the figure you drew.



**Step 5** - Unfold the figure.



At the end of the above activity you obtain a bilaterally symmetric figure. Its axis of symmetry is the initial line along which you folded the paper.

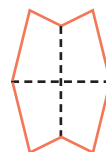
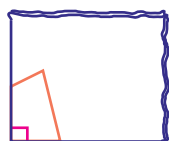


#### Activity 4

**Step 1** - Take another piece of paper and fold it twice so that you obtain a right angled corner.

**Step 2** - Now draw a figure on this paper so that it includes the right angled corner and such that it is limited to the region where the four portions of paper overlap.

Cut the figure and unfold it. You will obtain a bilaterally symmetric figure with two axes of symmetry, where the axes of symmetry are the two lines along which you folded the paper.



**Step 3** - Cut out other symmetric figures in this manner.



### Activity 5

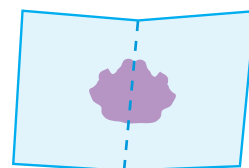
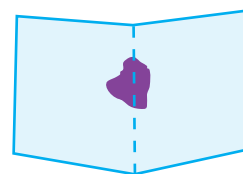
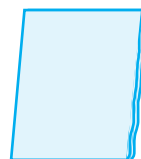
**Step 1** - Get a paper and some paint.

**Step 2** - Fold the paper into two parts.

**Step 3** - Now unfold the paper. On the side that is folded in, place a drop of paint so that it lies on the line of folding.

**Step 4** - Now fold the paper back and press with your hand.

**Step 5** - Unfold the paper.



At the end of this activity you will obtain a bilaterally symmetric figure as in the given diagram.

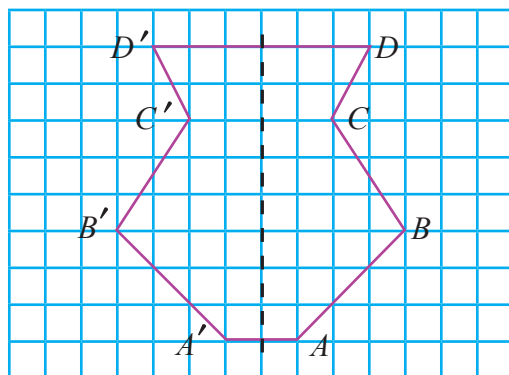
**Step 6** - Following the above steps, obtain different bilaterally symmetric figures by changing the amount of paint used or by pressing down in different directions.

### Assignment

- ▲ Create various bilaterally symmetric plane figures by cutting out folded paper as well as by placing drops of paint on folded paper as done in the previous activities.
- ▲ Prepare an attractive wall decoration using the symmetric figures that you created.

## 1.4 Drawing bilaterally symmetric plane figures

Let us consider the symmetric plane figure given below which has been drawn on a square ruled paper.



The axis of symmetry of this figure is the vertical line indicated by the dotted line. The points at which the straight line segments of a rectilinear plane figure meet are defined as the **vertices** of the plane figure. Usually the vertices are named using capital letters of the English alphabet.

The vertices  $A$ ,  $B$ ,  $C$  and  $D$  are on the right side of the axis of symmetry of the figure. Let us consider where the points  $A'$ ,  $B'$ ,  $C'$  and  $D'$  are located on the left side of the axis of symmetry.

The point  $A'$  is located at a distance from the axis of symmetry which is equal to the distance from  $A$  to the axis of symmetry, on a horizontal line which passes through  $A$ .  $A'$  is defined as **the vertex corresponding to  $A$** .

Similarly,  $B'$ ,  $C'$  and  $D'$  are defined as the vertices corresponding to  $B$ ,  $C$  and  $D$  respectively.

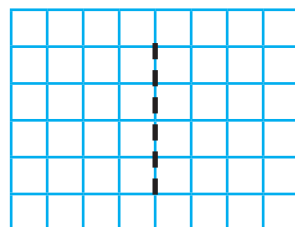
Let us consider how a bilaterally symmetric figure is drawn on a square ruled paper (or grid) by identifying corresponding vertices.



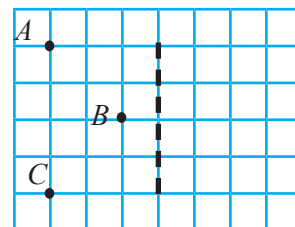


## Activity 6

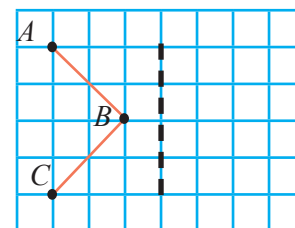
**Step 1** - As indicated in the figure, select a vertical line on the grid and mark it with a dotted line.



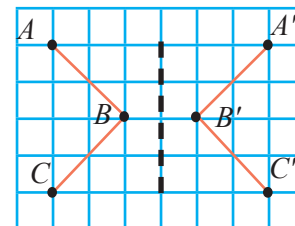
**Step 2** - Select three points of intersection of vertical and horizontal lines on the grid which lie on the left side of the dotted line. Name these points  $A$ ,  $B$  and  $C$  respectively.



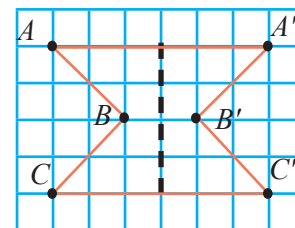
**Step 3** - Join the points  $A$  and  $B$ , and the points  $B$  and  $C$  using straight line segments.



