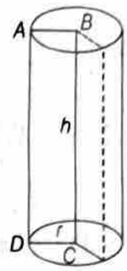
3. Right Circular Cylinder

Cylinder is a solid figure obtained by revolving the rectangle, say $ABCD$, about its one side, say BC. Let base radius of right circular cylinder be r units and its height be h units. Then,



(i) Curved surface area (CSA)
$= \text{Circumference of the base} \times \text{Height}$
$= 2\pi rh$ sq units

(ii) Total surface area (TSA)
$= \text{Curved surface area (CSA)} + \text{Area of two ends}$
$= 2\pi rh + 2\pi r^2 = 2\pi r(h + r)$ sq units

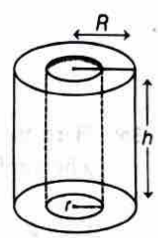
(iii) Volume of the cylinder $= \text{Area of base} \times \text{Height}$
$= \pi r^2 h$ cu units

4. Right Circular Hollow Cylinder

Let R units and r units be the external and internal radii of the hollow cylinder, respectively and h units be its height. Then,

(i) Curved surface area (CSA)
$= \text{CSA of outer cylinder} + \text{CSA of inner cylinder}$
$= 2\pi Rh + 2\pi rh = 2\pi(R + r)h$ sq units

(ii) Total surface area (TSA)



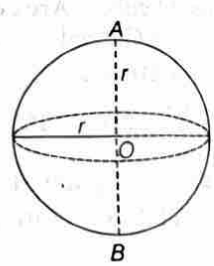
$= \text{CSA of hollow cylinder} + \text{Area of both ends}$
$= 2\pi(R + r)h + 2\pi(R^2 - r^2)$
$= 2\pi(R + r)h + 2\pi(R + r)(R - r)$
$= 2\pi(R + r)[h + R - r]$ sq units

(iii) Total outer surface area
$= 2\pi Rh + 2\pi(R^2 - r^2)$ sq units

(iv) Volume of hollow cylinder
$= \text{Volume of outer cylinder} - \text{Volume of inner cylinder}$
$= \pi R^2 h - \pi r^2 h = \pi(R^2 - r^2)h$ cu units

5. Sphere

A sphere is a solid generated by the revolution of a semi-circle about its diameter. Let radius of sphere be r units. Then,

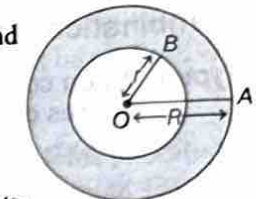


(i) Surface area (SA) of sphere $= 4\pi r^2$ sq units

(ii) Volume of sphere $= \dfrac{4}{3}\pi r^3$ cu units

6. Spherical Shell

If R and r are respectively the outer and inner radii of a spherical shell, then

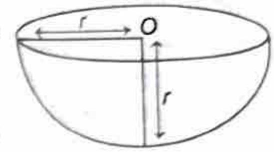


(i) Volume of a hollow sphere
$= \dfrac{4}{3}\pi(R^3 - r^3)$ cu units

(ii) Outer surface area $= 4\pi R^2$ sq units

7. Hemisphere

A plane passing through the centre, cuts the sphere in two equal parts, each part is called a hemisphere. Let radius of hemisphere be r units. Then,



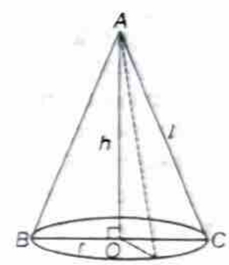
(i) Curved surface area (CSA) of hemisphere
$= 2\pi r^2$ sq units

(ii) Total surface area (TSA) of hemisphere = CSA of hemisphere + Area of one end $= 2\pi r^2 + \pi r^2$
$= 3\pi r^2$ sq units

(iii) Volume of hemisphere $= \dfrac{2}{3}\pi r^3$ cu units

8. Right Circular Cone

A right circular cone is a solid generated by the revolution of a right angled triangle about one of its sides containing the right angle as axis as shown in figure. Let height of a right circular cone be h units and its radius be r units. Then,



(i) Slant height of the cone,
$l = AC = \sqrt{r^2 + h^2}$ units

(ii) Curved surface area (CSA) of cone $= \pi rl$ sq units

(iii) Total surface area (TSA) of a cone
$= \text{Curved surface area (CSA)} + \text{Area of the base}$
$= \pi rl + \pi r^2 = \pi r(l + r)$ sq units

(iv) Volume of cone $= \dfrac{1}{3}\pi r^2 h$ cu units

Surface Area and Volume of Combination of Solids

In our day-to-day life we come across some complex solid figures, e.g. a circus tent consisting of a cylindrical base surmounted by a conical roof, a toy in the form of cone mounted on a hemisphere etc. All of these are combination of two or more basic solids.

