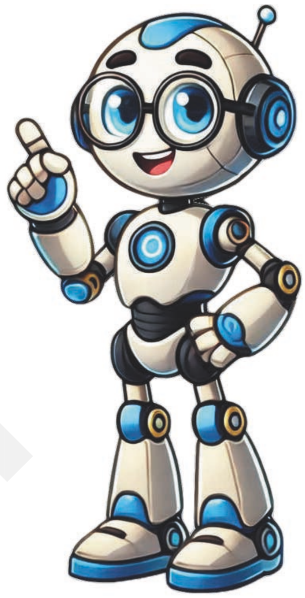
10
Chapter

Visualizing Solid Shapes

We'll cover the following key points:

→ Introduction to 2D and 3D figures
→ Vertices, edges and faces
→ Nets
→ Drawing 3D objects
→ Mapping around the space
→ Visualising solid objects



Hi, I'm EeeBee

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Do you Remember fundamental concept in previous class.
In class 5th we learnt
→ Perspective of Drawing Solid Objects

Learning Outcomes

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

- Define and identify 2D and 3D shapes and distinguish between the two types based on their properties.
- Understand and represent 2D shapes such as squares, rectangles, circles, triangles, and polygons on a flat surface, using appropriate notation and symbols.
- Understand and represent 3D shapes such as cubes, cuboids, spheres, cones, cylinders, and pyramids in space, and recognize their faces, edges, and vertices.
- Identify the properties of 2D shapes, including sides, angles, symmetry, and congruency, and use these properties to classify and compare shapes.
- Understand the relationship between 2D and 3D shapes, and how 2D shapes can form the faces of 3D objects.
- Use nets to represent 3D shapes, and understand how a net is a 2D representation of a 3D shape that can be folded to form the object.
- Calculate the surface area and volume of simple 3D shapes like cubes, cuboids, cylinders, and cones using appropriate formulas.

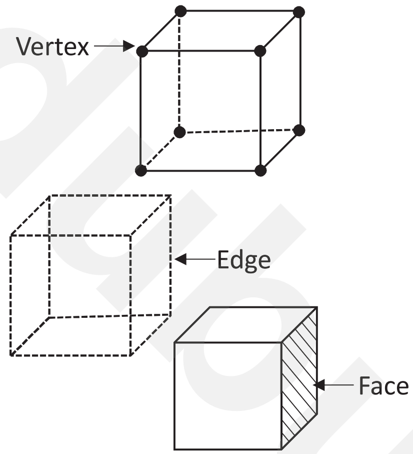
Mind Map

VISUALISING SOLID SHAPES

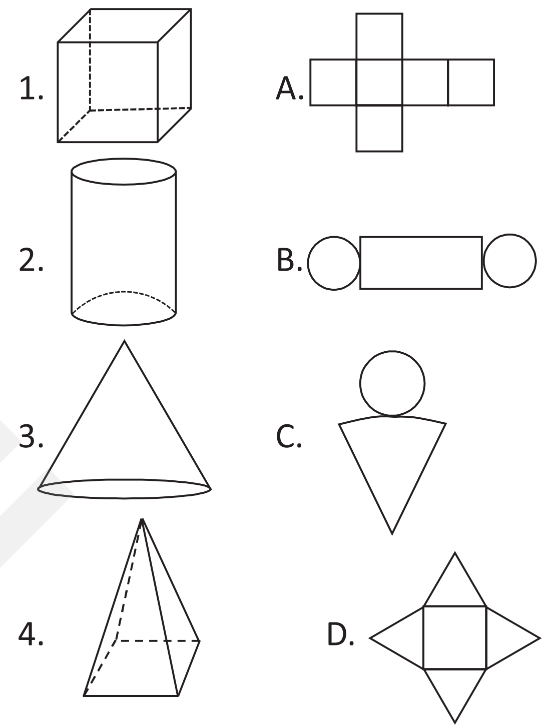
Plane figure and solid shapes

Plane figure	Solid shapes
Circle	Cube
Rectangle	Cuboid
Square	Cylinder
Quadrilateral	Cone
Triangle	Sphere
	Pyramid

Faces, Edges and Vertices

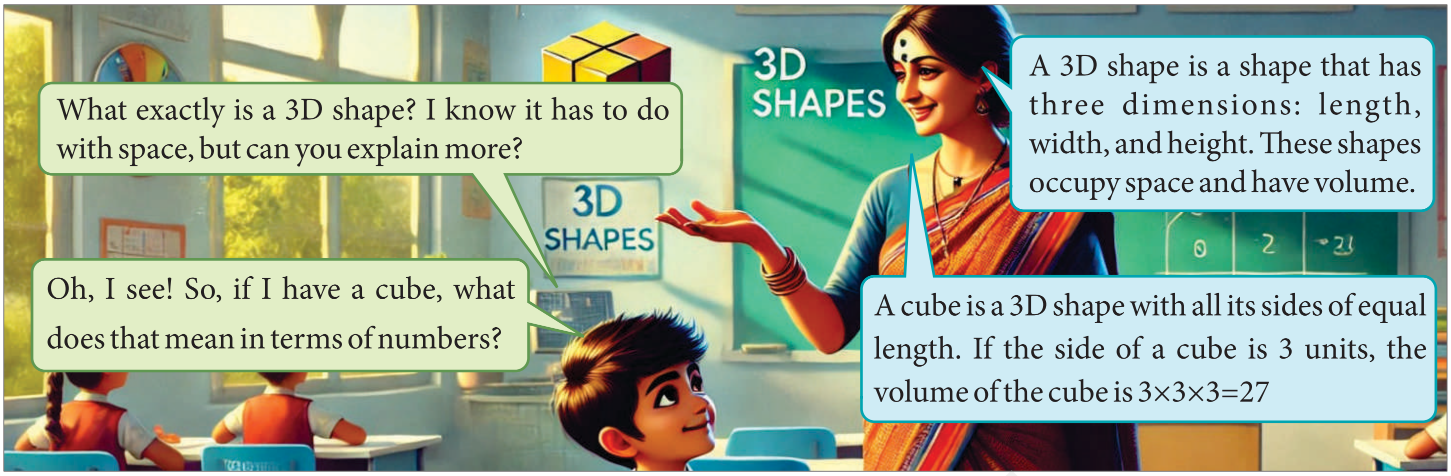


Nets for Building 3 – D Shapes



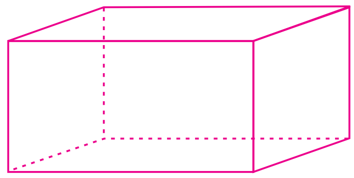
Based on NCERT*

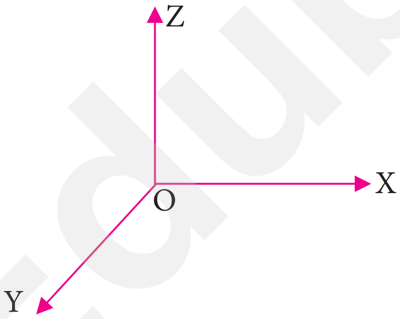
Introduction



Actually in this world the things are in three dimension i.e. it has length, breadth and height. The question arise that how we can show three dimension in a paper or plane which have 2 dimension. It is very easy to demonstrate the three dimensional things in 2D plane by showing lines in three dimension as follows:

i.e. shape of box. In actual the box is vertical and having 90° angles vertically. But in 2D paper this is way to show the 3D.





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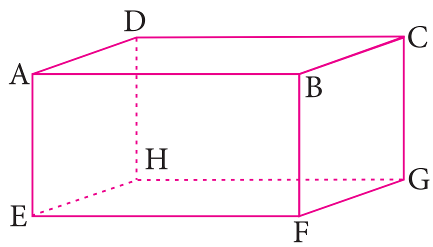
Here, $\angle ZOX = \angle ZOY = \angle YOX = 90°$

Cuboid

Cuboid is a solid with 6 rectangular surfaces. Bricks, rectangular pillars, matchboxes, books etc. are a few examples of cuboidal solids.



The given figure represents a cuboid. It is not a plane figure, although it has been drawn on a sheet of paper which is 2- dimensional.

A cuboid has 6 rectangular faces. Each face is a rectangular region. Edge of the cuboid is the line segment where two adjacent faces meet.

The point of intersection of three edges of a cuboid is called the **vertex** of the cuboid.

The end points of edges are called the **vertices** or **corners**.

In the given figure see previous page of cuboid, the dotted line is used to represent the hidden edges.

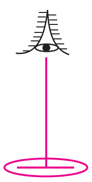
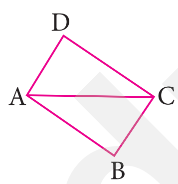
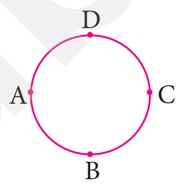
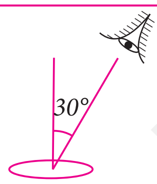
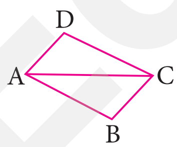
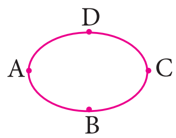
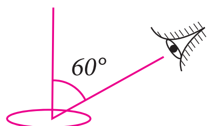
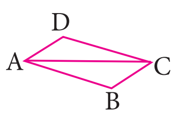
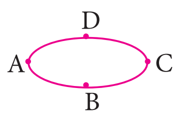
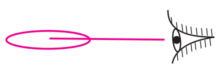
Description of the visible and hidden portion of the given cuboid :

Visible vertices	:	A, B, C, D, E, F and G
Hidden vertex	:	H
Visible edges	:	AB, AE, EF, BF, BC, CG, FG, AD and CD
Hidden edges	:	EH, GH and DH
Visible faces	:	ABCD, BCGF and ABFE
Hidden faces	:	EFGH, CDHG and ADHE

Viewing an Object

Is it possible to observe each part of any object seen from a certain angle ?

Let us first observe two two- dimensional laminas from different angles.

S. No.	Line of sight	Appearance of rectangular lamina	Appearance of circular lamina
1.	 *Top view*		
2.			
3.	 *Side view*		
4.	 *Front view*	 *(Here AD and DC are not distinctly visible.)*	 *(Portion ADC is not distinctly visible.)*

Now let us start thinking about 3- Dimensional objects. Since most objects we come across are opaque in nature, light from every part of the object is not able to reach our eyes. The same

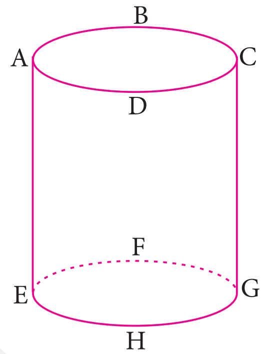
Note

It is not possible to observe more than 50 % area of an opaque cuboid, when it is observed at the certain angle.

object may appear differently when it is observed from different angles. In any case, it is not possible to observe every part of a 3- dimensional opaque object.

In case of a cuboid, we can only observe either of the top or bottom face, either of the two lateral faces and either of front or back faces.

Example 1 : Draw a cylinder showing all its edges. use a dotted line to draw the hidden edges.



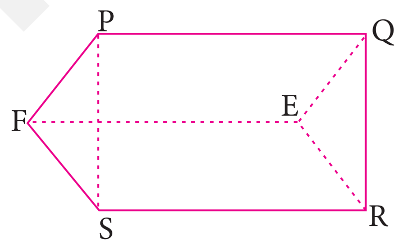
Solution : A cylinder is drawn alongside.

Visible edges : ABCD (curved edge),
EHG (curved edge)

Hidden edge : EFG (curved edge)

The half portion of lateral surface is visible and rest half part of the back side of cylinder is invisible.

Example 2 : How many vertices, edges and faces are visible and how many are hidden in the given figure? The dotted lines represent the hidden edges.

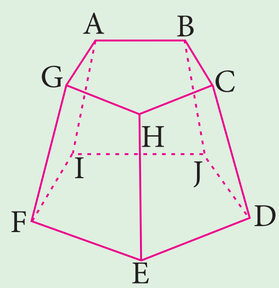


Solution :

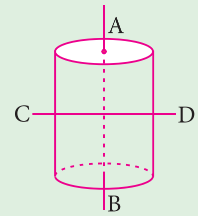
Visible vertices	:	P, Q, R, S and F
Hidden vertex	:	E
Visible edges	:	PQ, QR, RS, PS, PF and SF
Hidden edges	:	QE, RE and FE.
Visible faces	:	PQRS and PSF
Hidden faces	:	PQEF, REFS and QRE

Exercise 10.1

1. Draw a figure of a dining table whose top surface is circular .
2. How many edges and faces of a cuboidal-shaped building can be seen, when it is observed from the middle of its roof? Also, draw the building as it apears from this position. Only show the visible edges.
3. How many vertices, edges and faces are visible and how many are hidden in the given figure, where dotted lines represent the hidden edges.



4. There are two rods AB and CD and a hollow cylinder represented in the figure. The dotted line shows the hidden portion. You have to tell how the two rods are arranged. Which one is passing from inside the cylinder?



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Vertices, Edges and Faces

We have fairly good idea about edges, vertices, faces, etc.

Let us first define them to understand the meaning of the concept clearly.

Edge : (*i*) In a two dimensional lamina, the sides are called edges.

(*ii*) In a three dimensional object (i.e., solid figure), edge is the line segment where two surfaces intersect or meet.

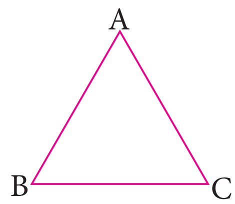
Vertex or Corner : Vertex is a point where two or more edges meet.

Face : A plane surface bounded by the edges is called a face.

Edges and Vertices in 2- Dimensional Figure

A two-dimensional figure is also called a plane figure, which lies in single plane. The sides of plane figure are called edges of the figure. The end-points of edges are called the vertices or corners.

A triangle has 3 edges (i.e. AB, BC, CA) and 3 vertices (i.e. A, B, C).



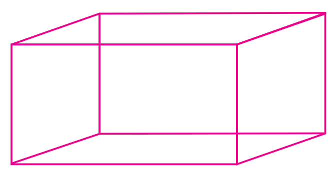
Edges, Vertices and Faces in 3-dimensional Figure

A 3-dimensional figure sometimes is called a solid figure. For example, cube, cuboid, cylinder, cone etc. are 3D objects. A 3-dimensional object has one or more than one edges, vertices, surfaces (plane / curved).

Let us count vertices, edges and faces of a simple solid figure, **cuboid**.

A cuboid had 6 rectangular faces and its opposite faces are equal and parallel.

A cuboid has 6 faces, 8 vertices (corners) and 12 edges.



Now, let us study a relationship among vertices, edges and faces in 3D objects using the formula called **Euler's formula**.

Where V represent the number of vertices.

E represent the number of edges.

F represent the number of faces.

Then for a cuboid, we have

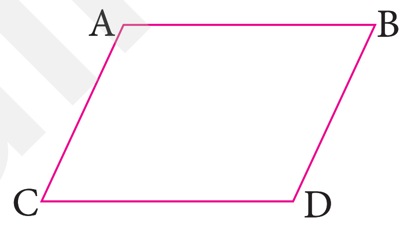
$$\boxed{V - E + F = 2}$$

This formula is known as Euler's Formula. This formula is true for all the solid figures which are covered by plane faces. The figure is called **Polyhedron**.

REMEMBER

1. The word "Polyhedron" comes from Greek word "polue", means many, and "hedra", means base or seat. A polyhedron is thus a figure with many bases or faces.
2. Cylinder and cone are not polyhedra, because all their faces are not plane.

Example 3 : Find the number of vertices and edges in the following parallelogram:



Solution : Let ABCD be the parallelogram. It has 4 edges named $\overline{AB}$, $\overline{BC}$, $\overline{CD}$, $\overline{DA}$ and 4 vertices named A, B, C, D.

Take a Task

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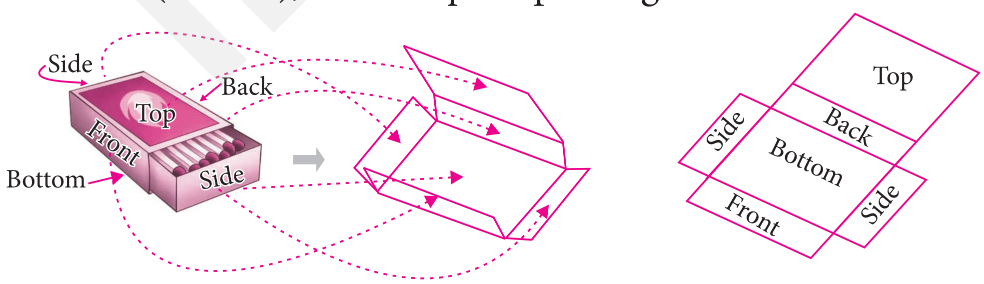
Nets

Solid Shapes and Their Nets

To know about the net, let us do one activity of converting a solid figure to 2-dimensional figure. This can be done by cutting (splitting) few edges such that all faces of a solid figure are interlinked to form one flat figure.

Let us take a matchbox (cuboid), cut and open up its edges as shown in the following figure.



(A) (B) (C)

Here, the transformed figure C is called a net of the original solid figure A, i.e., matchbox.

Net : Net is a two-dimensional tool for representing polyhedra. A polygon region which can be folded up to form a polyhedron is usually called a net of the polyhedron.

Let us study nets of some of the solid figures.

Net of Cube : To make a net of a cube, first look at the faces of the cube. How many faces does it have? Of course 6, so make sure that your net has 6 squares. Now, you must work out a way to arrange 6 squares, so they will fold up into a cube. The easiest way is to think of a cube as 4 sides, a top and a bottom. Arrange 4 squares in a line. These are the sides. Now, put the top square on one side of this line, and the bottom on the other. It doesn't really matter where on each side, they all work.

Can you imagine how many such arrangements of nets are possible for a cube ?

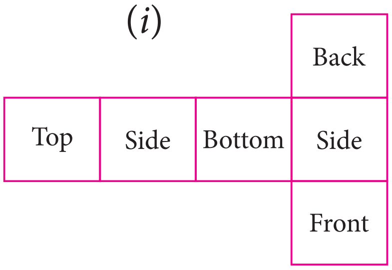
There can be 11 possible arrangements.

