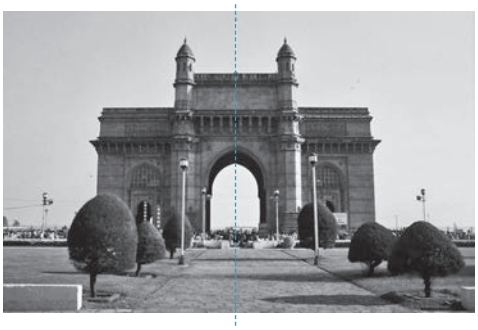
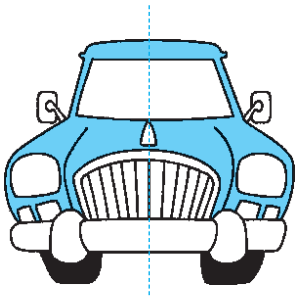
14 Symmetry

INTRODUCTION

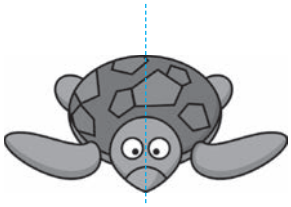
Symmetry is an important geometrical concept that is used in many fields of activity. Artists, professionals, designers of clothing or jewellary, car manufacturers, architects and many others use the idea of symmetry. In class VI, we have already learnt about line (s) of symmetry. We have seen the presence of line(s) of symmetry in many man-made things as well as in nature. Flowers, tree-leaves, beehives, fish, birds, animals, humans, religious symbols – everywhere we find symmetry.



Architecture



Engineering

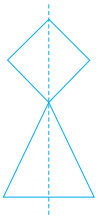


Nature

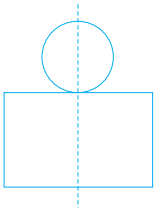
The above objects look beautiful because of their symmetry. In this chapter, we shall review and strengthen the concept of line symmetry and also learn the concept of rotational symmetry.

LINE SYMMETRY

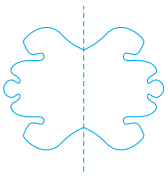
Look at the following plane figures and pictures of objects:



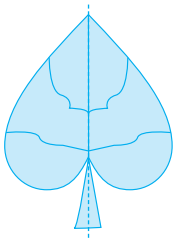
(*i*)



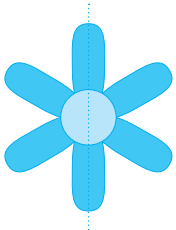
(*ii*)



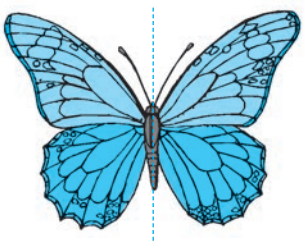
(*iii*)



(*iv*)



(*v*)



(*vi*)

We observe that if these figures (or pictures) are folded along a specific line (shown dotted), each figure on the left hand of the dotted line fits exactly on the top of the figure on the right hand side of the dotted line *i.e.* each figure is divided into two coincident parts about the dotted line. We can see that two halves are mirror images of each other. If we place a mirror on the fold line then the image of one side of the figure will exactly fall on the other side of the figure. This leads to:

If a figure is divided into two coincident parts (mirror images) by a line, then the figure is called ***symmetrical*** *about that line, and the line is called its* ***line of symmetry*** *or* ***axis of symmetry*** *or* ***mirror line***. *We also say that the figure has a* ***line of symmetry***.

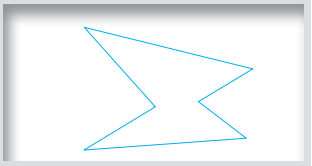
Each one of the figures (*i*), (*ii*) and (*iii*) and each one of the pictures (*iv*), (*v*) and (*vi*) shown above is symmetrical about the dotted line, and the dotted line is its axis (or line) of symmetry.

A simple test to determine whether a figure (or picture) has line symmetry is to fold the figure along the supposed line of symmetry and to see if the two parts of the figure coincide.