**Step 4** - On the right side of the dotted line, mark on the grid, the points corresponding to the above points. Name them  $A'$ ,  $B'$  and  $C'$ . Join the points  $A'$  and  $B'$ , and the points  $B'$  and  $C'$  using straight line segments.



**Step 5** - Join the points  $A$  and  $A'$ , and the points  $C$  and  $C'$  using straight line segments.



Now you have obtained a bilaterally symmetric rectilinear plane figure with the dotted line as its axis of symmetry and the marked points as vertices.

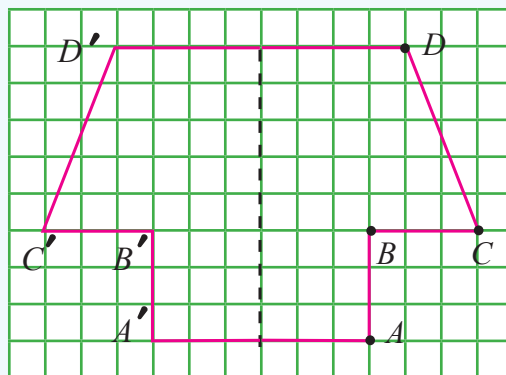
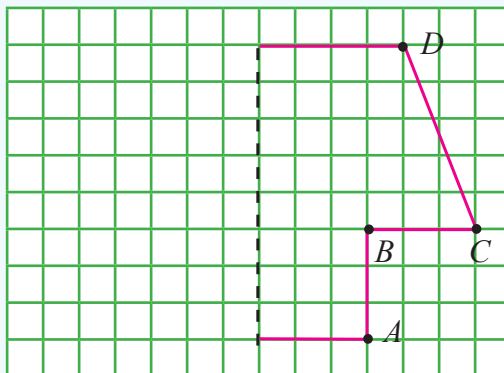
Let us consider how symmetric figures can be drawn by using the above properties.

### Example 1

Complete the bilaterally symmetric figure such that the dotted line in the diagram is its axis of symmetry.

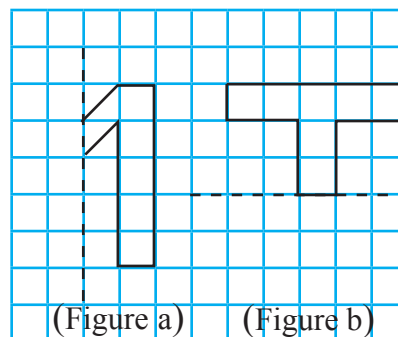
The distance from  $A$  and  $B$  to the axis of symmetry is equal to the length of three squares.

Therefore, let us mark the points  $A'$  and  $B'$  such that the distance from it to the axis of symmetry is also equal to the length of three squares, By similarly marking the points  $C'$  and  $D'$  such that the distance from  $C'$  to the axis of symmetry is equal to the length of 6 squares, and the distance from  $D'$  to the axis of symmetry is equal to the length of 4 squares as shown in the figure, and joining the points as indicated, we obtain a bilaterally symmetric figure.

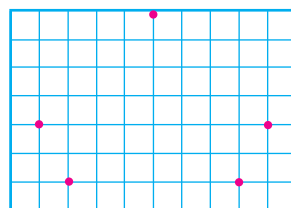


### Exercise 1.2

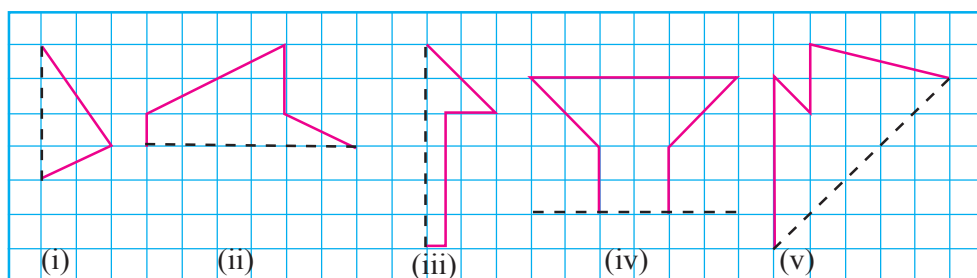
- (1) (i) Copy figure  $a$  in your square ruled exercise book.
- (ii) The dotted line indicates the axis of symmetry. Place a mirror on this line and observe the bilaterally symmetric figure.
- (iii) Draw and complete the bilaterally symmetric figure.
- (iv) Repeat the above steps for figure  $b$  and complete the bilaterally symmetric figure.



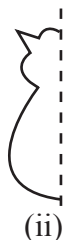
- (2) Draw a bilaterally symmetric figure with the points marked on the grid as vertices and identify its axis of symmetry.



- (3) Copy each of the figures given below in your exercise book. Complete the figures so that you obtain a bilaterally symmetric figure in each case.



- (4) Trace each of the figures given below on a tissue paper and copy them in your exercise book.



Now turn the tissue paper on the dotted line. Draw the other half of each of the figures to obtain bilaterally symmetric figures.

- (5) (i) Draw three bilaterally symmetric figures on a square ruled paper such that each figure has only one axis of symmetry.  
(ii) Draw the axis of symmetry of each of the above figures.

- (6) (i) Draw two bilaterally symmetric figures on a square ruled paper such that each figure has only 2 axes of symmetry.
- (ii) Draw the axes of symmetry of each figure.

### Summary

- If a plane figure is divided into two equal parts which coincide with each other when folded along a particular line, then that figure is defined as a bilaterally symmetric figure.
- The line of folding described above is an axis of symmetry of the figure.