Some of them are given below :

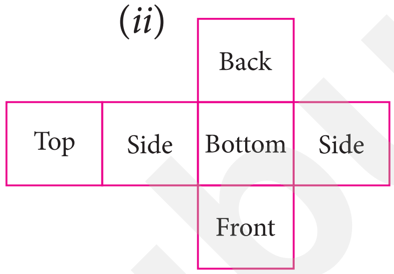
REMEMBER

1. A net is also known as a **development**.
2. All the nets of a cube has 6 square polygons.

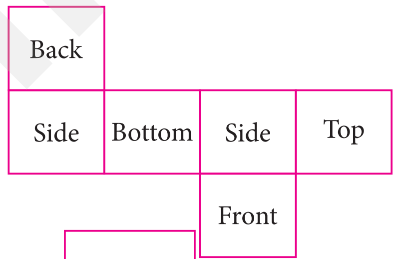
(*i*)



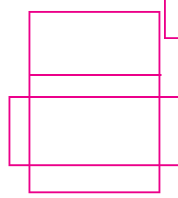
(*ii*)



(*iii*)

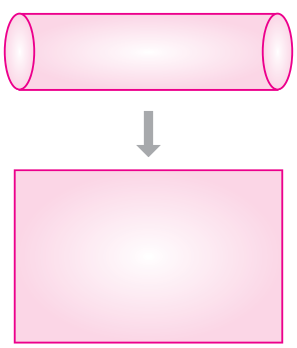


Net of Cuboid : The nets of cuboid will be similar to cube. It has 6 rectangular polygons. One of the nets of a cuboid is given alongside.

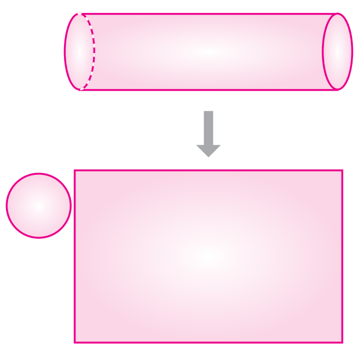

Net of a cuboid

Net of Cylinder : Take a rectangular/square piece of paper. Gently curve or roll the paper along its two sides such that the two sides come together. Hence, a cylinder opened at both ends is formed. Now, we can say that this rectangular or square piece is a net of the cylinder so formed. Some nets of the cylinder are shown below :

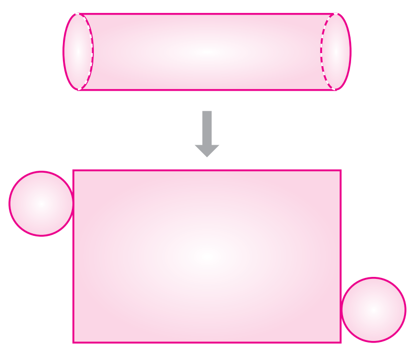
(*i*) A cylinder opened at both ends


Net

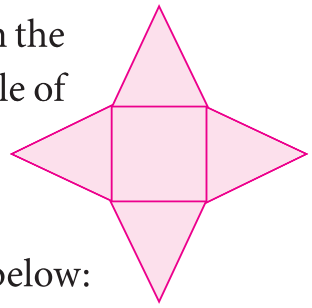
(*ii*) A cylinder closed at one end and opened at other end


Net

(*iii*) A cylinder closed at both ends

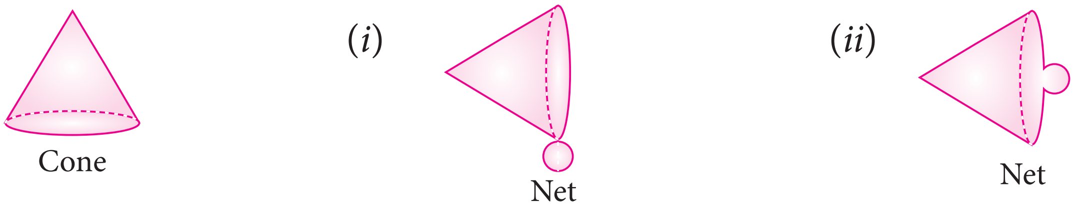

Net

Net of Square Pyramid : Square pyramid has square base and triangles on the four lateral sides. The famous Great Pyramid in Giza (Egypt) is an example of square pyramid.

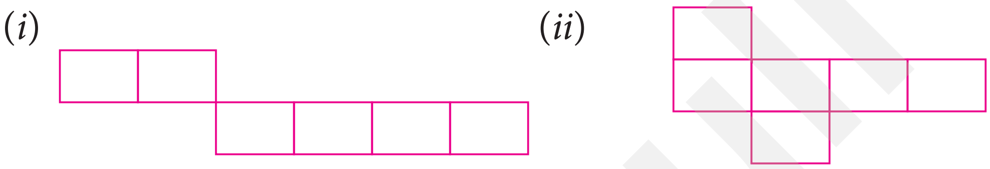


The figure given at right shows a net of a square pyramid.

Net of Cone : In the similar way, we can generate the net of a cone as given below:



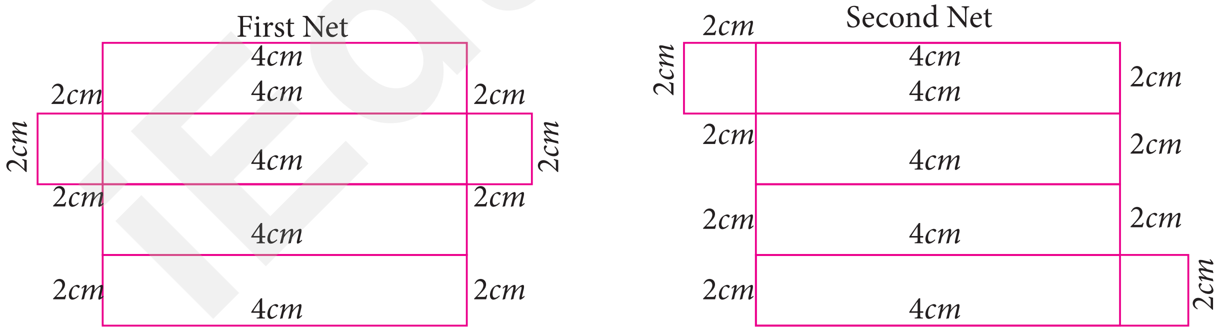
Example 4 : Which of the nets in the following figures represents cube ?



Solution : The fig. (*ii*) shows a net of a cube. We can check the validity of the net by tracing the diagram on any paper and folding it properly along the line of net.

Example 5 : Draw two nets of a cuboid whose length, breadth and heights are 4 cm, 2 cm and 2 cm respectively.

Solution :



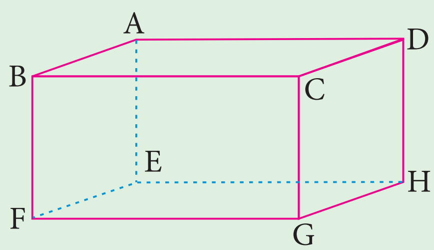
Exercise 10.2

1. Look at the figure at right and answer the following :

(*i*) Name the edges which meet in the vertex H.

(*ii*) Name the faces which meet in the edge AB.

(*iii*) Name the faces which are adjacent to BFGC.

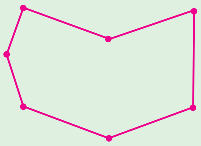


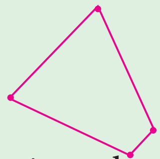
(*iv*) Name the face which is not adjacent to ABCD.

(*v*) Name the diagonals of the cuboid ABCDEFGH.

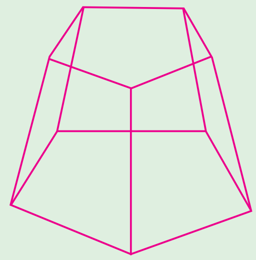
(*vi*) Let EFGH be the base, then name the four lateral faces.

2. How many vertices and edges do the following figures have ?

(*i*) 

(*ii*) 

3. Verify Euler's formula after counting the total number of vertices, edges and faces in the figure given at right.



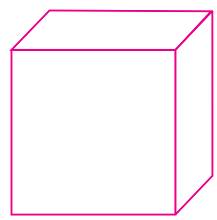
4. Name any four objects from your environment, which have the form of

(*i*) a cuboid (*ii*) cylinder

5. Draw the net of a cube and place the numbers 1, 2, 3, 4, 5, and 6 so that opposite faces have the sum as 7.

Drawing 3D Objects

Look at the given figure of pictorial representation of a cube. If we measure each side of the cube by a scale, they should be same. In this representation, though it looks exactly like cube, but sides are not looked same.



When we represent 3D objects on paper, the representation is slightly distorted to have a sight appearance as 3D objects. This is just a visual illusion, but in actual object it is not that.

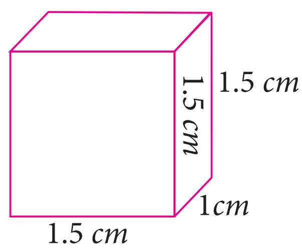
A 3D object can never be represented exactly on a 2D paper.

Only certain sketches can be drawn to give an outlook of 3D objects.

There are two types of sketches that can be drawn :

(*i*) Representation on squared paper (graph paper).

(*ii*) Representation on isometric dot paper (isometric graph paper).

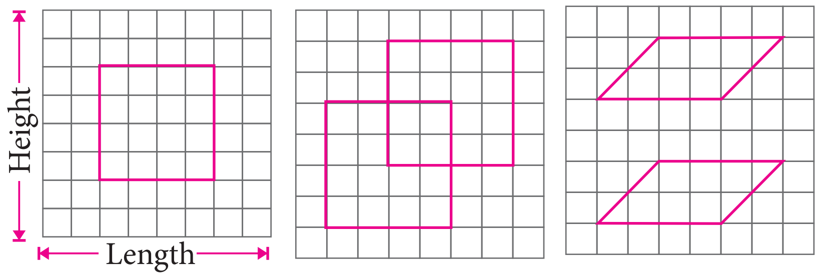


Representation on Squared Paper

A sketch on squared paper is called an **oblique sketch**. Here, dimensions may not be matched exactly same as the object. Also, the depth of objects is represented by oblique lines (i.e., diagonal).

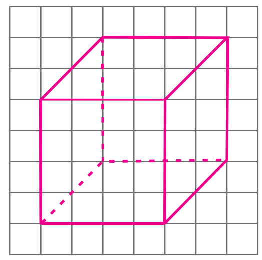
Let us draw an oblique sketch of a cube on a squared paper. Let the dimensions of a cube be $4 \times 4 \times 4$ i.e., length = 4 cm, breadth = 4 cm and height = 4 cm.

Drawing 4 units length and 4 units height as the front face on a graph, we get the figure as shown.



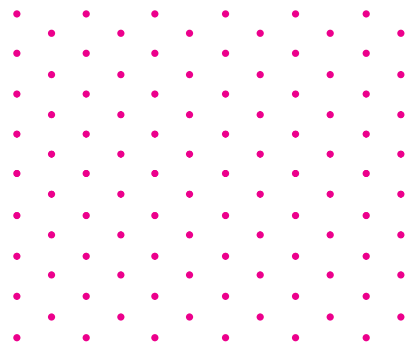
In the same way, opposite face can also be drawn, but this has to be some what displaced obliquely. Now, join the corresponding corners by dotted lines to give the effect of depth i.e., breadth. Here, breadth may not match the exact dimension of 3D object.

Now, let us draw the same cube using the basic convention of representing hidden edges by dotted lines as a complete representation.



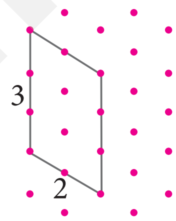
Representation on Isometric Dot Paper

An isometric group paper is a special paper on which dots are formed on a pattern of equilateral triangles as shown in the following figure.

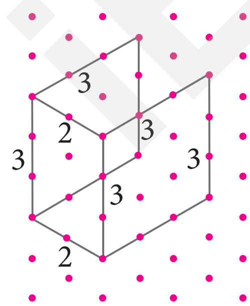


Now, let us represent a cuboid of size $3 \times 2 \times 3$ (length × breadth × height).

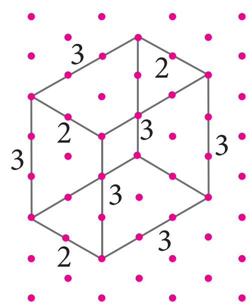
As per dimensions, first draw the front face of 3×2.



Then, create the depth (breadth) in the sketch.

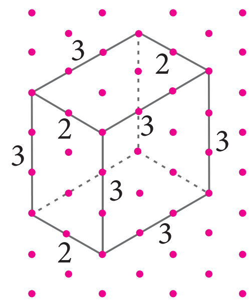


Connect the corners to complete the isometric sketch.

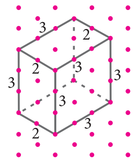
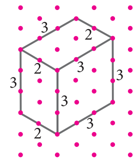


As per conventions, draw the hidden edges as dotted lines.