Remark

A plane figure may have no line of symmetry, it may have one line or more lines of symmetry.

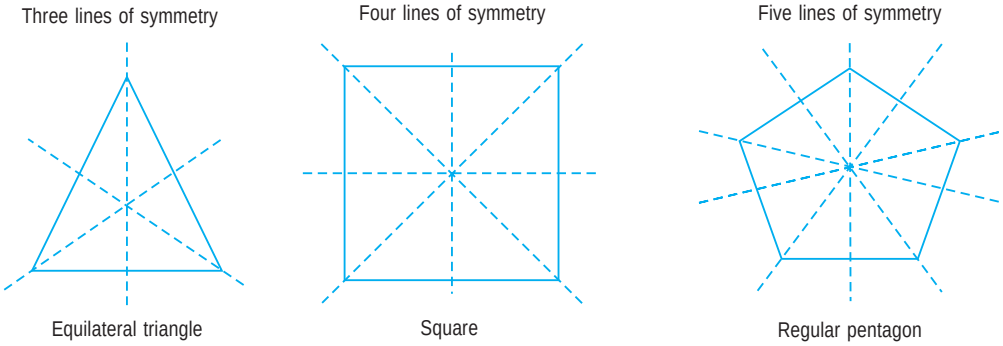
Note that the adjoining figure has no line of symmetry.



Lines of symmetry for regular polygons

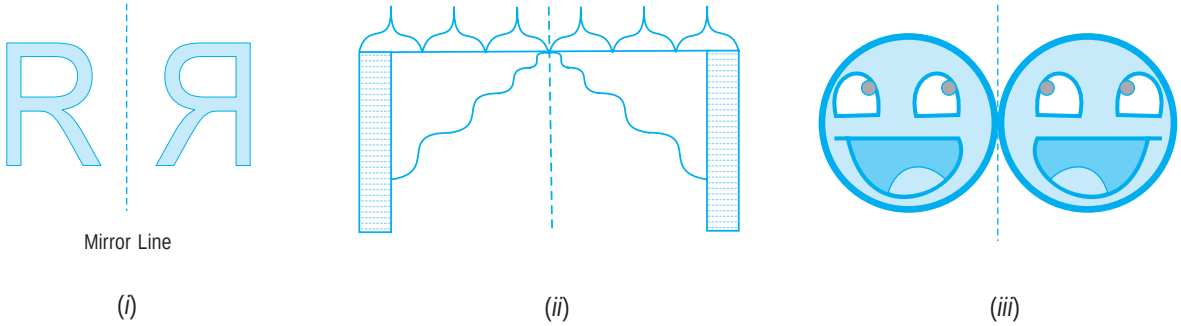
A simple closed curve made up entirely of line segments is called a **polygon.** A polygon consists of atleast three line segments. A polygon is said to be **regular** if all its sides are of equal length and all of its angles are of equal measure. Equilateral triangles, squares, regular pentagons etc. are all regular polygons. Regular polygons are symmetrical figure and have more than one line of symmetry. We say, they have multiple lines of symmetry.

In fact, each regular polygon has as many lines of symmetry as the number of sides.



Reflection and symmetry

Look at the following pictures of objects and their reflections in a plane mirror:



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

We see that if a fold is made on the mirror line, the object will fall exactly on the reflected image. Thus, the object and its image are symmetrical with reference to the mirror line, so the mirror line is the line of symmetry. Hence, the concept of line symmetry is closely related to mirror reflection. A mirror line helps us to visualize a line of symmetry. However, while dealing with mirror reflection there is a need to note the ***left-right change in orientation.***

Remark

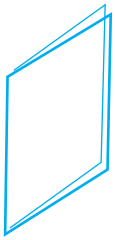
When we see the image of an object in a plane mirror, we notice that:

(*i*) the distance of the **image** behind the mirror is the same as the distance of the **object** in front of it.