In this topic, we will learn how to find the surface areas and volumes of combination of two or more similar or different solid figures.

Surface Areas and Volumes

CHAPTER 12

In earlier classes, we have learnt how to find the surface area and volume of solid figures, like cuboid, cube, cylinder, cone, sphere and hemisphere etc. In this chapter, we will learn how to find the surface area and volume of combination of solid figures.

Before starting topics of this chapter, we will review some important definitions and formulae that will be used frequently in this chapter.

Solid Figures

The objects having definite shape, size and occupies a fixed amount of space in three dimensions are called **solids** such as cube, cuboid, cylinder, cone, sphere and hemisphere, etc.

Surface Area (SA)

Surface area of a solid body is the area of all of its surfaces together and it is always measured in **square unit.**

e.g. A cube has 6 surfaces and each surface is in a square shape. Therefore, its surface area will be $6a^2$ sq units, where a^2 is the area of each surface of the cube.

Volume

Space occupied by an object/solid body is called the **volume** of that particular object/solid. Volume is always measured in **cube unit**.

e.g. Suppose, a cube has edge of length a units. Volume of a cube is equal to the product of area of base and height of a cube i.e. $a^2 \times a = a^3$ cu units.

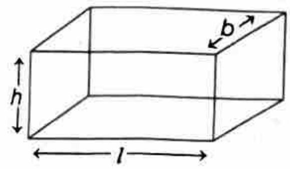
Important Formulae (Related to Some Solid Figures)

1. Cuboid

A cuboid is a solid figure having 6 rectangular faces. Let its length = l units, breadth = b units and height = h units. Then,

(i) Total surface area of cuboid (TSA)

$$= 2(lb + bh + hl) \text{ sq units}$$



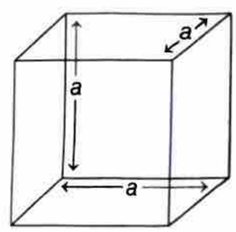
(ii) Lateral surface area of cuboid = $2(l + b)h$ sq units
or Lateral surface area = Area of the 4 faces

(iii) Diagonal of the cuboid = $\sqrt{l^2 + b^2 + h^2}$ units

(iv) Volume of cuboid = $l \times b \times h$ cu units

2. Cube

Cube is a special case of cuboid which has 6 equal square faces.



Let its length = breadth = height = a units

$\therefore$ Each edge of cube = a units

Then,

(i) Total surface area (TSA) of a cube

$$= 6 \times (\text{Edge})^2 = 6a^2 \text{ sq units}$$

(ii) Lateral surface area of cube

$$= 4 \times (\text{Edge})^2 = 4a^2 \text{ sq units}$$

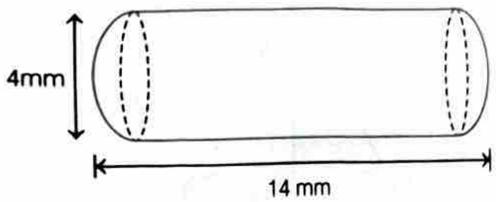
(iii) Diagonal of a cube = $\sqrt{3} \times$ Edge = $\sqrt{3}a$ units

(iv) Volume of a cube = $(\text{Edge})^3 = a^3$ cu units

Type III When combination of cylinder and hemisphere is given

Method of solving this type of problems can be understood with the help of following examples.