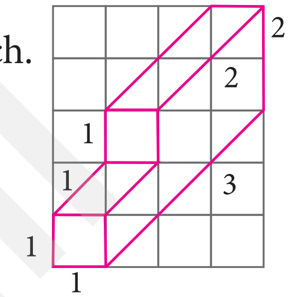
Now, an isometric sketch of the cuboid of size 3 × 2 × 3 is drawn as shown at right.



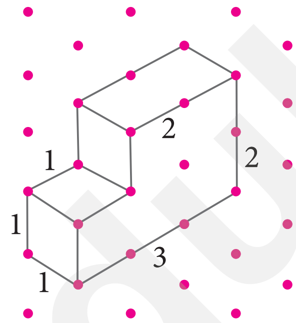
When we draw the isometric sketch of cube or cuboid, for convenience, we should not draw the dotted lines to show the hidden edges of the cube / cuboid.

So, the isometric sketch  should be given as 

Example 6 : Make the isometric sketch of the given oblique sketch.

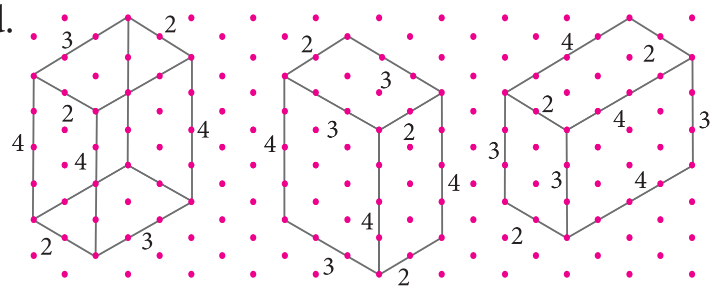


Solution : The required isometric sketch is drawn below.

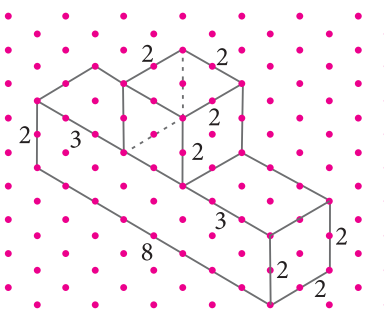


Example 7 : The dimensions of a cuboid are 4cm × 3 cm × 2cm. Draw three different isometric sketches of this cuboid.

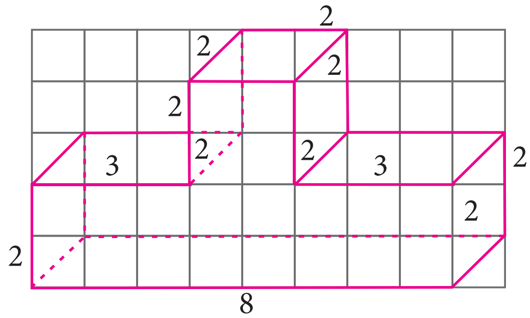
Solution : Three isometric sketches of a cuboid of dimensions 4 cm × 3 cm × 2 cm are drawn alongside.



Example 8 : Make an oblique sketch of the isometric sketch given in the figure.



Solution : The oblique sketch of the given isometric sketch is drawn as shown in the figure, given below .

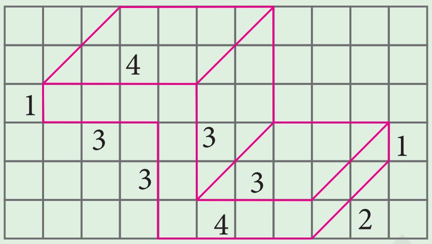


Exercise 10.3

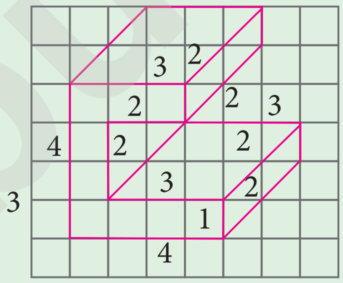
1. The dimensions of a cuboid are $4 \times 3 \times 2$ units. Draw three different isometric sketches of this cuboid .

2. Make the isometric sketches of the following oblique sketches : **Creativity and Innovation**

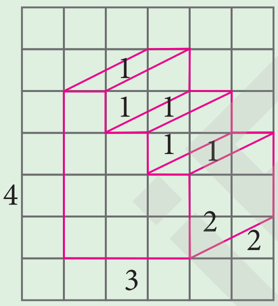
(*i*)



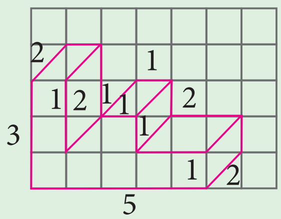
(*ii*)



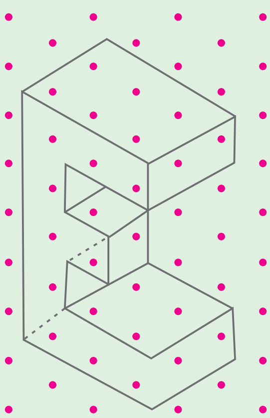
(*iii*)



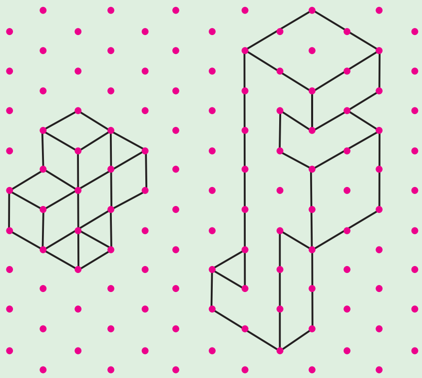
(*iv*)



3. Make the oblique sketch of the given isometric sketch.

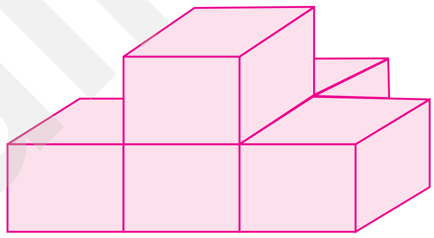


4. Make the oblique sketches of the following isometric sketches :



Mapping Around the Space

Sometimes, we have had to guess the amount of space available without actual measuring it. This is called mapping the space through the visual estimation.



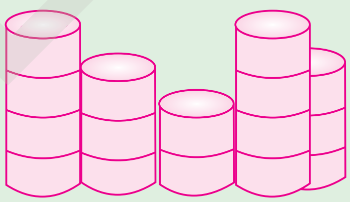
Example 9 : Five cubes of each of side 2 cm is arranged in the following figure. How many cubes of side 2 cm are needed to make a cube of side 6 cm ?

Solution : 22 cubes of side 2 cm are required to make a cube of side 6 cm.

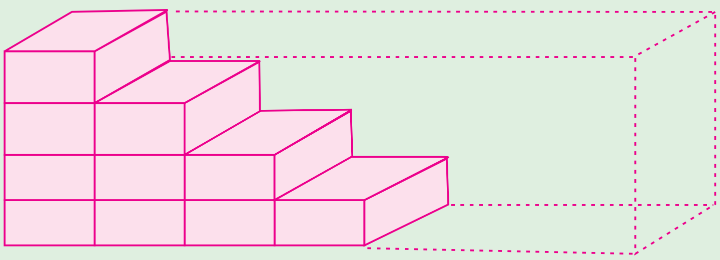
(Note : Try to find it with the help of matchboxes.)

Exercise 10.4

1. How many tins are there in the following figure ?



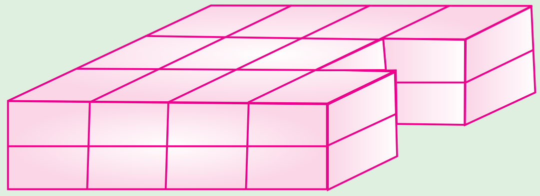
2. How many cubes are required to fill up the box given at right ?



3. See the following figure and answer the questions given below :

(*i*) How many cubes are there in the given figure ?

(*ii*) How many cubes are needed to fill up the space so that it becomes a cuboid ?



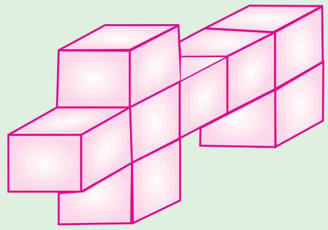
4. See the following figure carefully and answer the questions given below :

(*i*) How many cuboids are there in the base layer ?

(*ii*) How many cuboids are there in the middle layer ?

(*iii*) How many cuboids are there in the top layer ?

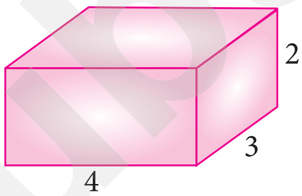
(*iv*) How many cuboids can be seen when it is viewed from the top and the side ?



Visualising Solid Objects

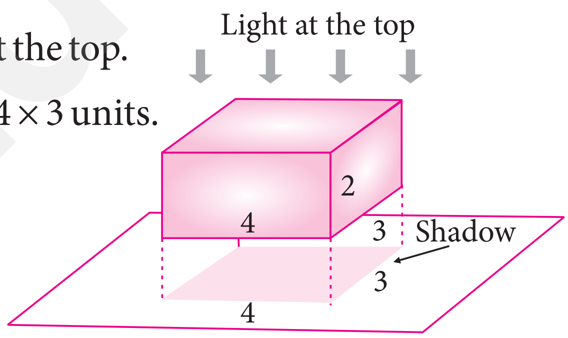
Let us perform an activity on a solid object to see its shadows from different angles.

Let us take a cuboid of size $4 \times 3 \times 2$ units.

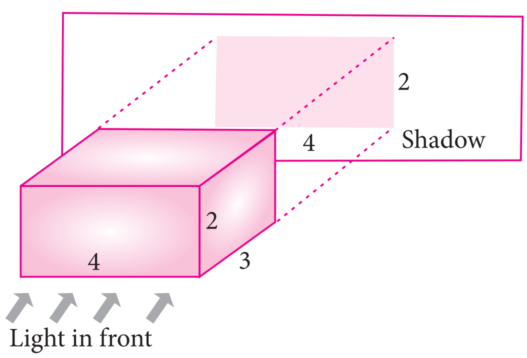


Let us hold a source of light (torch) at the top.

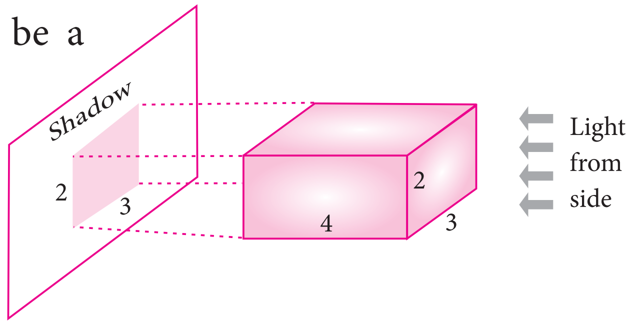
Shadow would be a rectangle of size 4×3 units.



Let us hold the torch at the front. The shadow would be a rectangle of size 4×2 units.



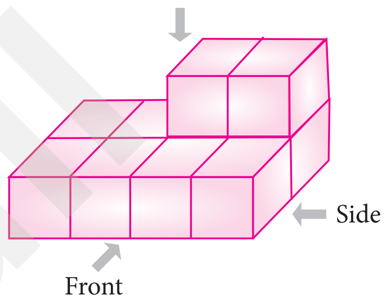
Let us hold the torch at a side. Shadow would be a rectangle of the size 3×2 units.



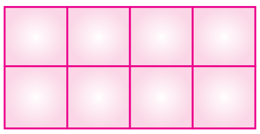
Thus, we see that when the source of light is held at the top, front and at side, it gives different shadows.

Even when we see objects from the top, the front or the side, they appear different if visualised in two dimensions.

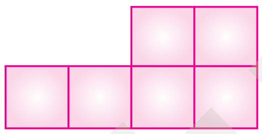
Example 10 : Draw the top view, front view and side view of the figure given at right.



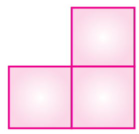
Solution : Top view :



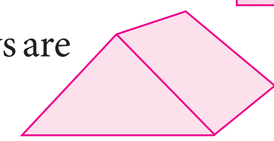
Front view :

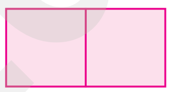
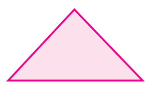
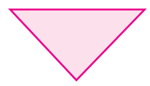


Side view :



Example 11 : For the solid given alongside, few views are given. The top view is :



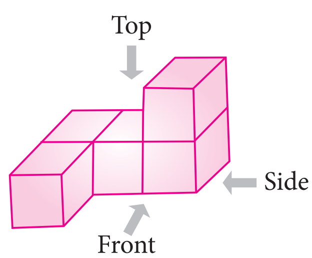
(*i*)  (*ii*)  (*iii*)  (*iv*) 

Solution : If we see from the top, we would be seeing two rectangles.

