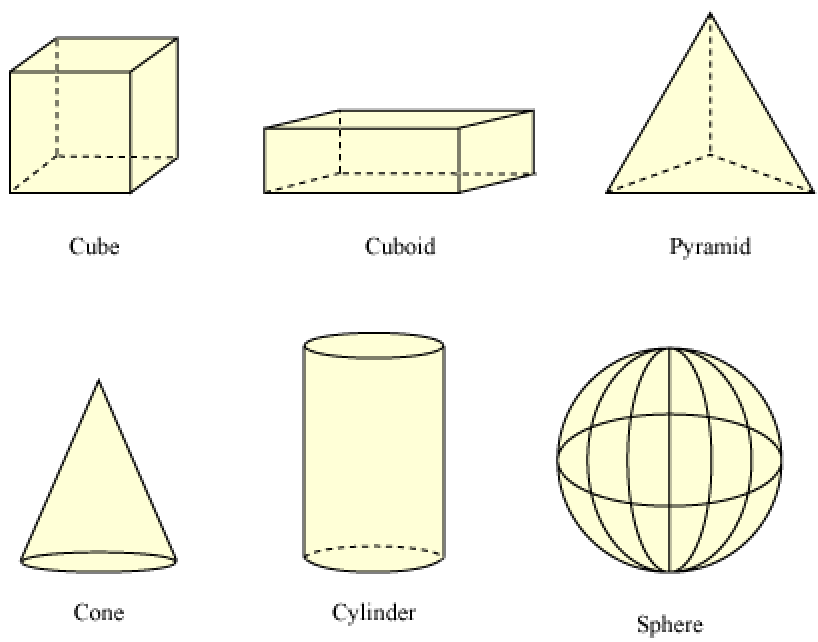
Visualising Solid Shapes

Nets of Three-Dimensional Figures

Look at the following figures.

What do you think about the shapes of the objects shown in the figure above?

These figures are three-dimensional in shape. Let us see some more three-dimensional figures.

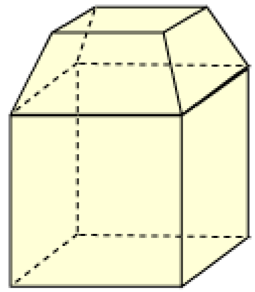


As the paper is two-dimensional, we cannot draw these figures on paper very easily. If we try to draw them on paper, then the back edges will not be shown. But we can draw the net of the three-dimensional solids.

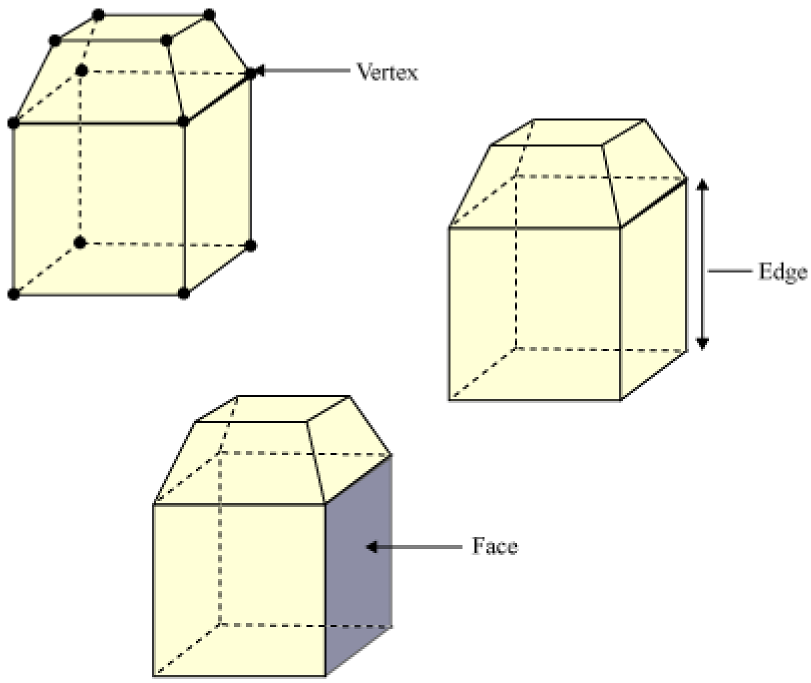
Let us learn more about three-dimensional shapes through various illustrative examples.

Example 1:

Find the number of vertices, edges, and faces in the following figure.



Solution:

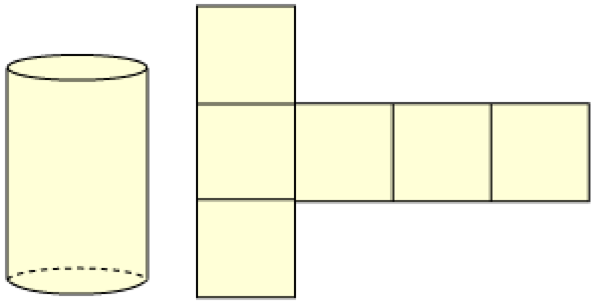


The given figure has 12 vertices, 20 edges, and 10 faces.

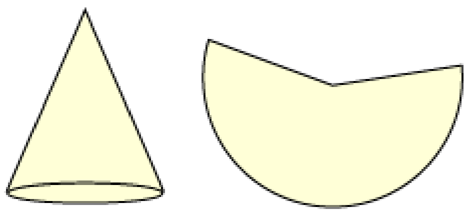
Example 2:

Match the following shapes with their appropriate nets.

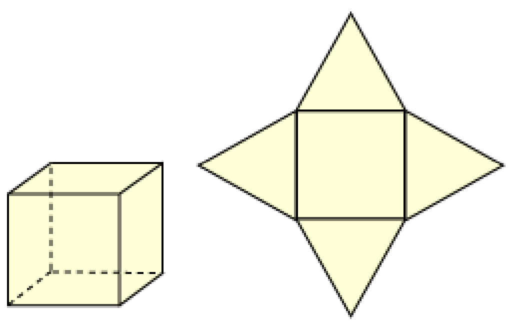
(i) (a)



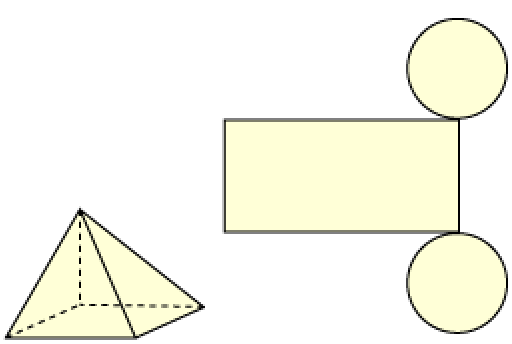
(ii) (b)



(iii) (c)

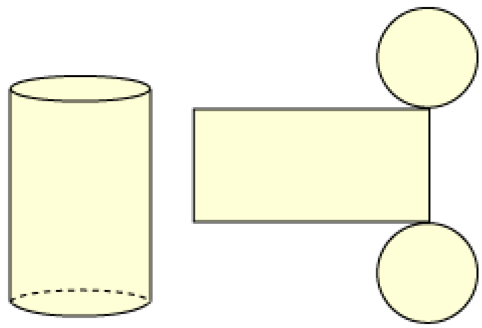


4. **(d)**

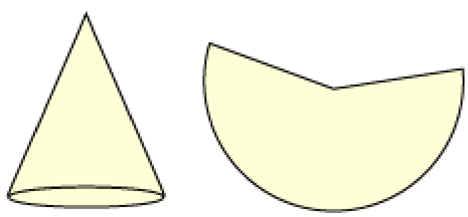


Solution:

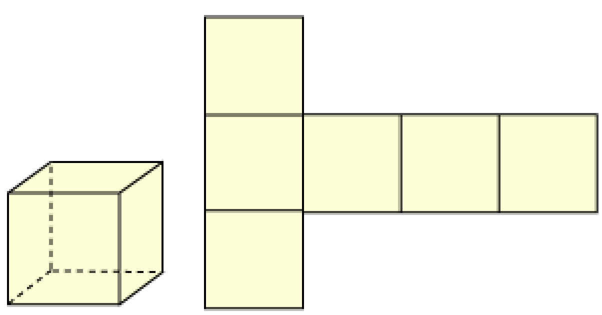
(i) (d)



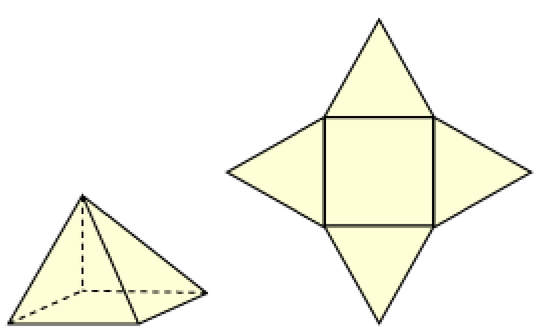
(ii) (b)



(iii) (a)



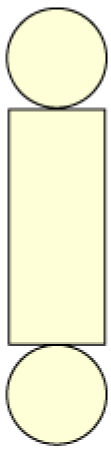
(iv) (c)



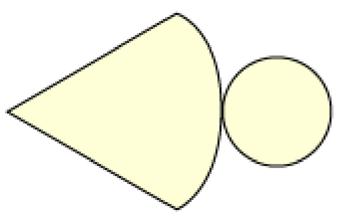
Example 3:

Draw the 3-D shapes that can be obtained from the following 2-D nets.

(i)

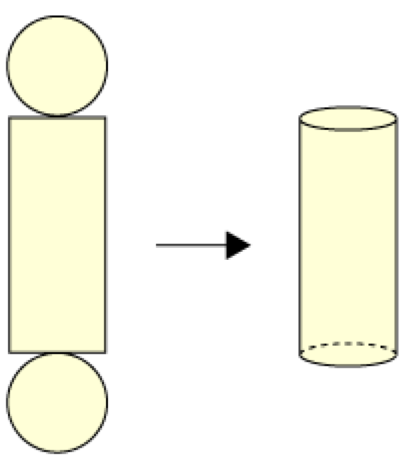


(ii)

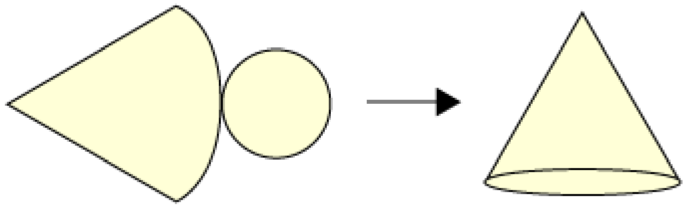


Solution:

(i) From the given net, a cylinder will be obtained.

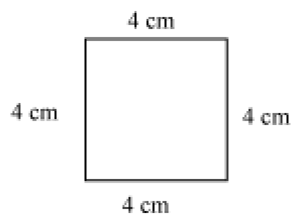


(ii) From the given net, a cone will be obtained.



Drawing Oblique Sketches of Solids on a Flat Surface

Can you draw a square of side 4 cm on a paper?



Yes, we can draw a square of side 4 cm on a paper. This is because both the paper and the square are two-dimensional figures.

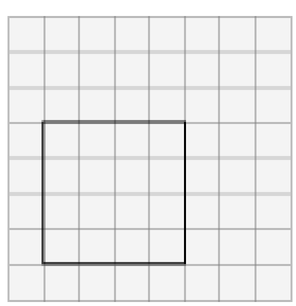
Then, can we draw a cube of edge 4 units on a paper?

Since a cube is a three-dimensional figure, it cannot be drawn with the same ease on the paper as a square.

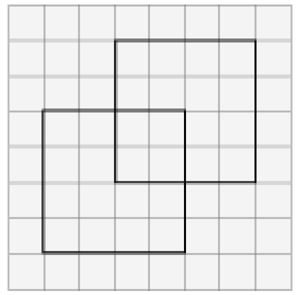
Now, let us learn how to draw three-dimensional figures such as cubes, cuboids etc. on a paper.

Let us first draw the given cube on a geo-board or a grid paper. Then, we will be able to draw it on a plain paper.

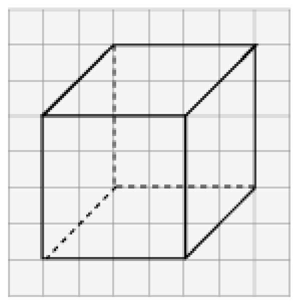
Step I: We draw the front face of the cube, which is a square of side 4 units.



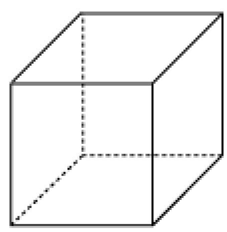
Step II: Then, we draw the back face of the cube, which is also a square of side 4 units (as shown in the figure).



Step III: Now, we join the corresponding vertices to obtain the cube.



We can re-draw the same cube on a plain paper as follows:



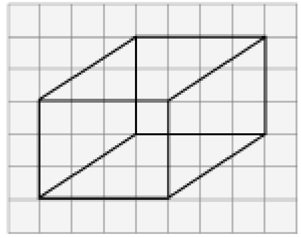
Note:

(i) Since the back edges of the cube are not visible, they are joined using dotted lines**.** By convention, the hidden edges have to be shown by doted lines.

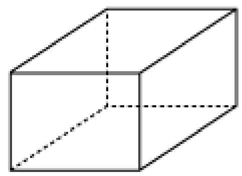
(ii) Here, we can see that all line segments are not equal (in measurement), yet they seem to be equal in the figure and we can easily recognize it as a cube.

These sketches are known as **oblique sketches.**

In the same way, we can draw a cuboid on a two-dimensional sheet.



By convention, the hidden edges have to be shown using doted lines.

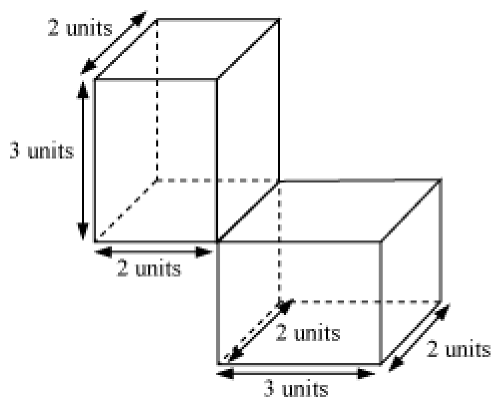


This is the required oblique sketch of the cuboid. In the oblique sketch, the lengths are not proportional to the original figure.

Let us see an example to understand the concept of oblique sketches more clearly.

Example 1:

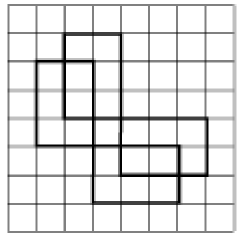
Draw the following oblique sketch on a grid paper:



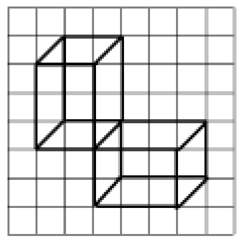
Solution:

Here, the upper cuboid is of length 2 units, breadth 2 units, and height 3 units. The lower cuboid is of length 3 units, breadth 2 units, and height 3 units.

First, the front and the back faces of the two cuboids are drawn as shown in the figure.



Now, the corresponding vertices are joined.



Hence, the required oblique sketch is obtained on the grid paper.

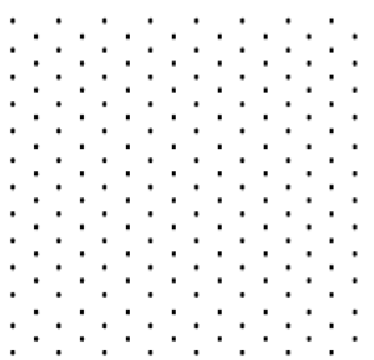
Drawing Isometric Sketches Of Solids On A Flat Surface

Three-dimensional figures can be drawn on a flat surface by drawing their oblique sketches. An oblique sketch gives all the important information about the appearance of the three-dimensional figure but the lengths in the oblique sketch are not proportional to the lengths in the original figure.

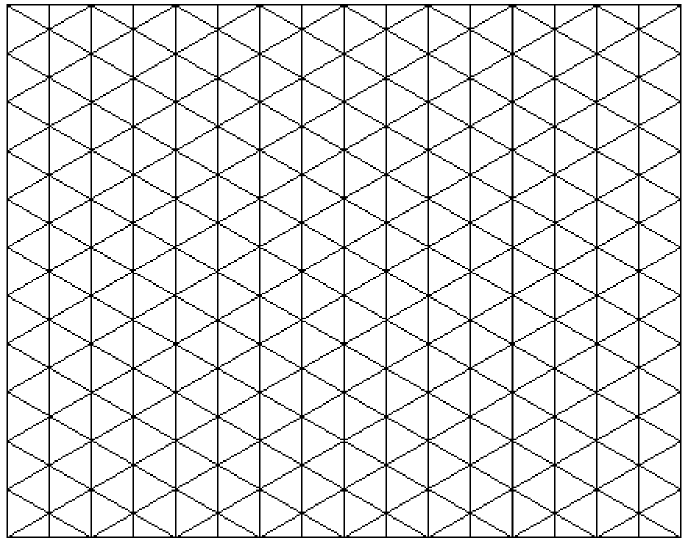
Let us now learn to draw sketches of three-dimensional figures on an isometric sheet.

To make isometric drawings we use special papers such as isometric dotted paper and isometric grid paper.

An **isometric dotted paper** is a paper having dots that make small equilateral triangles on the paper.



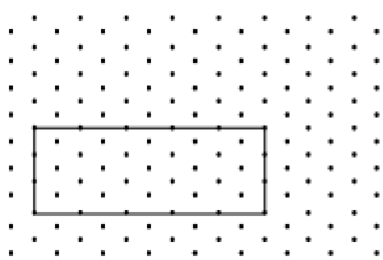
An **isometric grid paper** is a triangular graph paper which uses grid of small triangles.



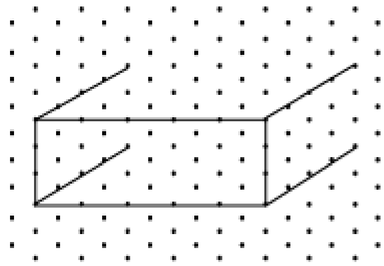
The sketch drawn on the isometric sheet by taking the sides of the figure proportional to the sides of the three-dimensional figure is known as isometric sketch of that three-dimensional figure.

Let us draw the isometric sketch of cuboid of length 5 units, breadth 4 units, and height 3 units on the isometric dotted paper. The steps to draw isometric sketch are as follows.

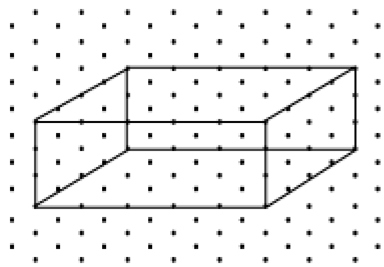
Step I First, we draw the front face of length 5 units and height 3 units as shown in figure.



Step II Then we draw four parallel line segments, each of length 4 units from the four vertices of the face drawn in step I as shown in the figure below.



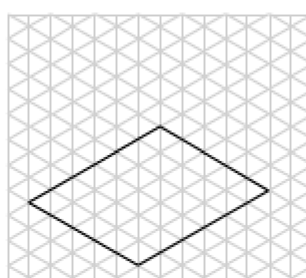
Step III Now, the back face is drawn by connecting the four matching corners.



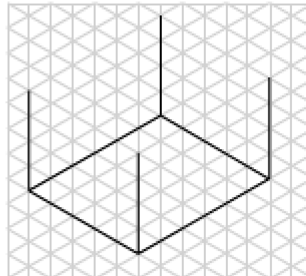
Thus, the isometric sketch of the cuboid is obtained.

Now, let us draw the isometric sketch of cuboid of length 6 units, breadth 5 units, and height 4 units on the isometric grid paper. The steps to draw isometric sketch are as follows.

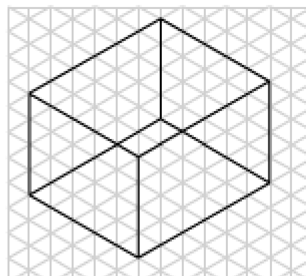
Step I: First, we draw the bottom face of length 6 units and breadth 5 units as shown in figure.



Step II: Then we draw four parallel line segments, each of length 4 units from the four vertices of the face drawn in step I as shown in the figure below.



Step III: Now, the top face is drawn by connecting the four matching corners.

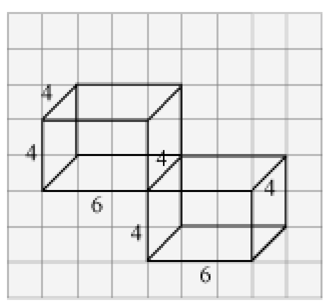


Thus, the isometric sketch of the cuboid is obtained.

Let us solve some examples to understand the concept better.

Example 1:

Draw an isometric sketch for the following figure on the isometric dotted paper.

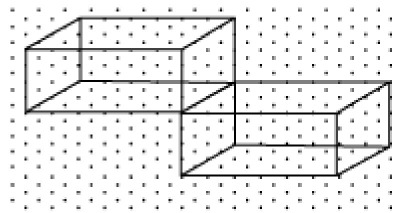


Solution:

In the given figure, two cuboids are joined together. The length, breadth, and width of each cuboid are 6 units, 4 units, and 4 units respectively.

1. First, we draw the front face of length 6 units and height 4 units.
2. Then we draw four parallel line segments, each of length 4 units from the four vertices of the front face.
3. Now, we draw the back face by connecting the four matching corners.

4. Similarly, we draw the second cuboid joined to the first one.

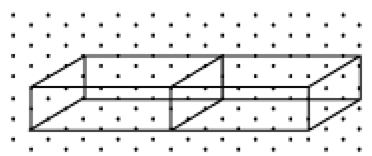


Example 2:

Draw an isometric sketch of two cuboids on the isometric dotted paper, each of dimensions 4 × 3 × 2, that are joined end to end.

Solution:

1. First, we draw the front face of length 4 units and height 2 units.
2. Then, four parallel line segments, each of length 3 units, are drawn from the four vertices of the front face.
3. Now, back face is drawn by connecting the four matching corners.
4. Similarly, the second cuboid joined end to end to the first one is drawn.



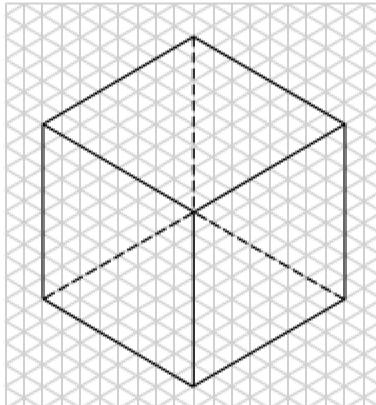
Example 3:

Draw an isometric sketch of a cube of sides 8 cm on the isometric grid paper.

Solution:

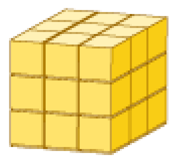
Note: Here, we have set the length represented between any points on the isometric grid paper to be 1 cm.

1. First, we draw the bottom square of side 8 cm.
2. Then we draw four parallel line segments, each of length 8 cm from the four vertices of the face drawn in step I.
3. Now, the top face is drawn by connecting the four matching corners.



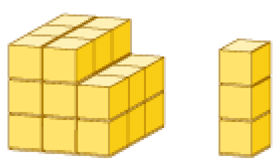
Arrangements Of Cubes

Look at the following figure.



The figure shows a Rubik's cube. Can you count the total number of cubes in it?

Yes, we can find the number of small cubes in the Rubik's cube by visualising it. By visualising, we will be able to see its hidden parts.



We can see that there are 3 small cubes in one column and there are 9 such columns in the Rubik's cube.

Therefore, total number of small cubes in the Rubik's cube

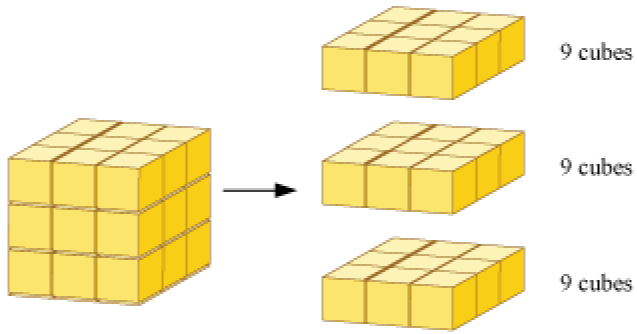
= Number of columns × Number of small cubes in one column

= 9 × 3

= 27

Now, there is another simple way to count the number of cubes in the given arrangement.

Let us look at the following figure.

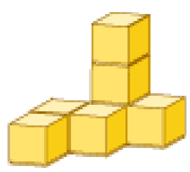


We can see that the arrangement can be split into three parts as shown in the above figure. Thus, total number of cubes in the arrangement = 9 + 9 + 9 = 27

Let us solve some more examples to understand the concept better.

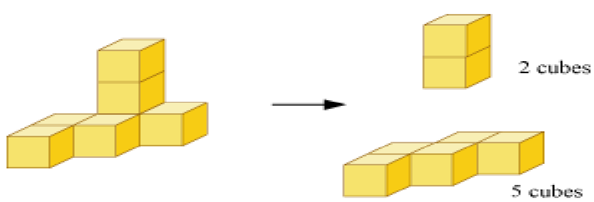
Example 1:

How many cubes are there in the following figure?



Solution:

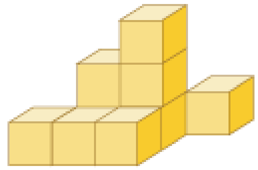
If we split the given arrangement into two parts, then we can clearly visualise the total number of cubes in it.



Thus, total number of cubes in the given arrangement = 5 + 2 = 7

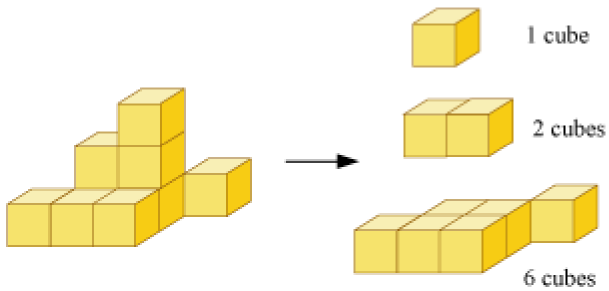
Example 2:

How many cubes are there in the following figure?



Solution:

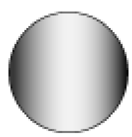
The splitting of the given arrangement into three parts leads to a total of 9 cubes.



Thus, total number of cubes in the given arrangement = 6 + 2 + 1 = 9

Cross-Section Of Solids

Let us consider the figure of a sphere.

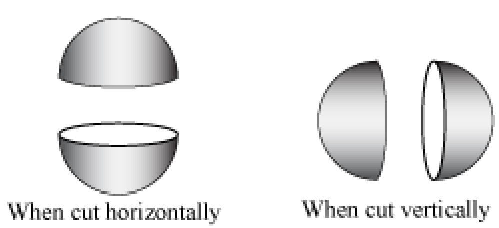


What will you observe if the sphere is cut into two equal halves?

Now, there are two ways to cut a solid sphere

1. Horizontally and
2. Vertically

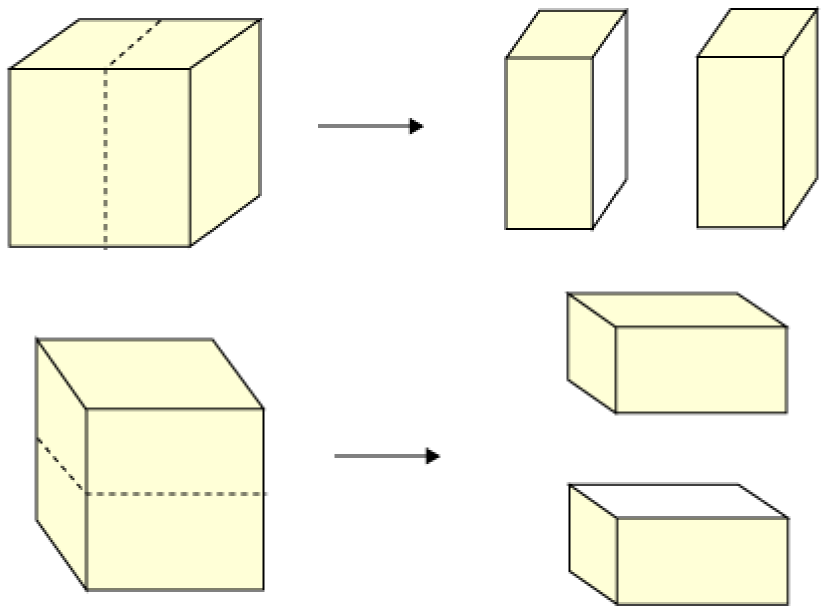
In each case, we will obtain two hemispheres.



When a 3-D figure is cut vertically or horizontally, the plane face so obtained is known as **cross-section.**

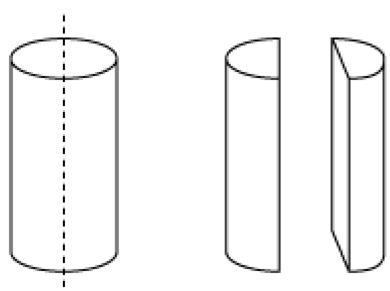
In the above figures, cross-section is a circle.

Now, let us cut a **cube** both vertically and horizontally.

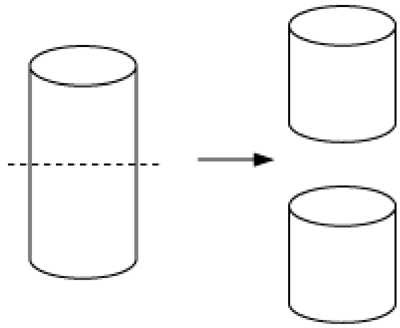


From the above figures, we can say that the cross-section of a cube is square.

Now, let us consider a cylinder. When it is cut vertically, its cross-section is a rectangle as shown below.



When it is cut horizontally, its cross-section is a circle as shown below.



Concept Of Shadows Of 2-D And 3-D Objects

Have you ever seen shadow play?

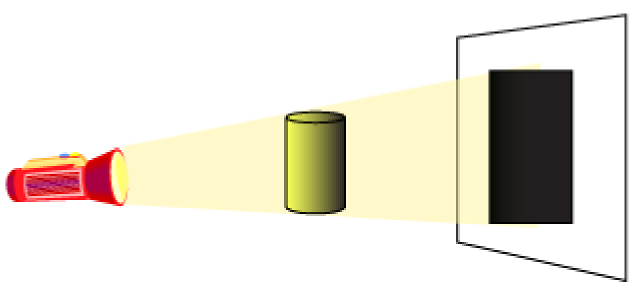
Shadow play is an ancient form of entertainment using opaque articulated figures in front of a source of light to create images.

Now, look at the following figures.

In these figures, different images have been formed by hands.

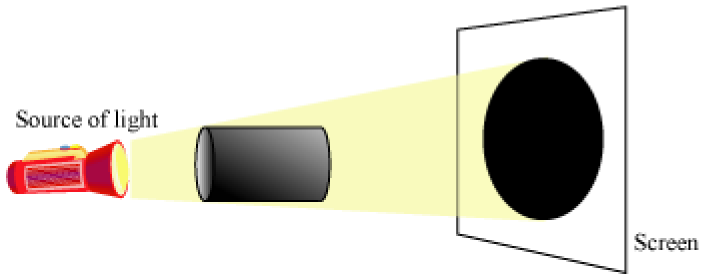
If we keep a torch light in front of a solid object, then we will obtain a shadow. Now, let us see what type of shadow is formed? Would we obtain the same shape or different shape?

If we keep the torch perpendicularly to the cylinder, then the shadow formed is shown below.

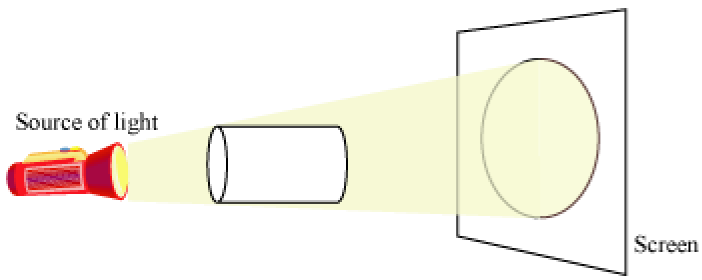


Here, we can observe that the shadow forms a rectangle which is a two-dimensional figure. Cylinder is a three-dimensional figure but the shadow is a two-dimensional figure.

Let us now keep the torch horizontally along the cylinder. Then, the shadow will be circular, which is also a two-dimensional figure.

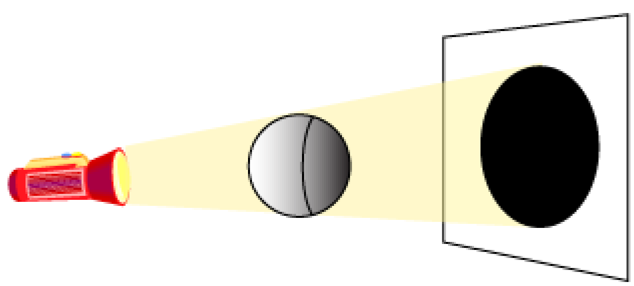


However, if the cylinder is hollow, then the shadow will be just a ring.



What type of shadow is formed for a sphere?

For a sphere, the shadow will always be a circle wherever the source of light is kept.



One thing we observe from the above discussion is that

"The shadow of any object is always two-dimensional. It does not depend upon the dimension of the object".

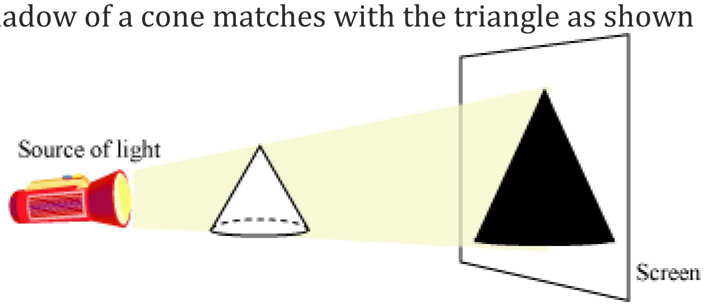
Let us now solve some examples to understand the concept better.

Example 1:

Name the 3-D objects whose shadow matches the given shadows.

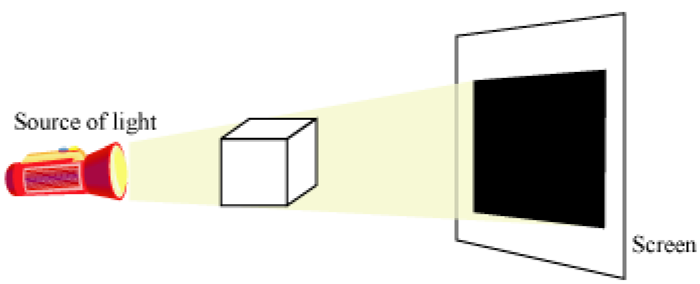
Solution:

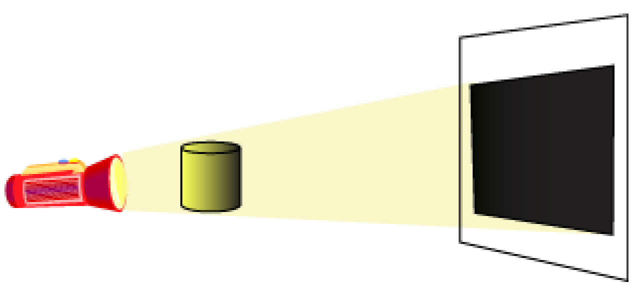
1. The shadow of a cone matches with the triangle as shown



below.

2. The shadow of a cube or a cylinder whose height is equal to the diameter of the base of cylinder matches with the square as shown below.





Solid Objects Viewed From Different Angles

Look at the following figure.

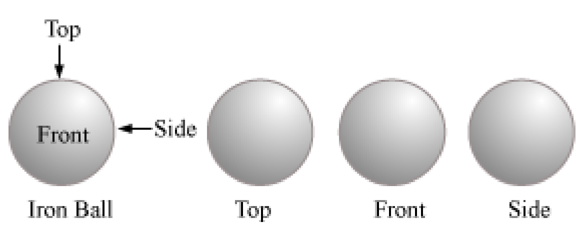
This figure shows the top view of Taj Mahal.

We obtain different views of objects depending upon the angle of looking at the objects. These views help us to know the shape of the object.

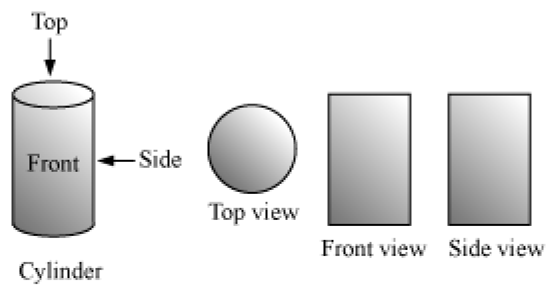
The following figures show the side view and front view of Taj Mahal.

Thus, we can see any object from different angles. It does not change the shape or position of the object. However, it makes a different view of the same object for the observer.

Let us use this concept in some more objects.



Thus, we can say that spherical objects look the same from all angles. It is a special property of such spherical solids.



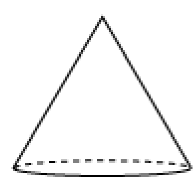
If a cylinder is considered, then its top view will be a circle. The front and side views are the same, which are rectangles.

Now, let us solve some examples to understand the concept better.

Example 1:

Which shape is formed when a cone is seen from

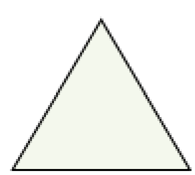
1. **front**
2. **side**
3. **top**



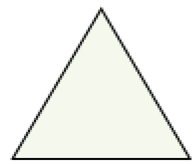
Solution:

When a cone is seen from

1. front, it looks like a triangle



2. side, it looks like a triangle



3. top, it looks like a circle and the vertex as dot