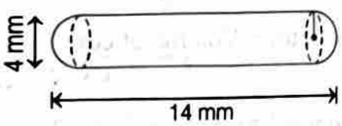
Example 4. **A medicine capsule is in the shape of a cylinder with two hemispheres stuck to each of its ends. The length of the entire capsule is 14 mm and the diameter of the capsule is 4 mm. Find its surface area. Also, find its volume.** CBSE 2024 (Standard)



Sol. Length of the capsule $= 14$ mm

Diameter of the capsule $= 4$ mm

Radius of the capsule $= \frac{4}{2} = 2$ mm



Length of the cylinder = Total length of capsule − Radius of left hemisphere − Radius of right hemisphere

$= 14 - 2 - 2 = 10$ mm

Surface area of capsule = Curved surface area of cylinder + Surface area of left hemisphere + Surface area of right hemisphere

$$= 2\pi rh + 2\pi r^2 + 2\pi r^2$$
$$= 2\pi rh + 4\pi r^2$$
$$= 2 \times \frac{22}{7} \times 2 \times 10 + 4 \times \frac{22}{7} \times 2 \times 2$$
$$= 125.71 + 50.29$$
$$= 176$$

Thus, the required surface area of the capsule is $176\ \text{mm}^2$.

Volume of capsule = Volume of cylinder + Volume of left hemisphere + Volume of right hemisphere

$$= \pi r^2 h + \frac{2}{3}\pi r^3 + \frac{2}{3}\pi r^3$$
$$= \pi r^2 h + \frac{4}{3}\pi r^3$$
$$= \frac{22}{7} \times 2 \times 2 \times 10 + \frac{4}{3} \times \frac{22}{7} \times 2 \times 2 \times 2$$
$$= 125.71 + 33.52$$
$$= 159.23\ \text{mm}^3$$

Type IV When combination of cone and hemisphere/cylinder is given

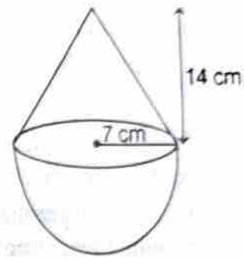
Method of solving this type of problems can be understood with the help of following examples.

Example 5. **A solid is in the shape of a right-circular cone surmounted on a hemisphere, the radius of each of them being 7 cm and the height of the cone is equal to its diameter. Find the volume of the solid.** $\left[\text{use } \pi = \frac{22}{7}\right]$

CBSE 2023 (Standard)

Sol. Given, radius of cone $(r) = 7$ cm

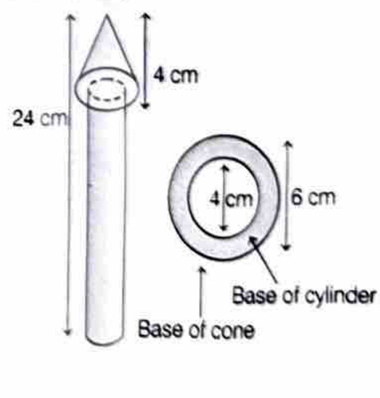
and height of cone $(h) = 2r = 14$ cm



$\therefore$ Volume of the solid = Volume of cone + Volume of hemisphere

$$= \frac{1}{3}\pi r^2 h + \frac{2}{3}\pi r^3$$
$$= \frac{1}{3} \times \frac{22}{7} \times 7^2 \times 14 + \frac{2}{3} \times \frac{22}{7} \times (7)^3$$
$$= \frac{1}{3} \times \frac{22}{7} \times 7^3 (2 + 2) = \frac{22}{3} \times 7^2 \times 4$$
$$= \frac{4312}{3}\ \text{cm}^3$$

Example 6. **A wooden toy rocket is in the shape of a cone mounted on a cylinder, as shown in figure. The height of the entire rocket is 24 cm, while the height of the conical part is 4 cm. The base of the conical portion has a diameter of 6 cm, while the base diameter of the cylindrical portion is 4 cm. If the conical portion is to be painted orange and the cylindrical portion yellow, then find the area of the rocket painted with each of these colours. [Take $\pi = 3.14$]**



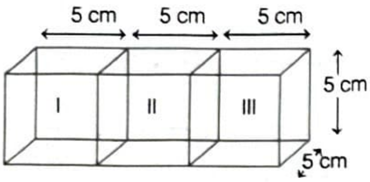
Different Types of Problems Based on Various Combination of Solids

Type I When combination of two or more than two figures of same type is given

Method of solving this type of problems can be understood with the help of the following examples.

Example 1. Three cubes each of side 5 cm are joined end to end. Find the surface area of the resulting solid.