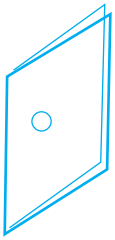
(*ii*) the **mirror line** is perpendicular to the line joining the object and its image.

(*iii*) The object and its image are **inversely congruent.**

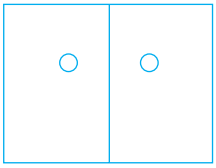
Punching holes



Fold a sheet into two halves

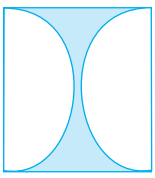


Punch a hole

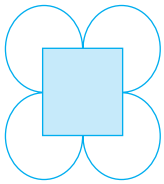


Two holes about the symmetric fold.

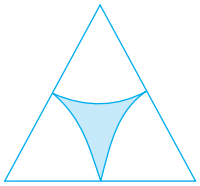
Example 1. Draw all lines of symmetry, if any, in each of the following figures:



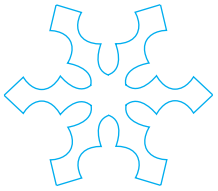
(*i*)



(*ii*)

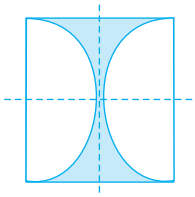


(*iii*)

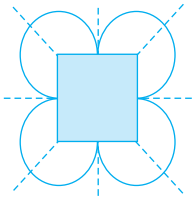


(*iv*)

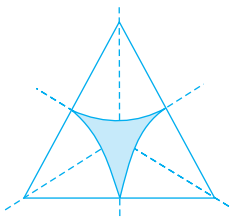
Solution. The lines of symmetry are shown by dotted lines in each of following figures:



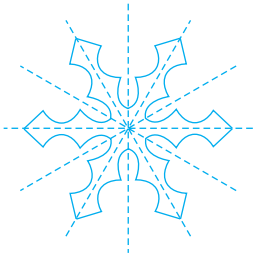
(*i*)



(*ii*)

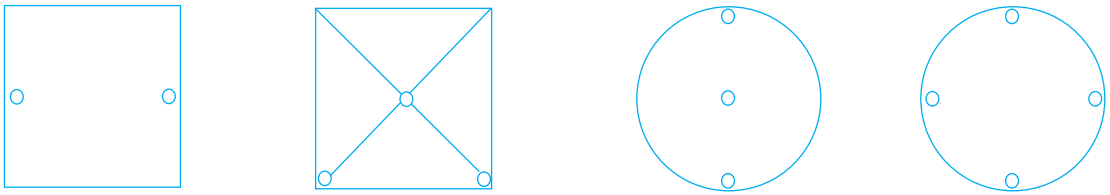


(*iii*)



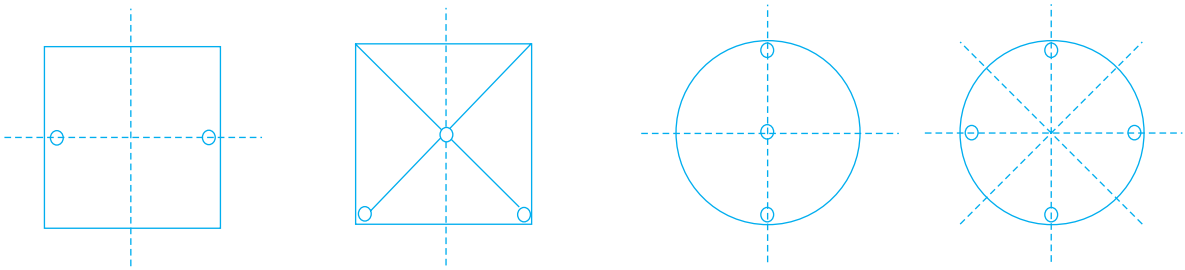
(*iv*)

Example 2. Copy the figures with punched holes and draw all the axes of symmetry in each of the following:



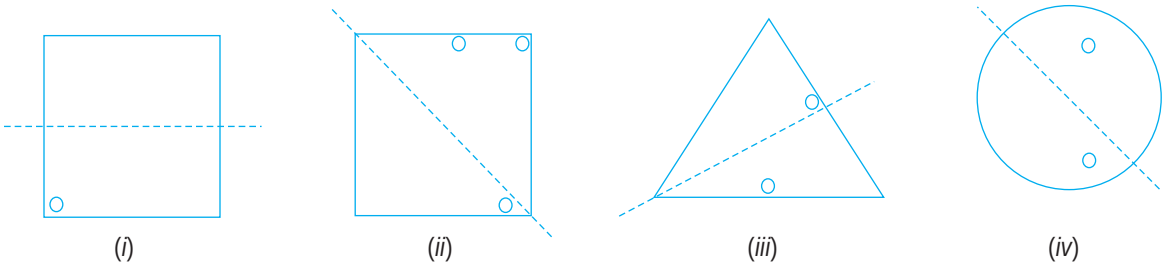
(*i*) (*ii*) (*iii*) (*iv*)

Solution. The lines of symmetry are shown by dotted lines in each of the following figures:



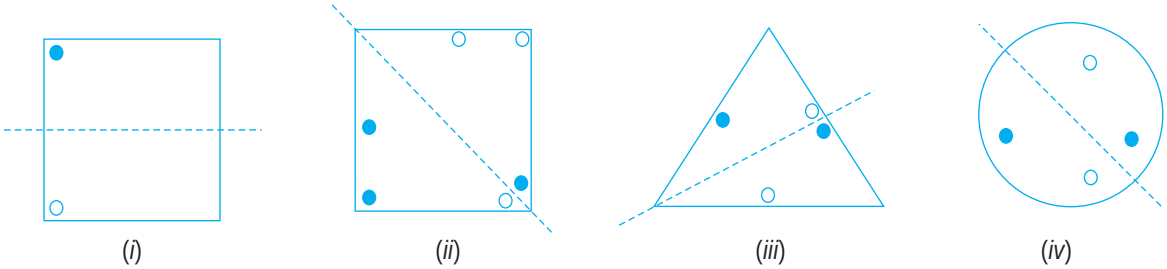
(*i*) (*ii*) (*iii*) (*iv*)

Example 3. In the following figures, mark the missing hole(s) in order to make them symmetrical about the dotted line:



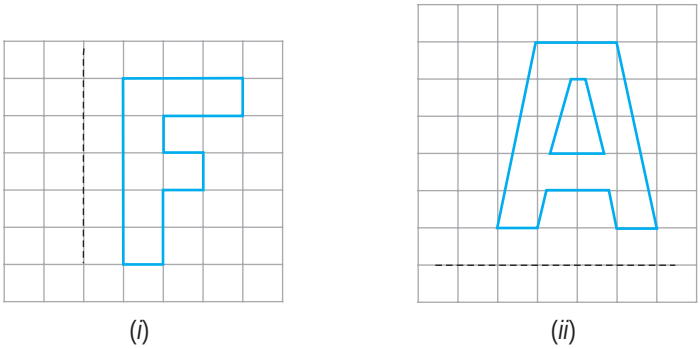
(*i*) (*ii*) (*iii*) (*iv*)

Solution. The missing hole(s) are marked by dark punches (small circles) in each of the following figures:



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

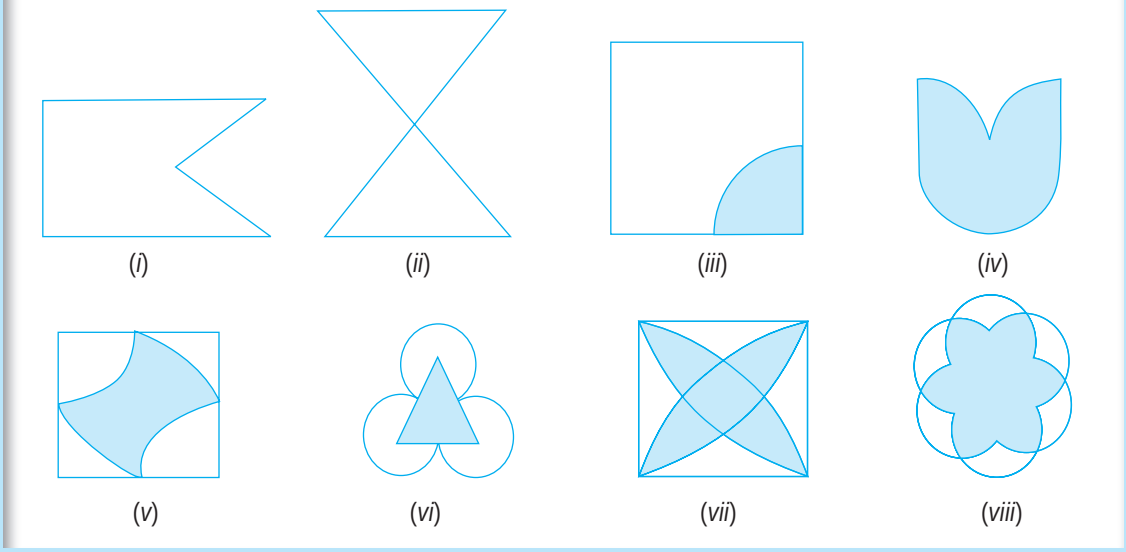
Example 4. Draw the reflection of the following letters in the given mirror line shown dotted:



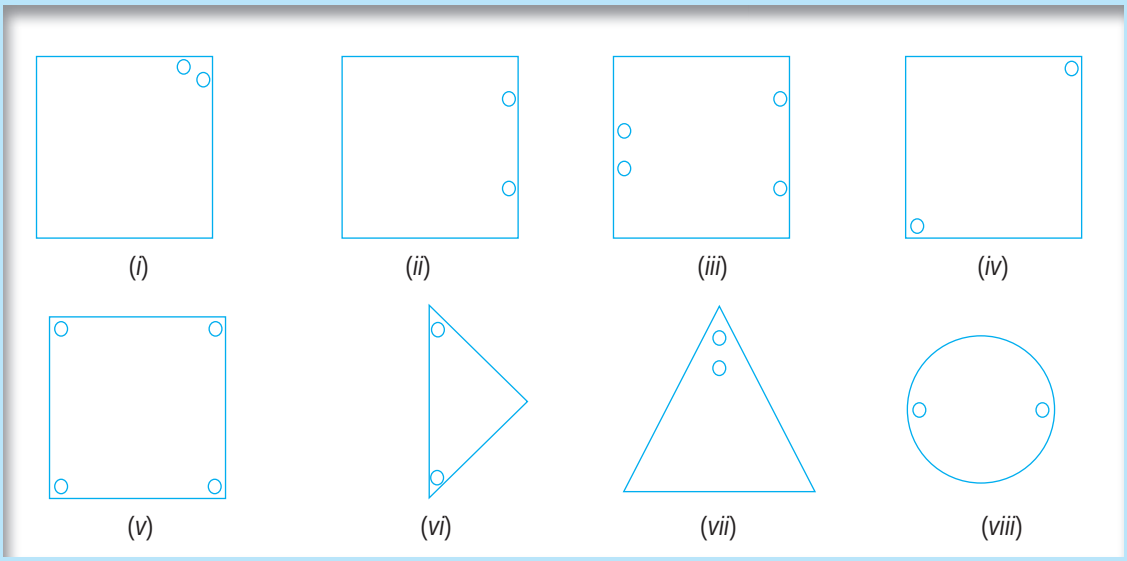
(*i*) (*ii*)

Exercise 14.1

1. Draw all lines of symmetry, if any, in each of the following figures:



2. Copy the figures with punched hole(s) and draw all the axes of symmetry in each of the following:



3. In the following figures, mark the missing hole(s) in order to make them symmetrical about the dotted line: