25 Solids

By studying this chapter you will be able to get a good understanding of the

- ★ construction of models of a square pyramid and a triangular prism.
- ★ Euler's equation for solids.

25.1 Introduction

Such things as a point, line, angle, triangle, rectangle, square, ... you have learned so far can be constructed on a plane. They are called plane figures. Now look at the following pictures.

(A)

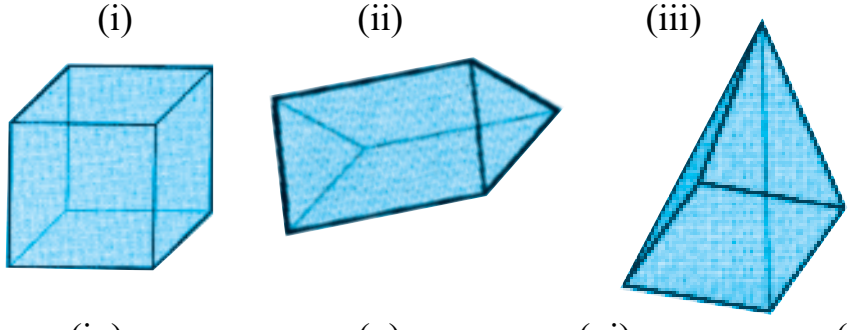
(i) (ii)

You will see that the two statues above cannot be constructed on a plane.

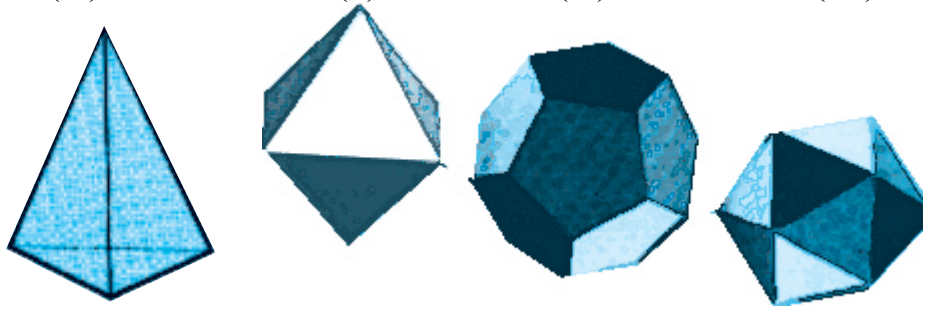
Let us consider the following figures of geometrical shapes.

(B)

(i) (ii) (iii)

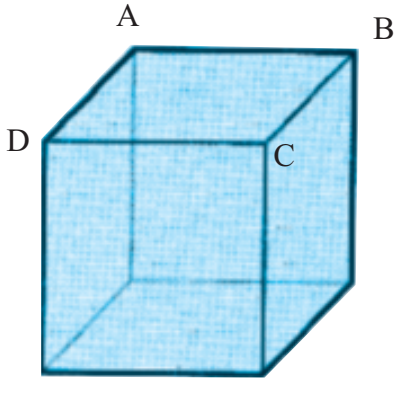


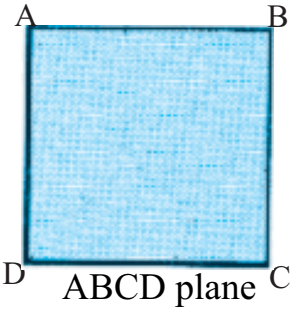
(iv) (v) (vi) (vii)



None of the above figures can be constructed on a plane.

