11 Volume and Nets

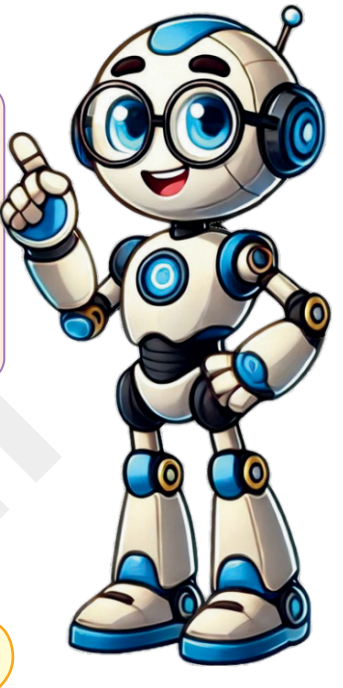
We'll cover the following key points:

→Volume

→Using a Shortcut

→Nets

→Net of Solid Figure



EeeBee

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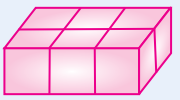
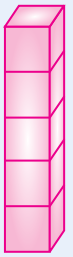
Learning Outcomes

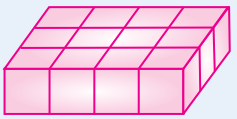
By the end of this chapter, students will be able to:

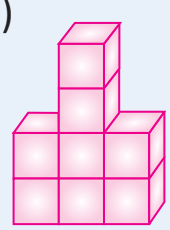
- Understand the concept of volume as the amount of space occupied by a solid object.
- Identify and measure the volume of different solid shapes such as cubes, cuboids, and cylinders.
- Use a shortcut formula to calculate the volume of cubes and cuboids.
- Recognize and describe the nets of 3D shapes, such as cubes, cuboids, and pyramids.
- Understand how nets are related to the faces of a 3D solid figure.
- Create and draw nets for different solid figures.
- Understand the relationship between the surface area and nets of a solid.
- Apply the concept of volume and nets to solve simple real-life problems involving solid objects.
- Identify the edges, faces, and vertices of 3D shapes and connect them to their nets.
- Compare and contrast different nets that can form the same solid figure.

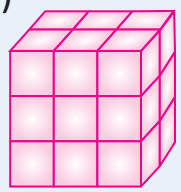
1. Find the volume of the following by counting the blocks of cubes.

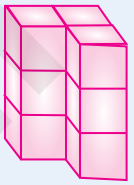
(a) 

(b) 

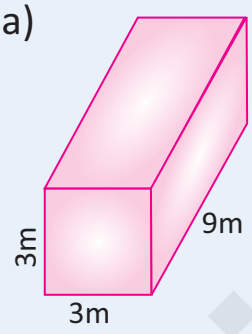
(c) 

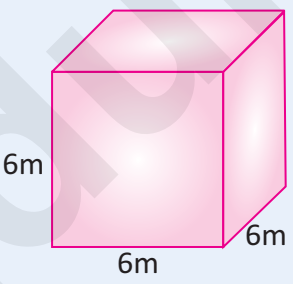
(d) 

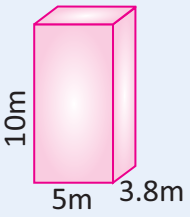
(e) 

(f) 

2. Find the volume of the solids with the given dimensions.

(a) 

(b) 

(c) 

3. Find the volume of the cuboids whose dimensions are as follows.

(a) $l = 15$ cm, $b = 14$ cm, and $h = 8.2$ cm

(b) $l = 12$ cm, $b = 1.3$ m, and $h = 0.9$ m

(c) $l = 4.3$ m, $b = 2.9$ m, and $h = 0.8$ m

4. Find the volume of a cube whose edge is

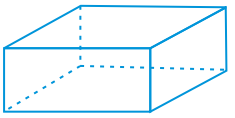
(a) 9 cm (b) 3.5 cm (c) 1.3 m (d) 0.9 m

Volume

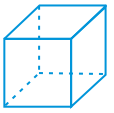
Take a Task

Watch Remedial

We have already learnt how to measure line segments and plane regions. Now, we will learn to measure solids such as **a cuboid** or **a cube**.

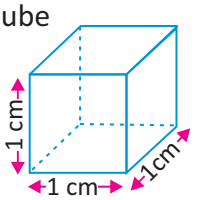


Cuboid



Cube

Every solid body occupies a certain space which is called its volume. We measure volume by using a unit-solid. The unit-solid is a cube of side 1 mm or 1 cm or 1 m. The number of such unit-solids (or unit-cubes) contained in the given solid gives the volume of the solid. The adjoining figure represents a unit-solid or a unit-cube of side 1 cm.



Unit Cube

REMEMBER

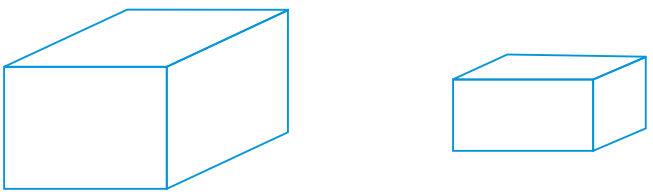
1. We measure a line segment by a unit-line segment (cm or m) and see how many such line segments are contained in the given line segment.
2. A region (area) is measured in terms of a unit-region (sq. cm or sq.m) and see how many such unit-regions together make the given region.
3. A space (volume) occupied by a solid can be measured in terms of unit-cube of side as 1 mm or 1 cm etc.

The unit-cube of 1 cm means 1 cm each in length, breadth and height. The volume of this unit-cube is written as **cubic-centimetre** (cu. cm) or **cm^3**.

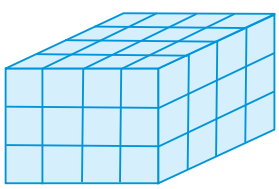
Finding Volume by Counting Cubes

We count the no. of unit-cubes contained by the solid which give us the space occupied by a solid. The total number of unit cubes gives us the **volume** of the solid.

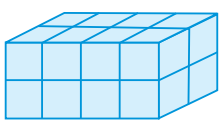
Example : Find the volume of the cuboids given below :



Solution : We divide the given cuboids into unit-cubes as shown below :



A



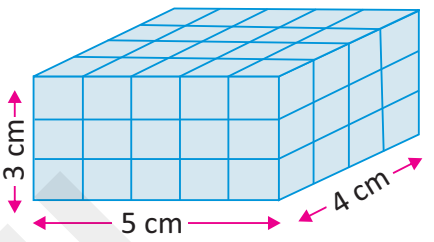
B

We see that the solid A can be filled completely with 48 one-centimetre cubes. Thus, the volume of solid A is **48 cu. cm**.

Similarly, solid B can be filled with 16 one-cm cubes. Thus the volume of solid B is **16 cu. cm**.

Determining Volume by Calculation

Observe the figure of a cuboid given alongside.



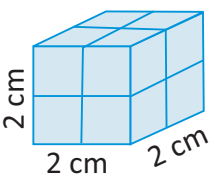
It is 5 cm long, 4 cm broad and 3 cm high. There are 60 one-centimetre cubes in all. So, the volume of the cuboid is 60 cu. cm.

Thus, volume = 60 cu. cm = 5 cm × 4 cm × 3 cm

= length × breadth × height

∴ Volume of a cuboid = length × breadth × height

Look at the figure given alongside.



It is the figure of a cube whose length, breadth and height is 2 cm each. There are 8 one-centimetre cubes in all. So, the volume of the cube is 8 cu. cm.

Thus, volume = 8 cu. cm = 2 cm × 2 cm × 2 cm = side × side × side

∴ Volume of a cube = side × side × side

Example : The length, breadth and height of a cuboid are 12 cm, 8 cm and 6 cm respectively. Find its volume.

Solution: Length of the cuboid = 12 cm, Breadth = 8 cm, Height = 6 cm

Now, volume of the cuboid = length × breadth × height

= 12 cm × 8 cm × 6 cm = 12 × 8 × 6 = **576 cu. cm**.

Example : Find the volume of a cube whose edge is 12 cm.

Solution : Length of an edge of the cube = 12 cm

Now, volume of the cube = edge × edge × edge

= 12 cm × 12 cm × 12 cm = **1728 cu. cm**.

Example : A tank is 1 m long, 70 cm wide and 40 cm high. How many cubic centimetres of water will it hold ?

Solution : Length of the tank = 1 m = 100 cm

Breadth of the tank = 70 cm, height of the tank = 40 cm

Now, volume of the tank = Length × Breadth × Height

= 100 cm × 70 cm × 40 cm

= 280000 cu. cm.

Thus, the tank hold **280000 cu. cm** of water

REMEMBER

Before finding the volume, convert the length, breadth and height into the same unit.

Exercise 11.1

Knowledge Application

1. Fill in the blanks :

(a) The volume of a cuboid = _____ × _____ × _____

(b) The volume of a cube = _____ × _____ × _____

(c) If each side of a cube is 1 m, its volume is _____ .

2. Find the volume of a cube whose edge is 12 cm.

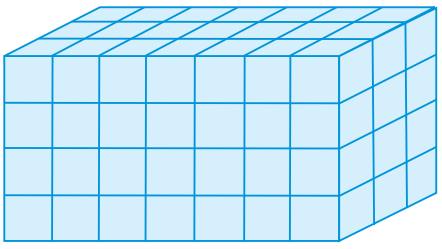
3. A block of wood measuring 12 cm by 16 cm by 8 cm is cut into cubical blocks of the same size. Find the number of cubical blocks if each side measures 4 cm.

4. Find the volume of a cuboid whose length is 3 m, breadth 1 m and height 5 m.

5. A cuboid is 9 cm long, 5 cm broad and 6 cm high. Find its volume.

6. A swimming pool is 15 m long and 10 m wide. How many kilolitres of water must be pumped into it so as to raise the level of water by 3 m ? [**Hint :** Put 1 m^3 = 1 kilolitre]

Using a Shortcut



Look at the cuboid shown alongside.

The volume of this cuboid is equal to the total number of cubes in it. Each small cube measures 1 cu. cm.

Number of cubes in 1 layer = 7 × 3

Number of cubes in 4 layers = 7 × 3 × 4 = 84

Volume of the cuboid = 84 cu. cm

Volume of a cuboid = Number of cubes in a layer × Number of layers

= length × breadth × height

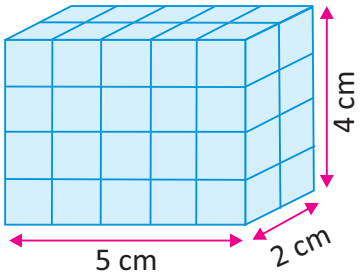
$$V = l \times b \times h$$

Example : Find the volume of a cuboid of length 5 cm, breadth 2 cm and height 4 cm.

Solution : $V = l \times b \times h$

$= 5 \times 2 \times 4 = 40$ cu. cm

The volume of the cuboid is 40 cu. cm.

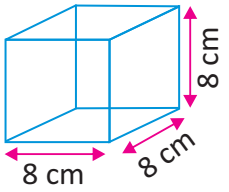


Example : Find the volume of a box with each side measuring 8 cm.

Solution : $V = l \times b \times h$

$= 8 \times 8 \times 8 = 512$ cu. cm

Hence, The volume of the box is 512 cu. cm.



Example : Find the length of a box of volume 100 cu. cm with height 5 cm and breadth 4 cm.

Solution : $V = l \times b \times h$

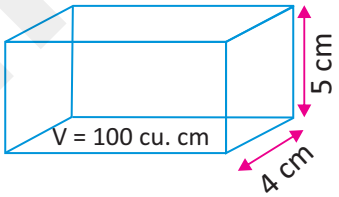
$\therefore l = V \div (b \times h)$

Solve the brackets first.

$= 100 \div (5 \times 4)$

$= 100 \div 20 = 5$ cm

The length of the box is 5 cm.

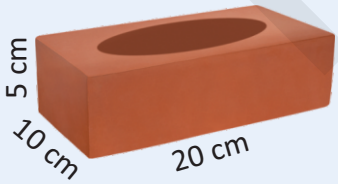


Exercise 11.2

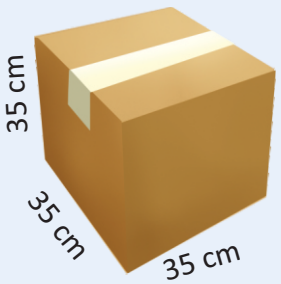
Knowledge Application

1. Find the volume of these objects:

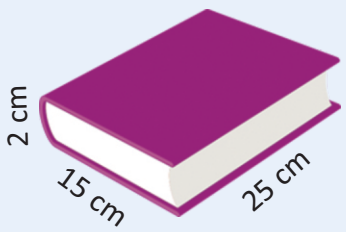
(a)



(b)



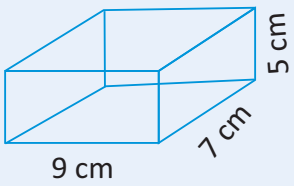
(c)

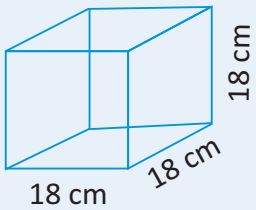


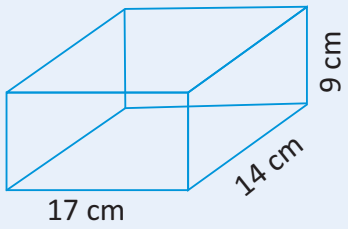
(d)

(e)

2. Find the volume of the solids of the given dimensions:

(a) 

(b) 

(c) 

3. Solve these word problems:

(a) Find the volume of an ice-cream brick of length 22 cm, breadth 10 cm and height 8 cm.

(b) There is a flower bed 80 cm long, 40 cm wide and 2 cm deep in Shruti's garden. Find the volume of the soil the gardener dug out to make the bed.

(c) Find the volume of 20 ice cubes, each of side 5 cm.

(d) Pinky's almirah is 80 cm long, 40 cm wide and 102 cm high. What is the volume of her almirah?

(e) Find the volume of air in a room 22 m long, 16 m wide and 14 m high.

Mental Math

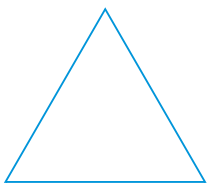
Knowledge Application

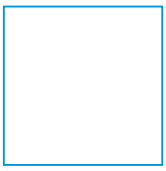
Complete the table.

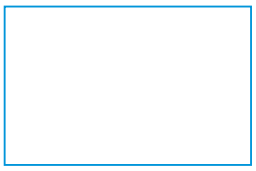
	LENGTH	BREADTH	HEIGHT	VOLUME
1.	7 mm	5 mm	5 mm	
2.	14 cm	4 cm	8 cm	
3.	5 cm	4 cm		120 cu. cm
4.		11 m	10 m	990 cu. m
5.		3 m	4 m	144 cu. m

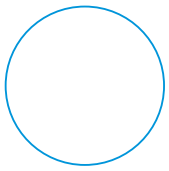
Nets

2-dimensional shapes


Triangle

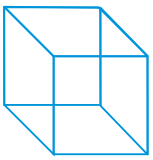

Square


Rectangle

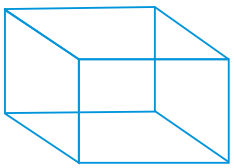

Circle

These shapes have only length and breadth, that is, 2 dimensions. These are 2-dimensional shapes.

Three dimensional shapes



Cube



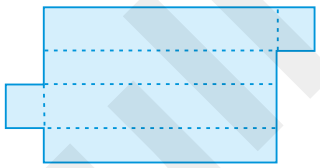
Cuboid

These shapes have length, breadth and height, that is, 3 dimensions. These are 3-dimensional shapes.

Converting a 3-D shape into a 2 - D shape

Take an empty pencil box. Open it.

How many faces does it have? _____

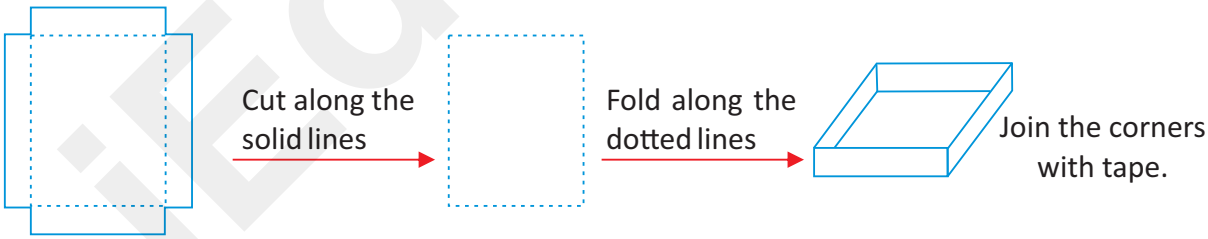


How many faces does it have? _____

Does the open box have the same number of faces as the closed box? Yes / No

Converting a 2-D shape into a 3-D shape

Take an A4 sheet of paper. On it draw the shape shown below. Paste it on cardboard.



You have changed a _____ dimensional shape to a _____ dimensional shape.

A plane 2-dimensional shape used to make a 3-dimensional shape is called a net. Nets are used to make layout plans of houses, buildings, bridges and so on.

Net of Solid Figure

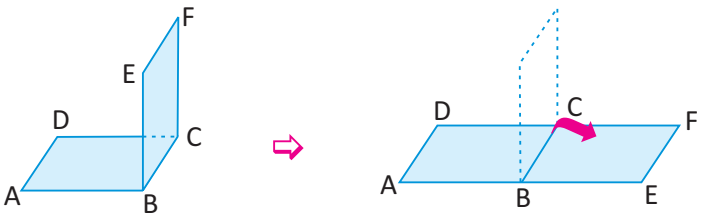
Net is two-dimensional (2-D) tool for representing three-dimensional (3-D) object.

Let us do some activities to convert a solid (3-D) figure into a two-dimensional figure (2-D).

Net of Cube / Cuboid

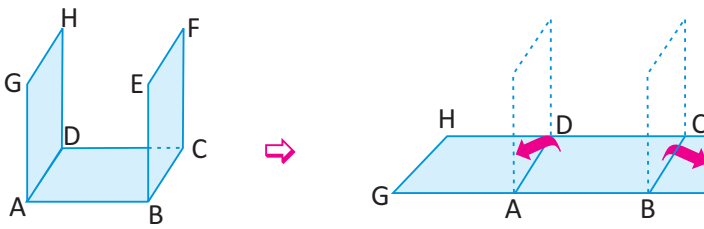
A. Let us think of a cube and look at the following figures carefully.

(i)



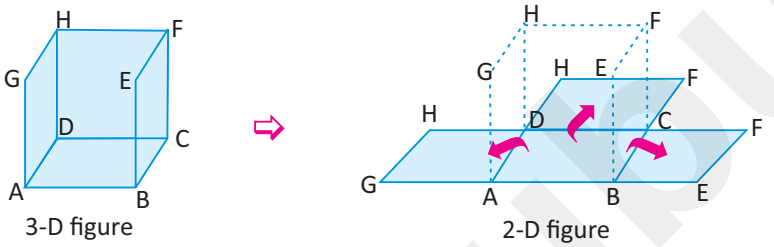
2-D figure 2-D figure

(ii)



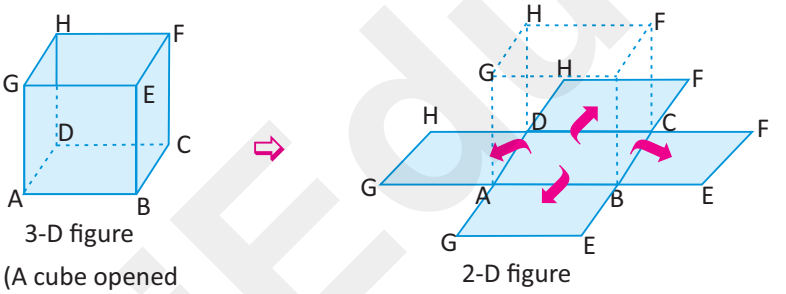
3-D figure 2-D figure

(iii)



3-D figure 2-D figure

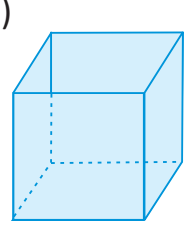
(iv)



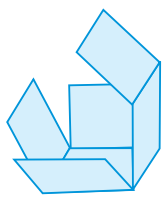
3-D figure (A cube opened from top) 2-D figure

B. Let us think of a cardboard box of cube-shaped (a 3-D figure) and generate the 2-D figure by cutting and flattening its edges as shown in the following figures.

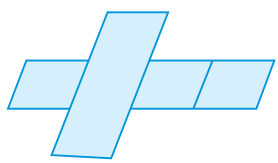
(i)



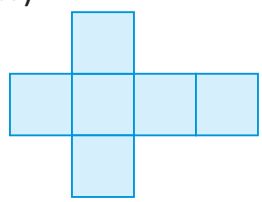
(ii)



(iii)



(iv)



When the fig. (iii) is viewed from top, it looks like the figure (iv) as shown.

The figure (iv) is usually called the net of the cube.

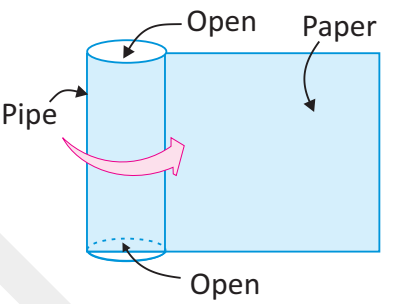
By splitting this cube-shaped box in different manners, we can generate some more different nets.

REMEMBER

1. A net of a cube always has 6 squares, each square corresponds to each face of a cube.
2. There can be 1 possible nets of a cube.
3. The nets of a cuboid are similar to that of cube. It has 6 rectangles.

Net of Cylinder

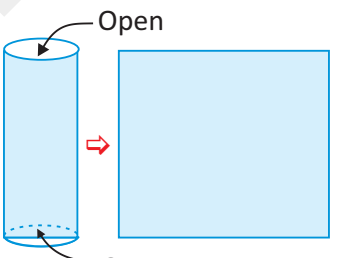
We can extend the technique of getting nets of cube in generating the net of cylinder.



In our day to day life, we come across several solids like circular pipe, measuring jar, gas cylinder etc. These solids have cylindrical shape.

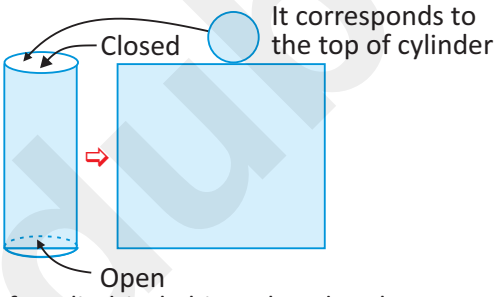
Let us think of any cylindrical-shaped object, say a small pipe. Wrap up a paper such that it completely covers the pipe.

Now, the shape of the paper which completely covers the cylinder is the net of the cylindrical-shaped pipe.



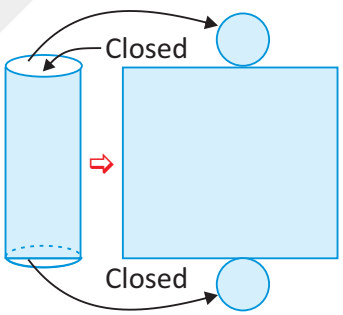
Net of a cylindrical object open at both ends

Now, cover its top portion of pipe by making a suitable circle-shaped paper and spread it.



Net of a cylindrical object closed at the top end and open from the bottom end.

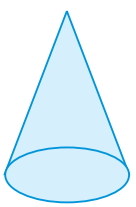
Now, close the both ends of pipe and spread it.



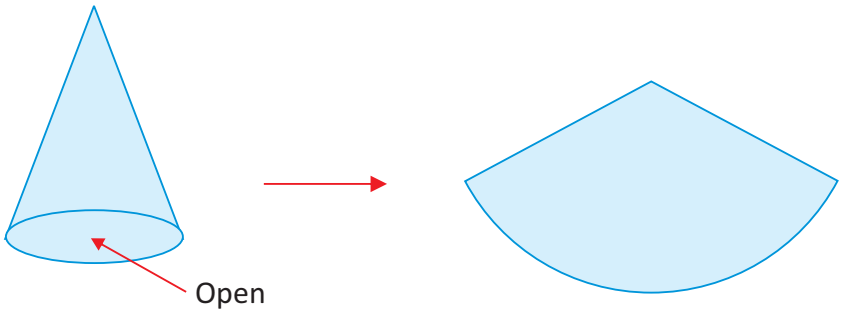
Net of a cylindrical object closed from both ends.

Net of Cone

There are various objects in our every-day life like the tapered end of a pencil, ice-cream cone, a conical vessel, etc. The shapes of these objects are conical. We call them cone-shaped.



Let us take a cone- shaped object and wrap paper around it such that it completely covers the cone. Now spread the paper.

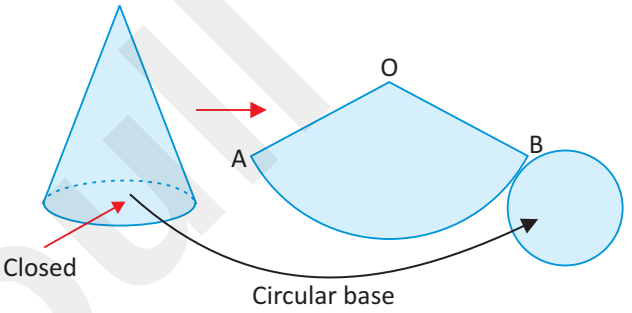


Net of a cone which has open base.

Now, think of a cone closed from the bottom.

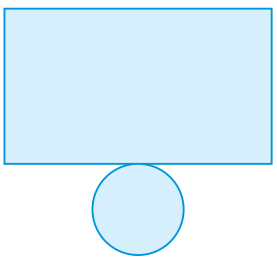
The circular part in this net can lie anywhere in arc AB.

We have seen how the net of a 3-D object is generated. In the similar way, if net of an object is provided, we can generate the corresponding 3-dimensional object.



Net of a cone which is closed from base.

Example : Which of the following objects represents the net given below :



(a) Measuring jar

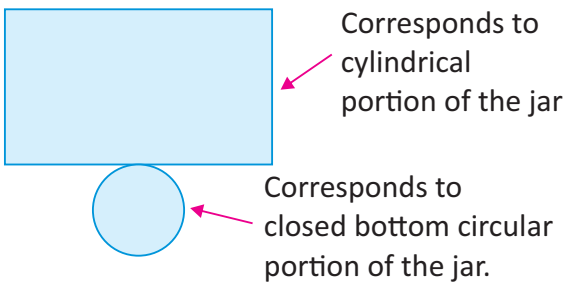
(b) Foot ball

(c) Shuttle (used in badminton game)

(d) Book

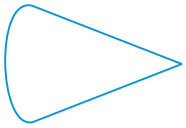
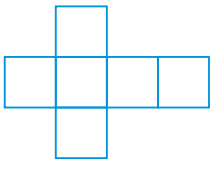
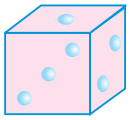
Solution : (a) Measuring jar is a cylindrical-shaped object closed at the bottom end.

Since there is no side provided at the top portion of net, the given net represents the **measuring jar**.



Example : Match the each net provided in column A to its corresponding object provided in column B :

Experiential Learning

Column A		Column B	
(i)		(a)	
(ii)		(b)	
(iii)		(c)	

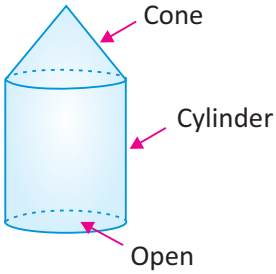
Solution : (i) ⟷ (b) (ii) ⟷ (c) (iii) ⟷ (a)

Tapered-end of the pencil is conical in shape.

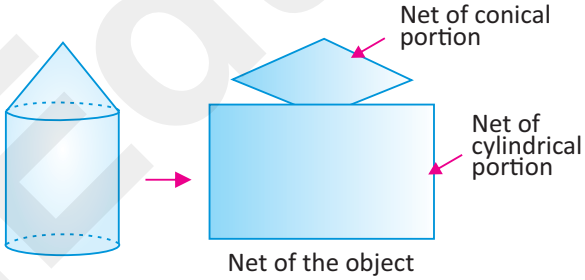
Die is a cube-shaped object and pipe is a cylindrical object opened from both ends.

Example : Generate the net of the following object which is opened from the bottom.

Solution : The given object is a combination of two 3-D figures. (i.e., a cylinder opened from both ends and a cone opened from its base).



Therefore, one of its possible net will be as follows :



Exercise 11.3

Knowledge Application

1. Multiple Choice Questions (MCQs)

Choose the correct option.

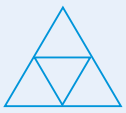
(a) As any object goes farther, it appears to be

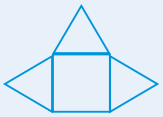
(i) bigger ☐ (ii) smaller ☐ (iii) biggest ☐

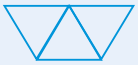
(b) Maximum number of types of rectangles in the net of a cuboid is

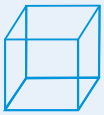
(i) 3 types ☐ (ii) 2 types ☐ (iii) 4 types ☐

(c) Which of the following is the net of  ?

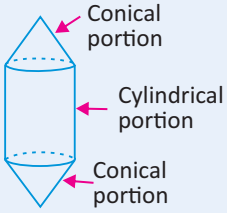
(i) 

(ii) 

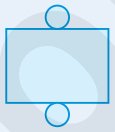
(iii) 

2. Generate a net of a cubical water tank opened from the top. 

3. Generate the net of following object.



4. Match each object provided in column A to its corresponding net provided in column B :

Column A		Column B	
(i)		(a)	
(ii)		(b)	
(iii)		(c)	

Think Tank

Gap Analyzer™
Take a Test

1. Tick (✓) the correct option.

(a) A square has _____ dimensions.

(i) one ☐ (ii) two ☐

(iii) three ☐ (iv) four ☐

(b) A cuboid has _____ dimensions.

(i) one ☐ (ii) two ☐

(iii) three ☐ (iv) four ☐

(c) The unit of volume is _____

(i) cu. m ☐ (ii) cu. mm ☐

(iii) cu. cm ☐ (iv) all of these ☐

2. **Find the volume of the cubes whose lengths are:**

(a) 4 cm (b) 6 cm (c) 5 cm (d) 8 cm

3. **Find the volume of a cube whose edge is 15 cm.**

4. **Find the volume of a cuboid of length 5 m, breadth 120 cm and height 95 cm.**

5. **Find the volume of a box with each side measuring 17 cm.**

Custom Learning Path

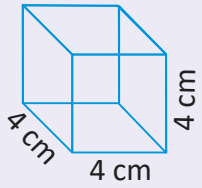
Scan to Create Your Own Learning Path

Puzzle

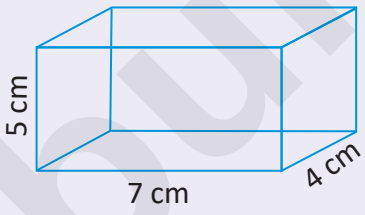
Conceptual Learning

Find the volume of the following figures:

(a)



(b)

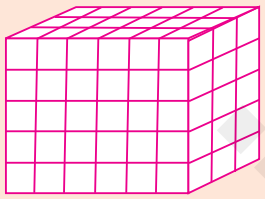


Mental Math

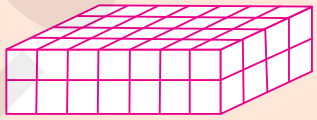
Critical Thinking

Find the volume of the following solids in terms of unit-cubes :

1.



2.



Maths Lab Activity

Collaboration

Material required:

20 empty matchboxes and a centimetre scale (for each group)

Procedure:

1. Work in groups of 5.
2. Use the centimetre scale to measure the length, breadth and height of a matchbox to the nearest centimetre.

- Length of each matchbox = _____ cm
- Breadth of each matchbox = _____ cm
- Height of each matchbox = _____ cm

3. Calculate the volume.
   - Volume of 1 matchbox = _____ cu. cm
   - Volume of 2 matchboxes = _____ cu. cm
   - Volume of 20 matchboxes = _____ cu. cm
4. Arrange the 20 matchboxes in different towers. Two possible towers are shown below.
5. Find the volume of each tower of matchboxes.
   - What is the volume of each tower?_____ cu. cm, _____ cu. cm
   - Does the volume depend on the shape of the tower? _____