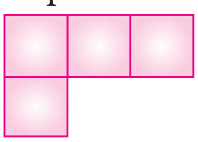
So, view (*ii*) would be the top view.

So, the option (*ii*) is correct, which is the required answer, i.e. answer (*ii*).

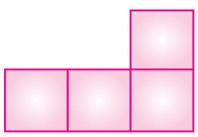
Example 12 : Draw the top, front and side views of the following solid figure made up of cubes:



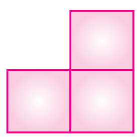
Solution : Top view



Front view

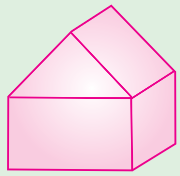


Side view

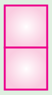
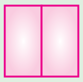
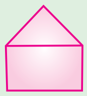
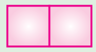


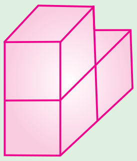
Exercise 10.5

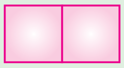
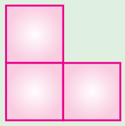
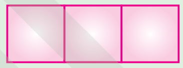
1. **Choose the correct option:**



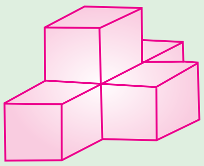
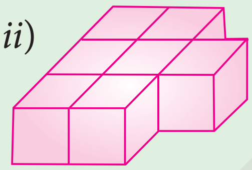
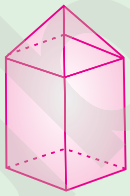
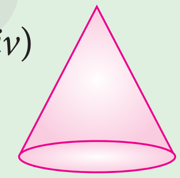
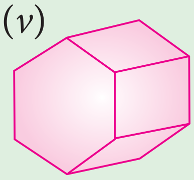
   (*i*) For a solid as shown at right, few views are given in the options given below. The side view is:

   (*a*)  (*b*)  (*c*)  (*d*) 

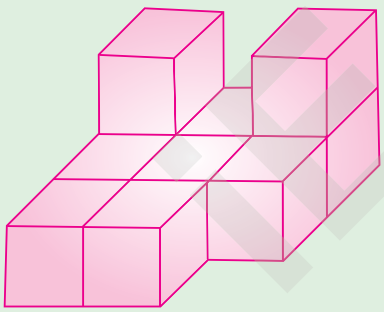
   (*ii*) The top view of  **is:**

   (*a*)  (*b*)  (*c*)  (*d*) 

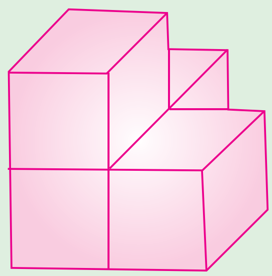
2. **Draw the top, front and side views of the following solid objects :**

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

3. **Draw the top view, front view and side view of the following figure:**



4. **Draw the top, front and side views of the following solid figure made up of cubes:**



Chapter-end Exercise

Gap Analyzer™

A. Multiple Choice Questions (MCQs)

Tick (✓) the correct option:

1. The shape of one of the plane surface of a cylinder is :

   (*a*) rectangular ☐ (*b*) square ☐

   (*c*) circular ☐ (*d*) Both (*a*) and (*c*) ☐

2. If V, E and F are respectively representing the number of vertices, edges and faces in a 3D object, then the Euler's formula is given by:

   (*a*) $V - E - F = 2$ ☐ (*b*) $F + E - V = 2$ ☐

   (*c*) $E - V + F = 2$ ☐ (*d*) $V - E + F = 2$ ☐

3. A net of a cube has:

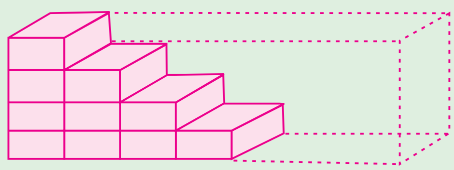
   (*a*) 4 square polygons ☐ (*b*) 4 rectangular polygons ☐

   (*c*) 6 square polygons ☐ (*d*) 6 rectangular polygons ☐

4. In the Fig., the number of cuboids required to fill up the box is :

   (*a*) 15 ☐ (*b*) 14 ☐

   (*c*) 12 ☐ (*d*) 10 ☐



B. True / False.

Knowledge Application

1. A die looks like a cuboid. ☐
2. The net of a cone is an isosceles triangle. ☐
3. A cuboid has 4 flat faces and 2 curved faces. ☐
4. All faces of a prism are rectangular. ☐
5. A cricket ball is an example of a sphere. ☐

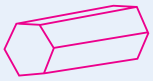
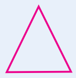
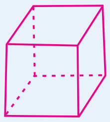
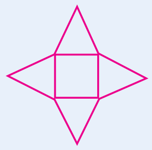
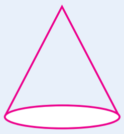
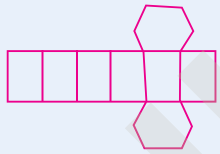
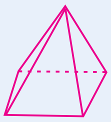
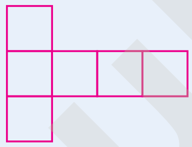
Scan to Create Your Own Learning Path

Custom Learning Path

Mental Maths

Knowledge Application

Match the Columns:

Column A	Column B
(*a*) 	(*i*) 
(*b*) 	(*ii*) 
(*c*) 	(*iii*) 
(*d*) 	(*iv*) 

Assertion and Reason

Critical Thinking

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) :** The net of a cone is an isosceles triangle.
   Reason (R) : V + F – E = 4 is Euler's formula.
2. **Assertion (A) :** A cuboid has 4 flat faces and 2 curved faces.
   Reason (R) : All faces of a prism are rectangular.
3. **Assertion (A) :** Two faces of a solid meet in an edge.
   Reason (R) : Cone is a special type of a pyramid.
4. **Assertion (A) :** A cube has 12 edges and 6 vertices.
   Reason (R) : A tetrahedron has 6 edges.
5. **Assertion (A) :** A cylinder is a special type of prism.
   Reason (R) : A cuboid has 4 flat faces and 2 curved faces.