(C)





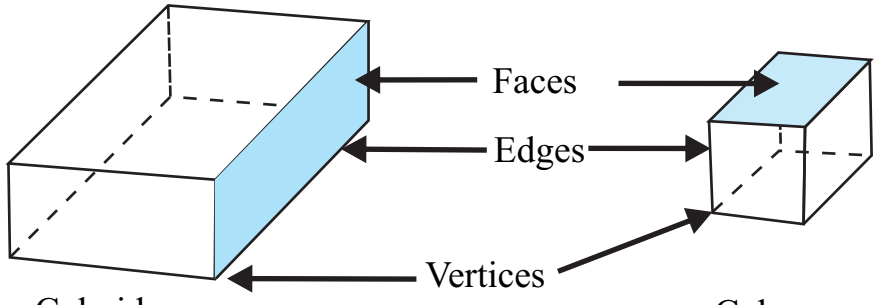
ABCD plane face

The above figure is a cube. It has six square faces. What is shown on the right side is the square face ABCD. All these six square faces are plane figures. A cube has six square faces. But the constructed cube is not a plane figure. Hence a cube too cannot be constructed on a plane.

All figures that can be constructed on a plane are two dimensional and those that cannot be constructed so are three dimensional. Hence the model figures illustrated in (A), (B) and (C) are three dimensional objects and they are called **solid bodies.**

In this lesson we will study only the two solids, the square pyramid and the triangular prism.

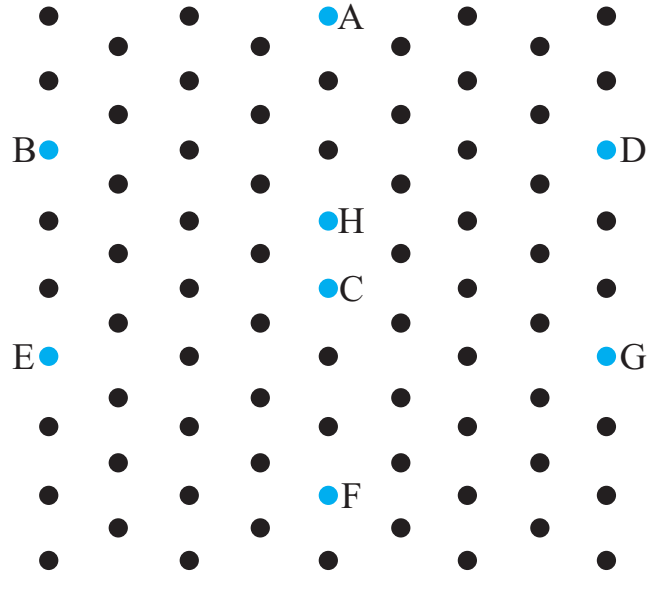
First revise about the cube and the cuboid you have learned in Grade 6.



Accordingly the above cube and cuboid have 6 faces, 12 edges and 8 vertices.

Exercise 25.1

(1) Find some paper having dots as seen in the figure.



(i) According to the letters given in the figure, draw the following line segments.

AB, BC, CD, DA,
HE, EF, FG, GH,
BE, CF, DG, AH

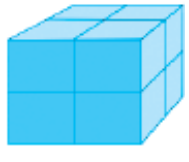
(ii) In the figure you get, draw the edges you can see with dark lines and the edges you cannot see with dotted lines.

(iii) What is the figure you get?

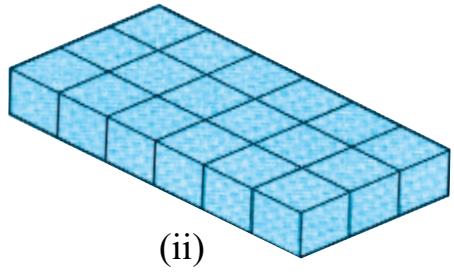
(2) The following solids are constructed with cubes of sides 1 cm in length.

(i) Write the names of the solids.

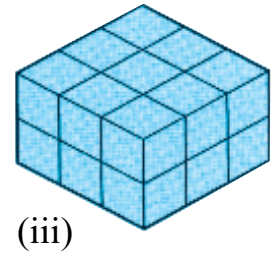
(ii) Find the length, breadth and height of each of the solids.



(i)

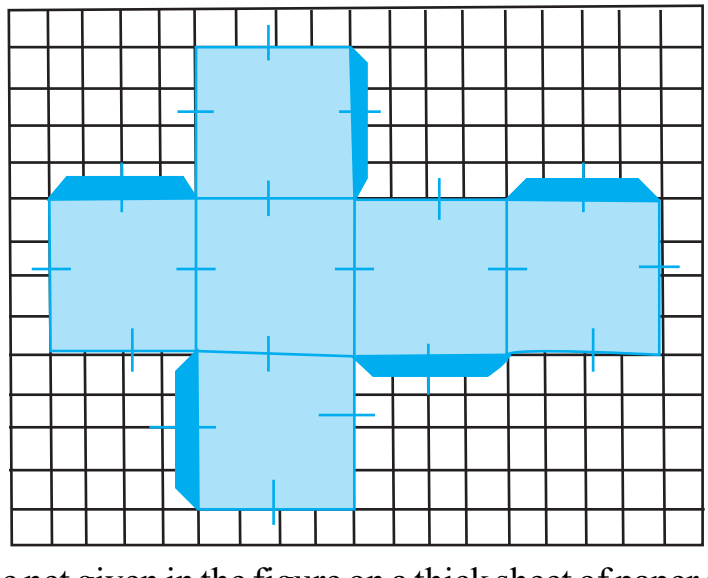


(ii)



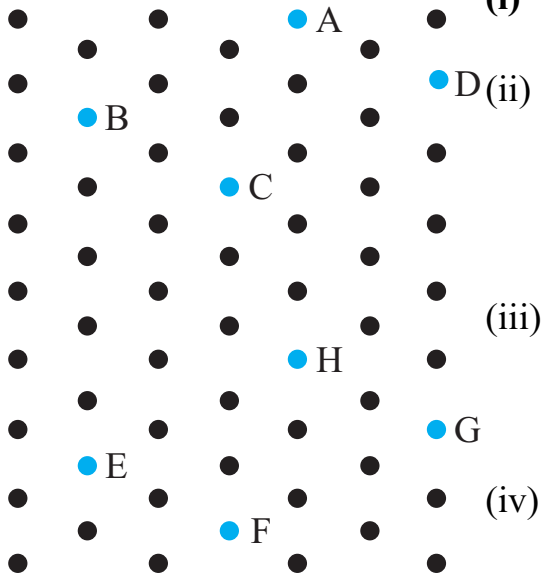
(iii)

Activity 25. 1



Copy the net given in the figure on a thick sheet of paper and cut it out. By folding and pasting it correctly construct a model cube. Find the number of edges, faces and vertices of that model solid.

Activity 25 .2



(i) Find a dotted paper of the form given in the figure.

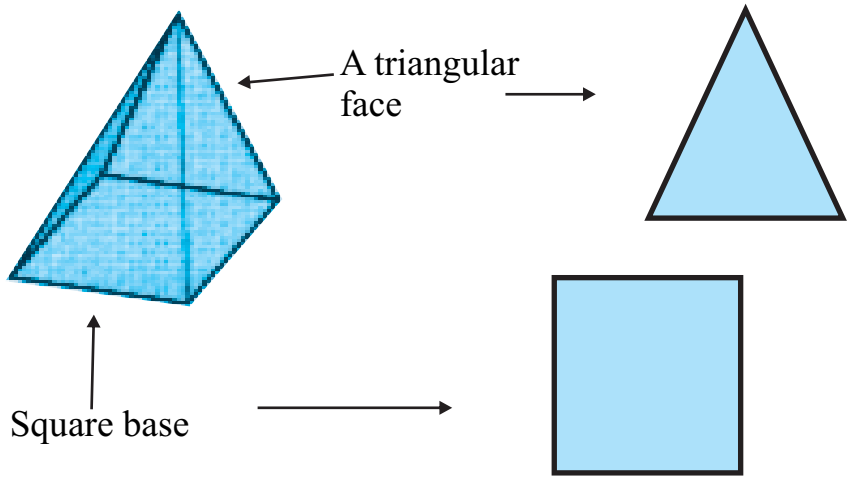
(ii) Draw the line segments AB, BC, CD, DA, HE, EF, FG, GH, BE, CF, DG, AH by joining the letters given in the figure.

(iii) In the figure you get, draw the edges you can see with dark lines and the edges you cannot see with dotted lines.

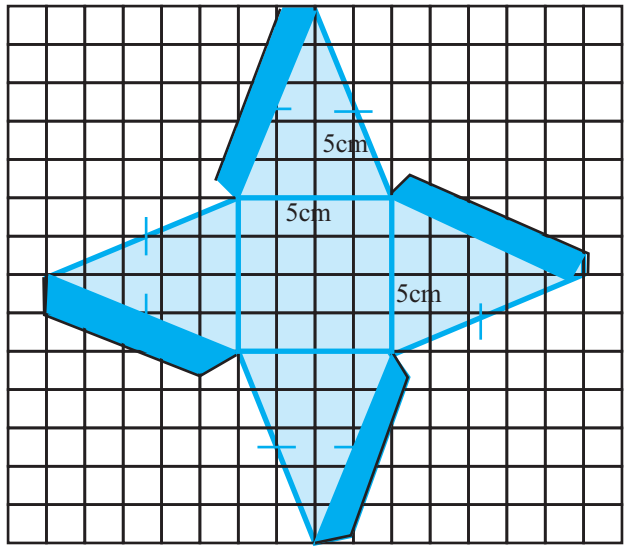
(iv) What is the figure you get?

25. 2 Square pyramid

A solid with a square base and the other faces are identical triangles with a common vertex is called a **square pyramid.**



Activity 25.3



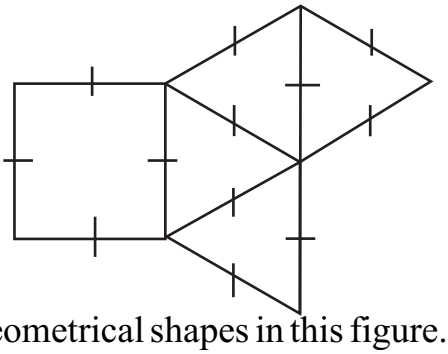
Draw the net given in the figure on a thick sheet of paper and cut it out.

(i) Construct a model square pyramid by folding and pasting the net.

(ii) How many edges, faces and vertices are there in the pyramid?

Activity 25.4

Draw the following shape on a square ruled paper.



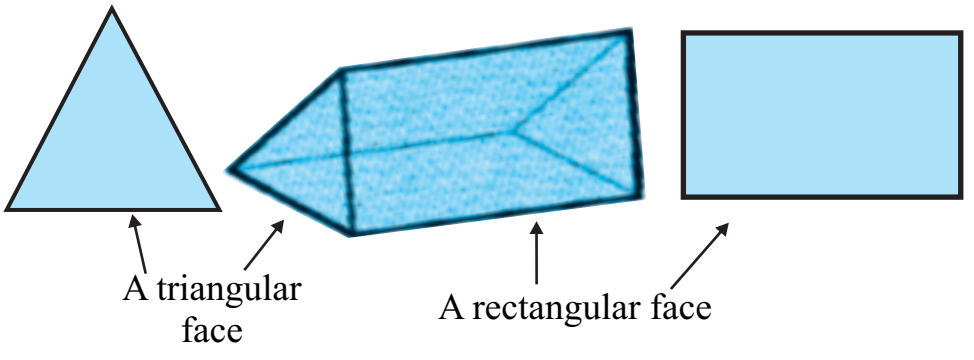
(i) Name the geometrical shapes in this figure.

(ii) Cut this figure along the dark lines fold and paste with cellotape.

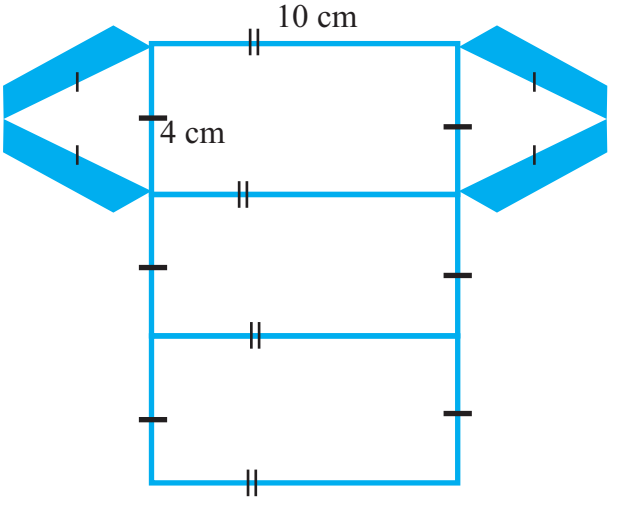
(iii) What is the object constructed?

25.3 Triangular Prism

A triangular prism is a solid with three rectangular faces and two triangular faces.



Activity 25.5



(i) Draw the above net on a thick sheet of paper and cut it out.

(ii) By folding it correctly and pasting, construct a model triangular prism.

(iii) How many edges, faces and vertices are there in the triangular prism?

25.4 Obtaining Euler's Relation

Activity 25.6

Examine the solids you studied in the activities 25.1, 25.2, 25.4 and 25.5 and fill in the blanks in the following table.

Solid	Number of vertices V	Number of faces F	The sum of the number of vertices and the number of faces V + F	Number of edges E
Cube	8	6	14	12
Cuboid	8	6	14	12
Triangular Prism	.....	.....	.....	.....
Square Pyramid	.....	.....	.....	.....

Pay attention to the 4th and 5th columns of the above table and complete the following statements.

The sum of the number of vertices and the number of faces of each of the above solids is always ..... number of edges.

Hence when ..... is added to the number of edges then the value is equal to the sum of the number of faces and vertices .

Hence we get the following relation.

Number of vertices + Number of faces = Number of edges + 2
(V) (F) (E)

$$V + F = E + 2$$

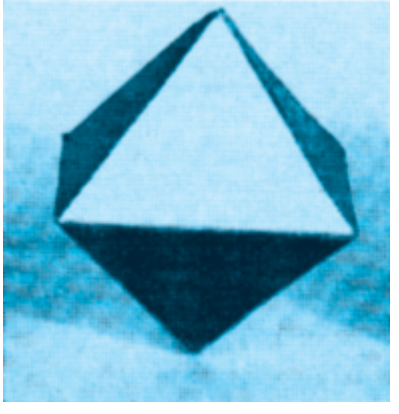
This relation is known as "Euler's relation." In this, the number of vertices is represented by 'V', the number of faces by 'F' and the number of edges by 'E'. This relation is true for solids having plane faces. Do an exploration about the truth of it.

> The above relation was found for the first time by the mathematician Euler. Hence this equation is known as **Euler's Formula**.

Exercise 25.2

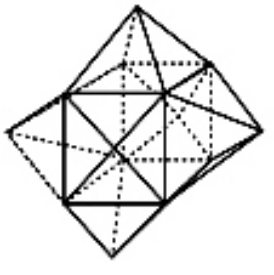
(1) A certain solid has 6 faces and 12 edges and its number of vertices is not known. By using Euler's equation, find the number of vertices of the solid.

(2) A certain solid has 5 vertices and 5 faces. What is the number of edges it has?

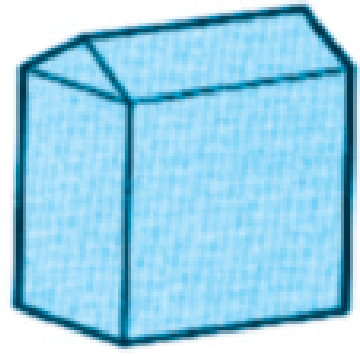


(3) A certain student constructed a solid as in the figure by pasting the square faces of two square pyramids. Find the number of edges, faces and vertices of this new solid. Show that these values satisfy Euler's equation.

(4) A new solid has been constructed as in the figure by fixing the equal square faces of six identical square pyramids on the six sides of a cube of suitable size. Construct a model of such a solid. Find the number of vertices, faces and edges of this new solid. Do these values agree with Euler's relation? Verify your result.

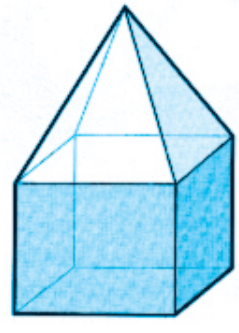


(5) The solid seen in the figure has been constructed by using a cuboid and a triangular prism. How many vertices, faces and edges does it has? Do these values agree with Euler's relation? Verify your result.

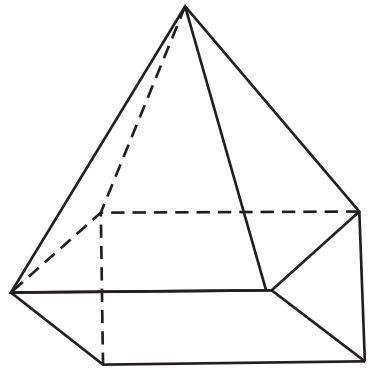


(6) Construct new solids by using the cube, cuboid, square pyramid and the triangular prism and verify Euler's relation for these new solids.

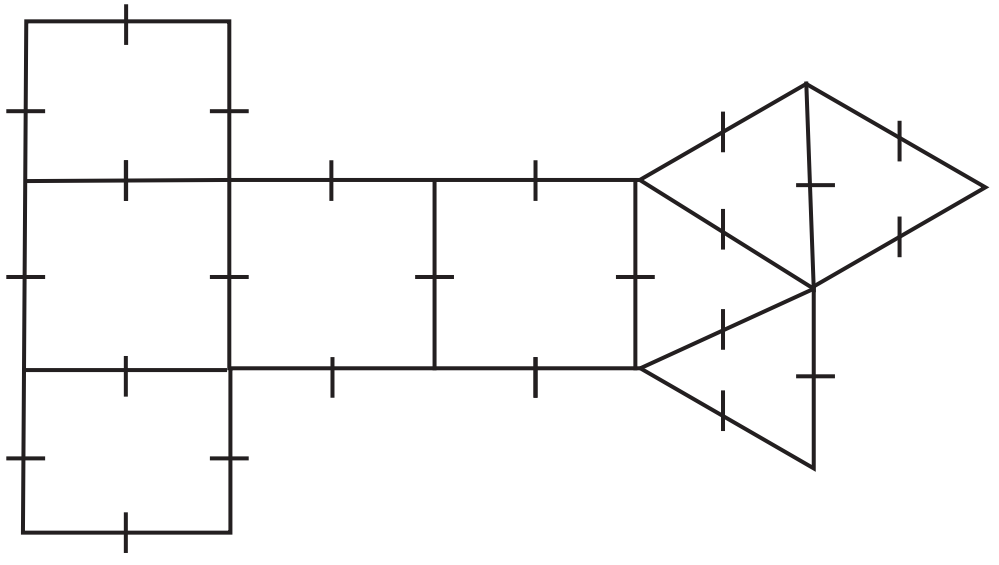
(7) The solid shown in the figure has been constructed using a cube and a square pyramid. Do the number of edges, vertices and faces of this solid agree with Euler's relation?



(8) Does the following solid constructed by using a triangular prism and a square pyramid agree with Euler's relation?



(9) Use the net given in the figure and construct a solid and examine Euler's relation with it.



Summary

★ A solid with a square base, and the other faces are four identical triangles with a common vertex is a **square pyramid.**

★ A square pyramid has 8 edges, 5 faces and 5 vertices.

★ A solid with three rectangular faces and two parallel triangular faces is a **triangular prism.**

★ A triangular prism has 9 edges, 5 faces and 6 vertices.

★ If the number of edges of a solid is 'E', the number of faces 'F' and the number of vertices 'V', these are connected by **Euler's relation,**

$$V + F = E + 2$$