Sol. Here, on joining three cubes, we get a cuboid whose length, $l = 5 + 5 + 5 = 15$ cm, breadth, $b = 5$ cm and height, $h = 5$ cm



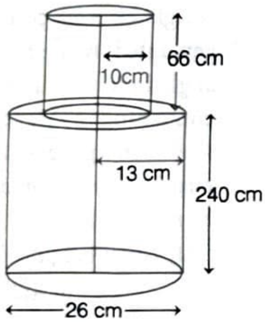
$\therefore$ Required surface area of the resulting solid

= Surface area of new cuboid

$= 2(lb + bh + hl) = 2(15 \times 5 + 5 \times 5 + 5 \times 15)$

$= 2(75 + 25 + 75) = 2(175) = 350 \text{ cm}^2$

Example 2. An iron pole consists of a cylinder of height 240 cm and base diameter 26 cm, which is surmounted by another cylinder of height 66 cm and radius 10 cm. Find the mass of the pole given that 1 cm^3 of iron has approximately 8 g mass. [Take, $\pi = 3.14$]



Sol. Here, solid iron pole is a combination of two cylinders.

For first cylinder,

Height = 240 cm

Base diameter = 26 cm

$\therefore$ Base radius $= \frac{26}{2}$ cm $= 13$ cm

For second cylinder,

Height = 66 cm, Radius = 10 cm

We know that,

Volume of cylinder $= \pi r^2 h$

$\therefore$ Total volume of iron pole = Volume of first cylinder + Volume of second cylinder

$= \pi (13)^2 \times 240 + \pi (10)^2 \times 66$

$= \pi [169 \times 240 + 100 \times 66]$

$= 3.14 [40560 + 6600]$

$= 3.14 \times 47160 = 148082.4 \text{ cm}^3$

Hence, total mass of the iron pole

$= 148082.4 \times 8 \text{ g} = 1184659.2 \text{ g}$ [given, $1 \text{ cm}^3 \approx 8 \text{ g}$]

$= \frac{1184659.2}{1000}$ kg

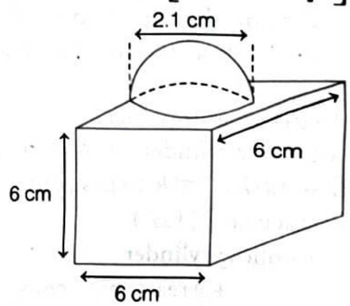
$= 1184.66$ kg $\left[\because 1 \text{g} = \frac{1}{1000} \text{kg}\right]$

Type II When combination of sphere (or hemisphere) and cube/cuboid is given

Method of solving this type of problems can be understood with the help of following example.

Example 3. The decorative block shown in the following figure is made of two solids, a cube and a hemisphere.

The base of the block is a cube with edge 6 cm and the hemisphere fixed on the top has a diameter of 2.1 cm, then find the total surface area of the block and find the total area to be painted. $\left[\text{Take } \pi = \frac{22}{7}\right]$



Sol. Here, the decorative block is a combination of a cube and a hemisphere.

For cubical portion,

Each edge = 6 cm

For hemispherical portion,

Diameter = 2.1 cm

$\therefore$ Radius, $r = \frac{2.1}{2}$ cm

Now, total surface area of the cube

$= 6 \times (\text{Edge})^2 = 6 \times 6 \times 6 = 216 \text{ cm}^2$

Here, the part of the cube where the hemisphere is attached, is not included in the surface area.

So, the total surface area of the decorative block

= Total surface area of cube − Area of base of hemisphere + Curved surface area of hemisphere

$= 216 - \pi r^2 + 2\pi r^2 = 216 + \pi r^2$

$= 216 + \frac{22}{7} \times \frac{2.1}{2} \times \frac{2.1}{2} = 216 + 3.465 = 219.465 \text{ cm}^2$

Clearly, the total area to be painted

= Total surface area of the decorative block − Area of base of cube

$= 219.465 - 6^2 = 219.465 - 36 = 183.465 \text{ cm}^2$

Note it In calculating the surface area, we do not add the surface areas of the two or more individual solids because some part of the surface area disappears in the process of joining them.

NCERT FOLDER

Complete Solutions of All Exercises of NCERT Textbook

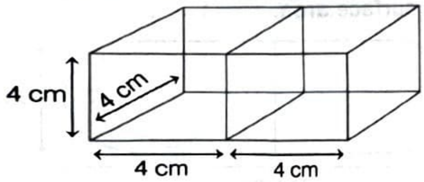
EXERCISE 12.1

Unless stated otherwise, take $\pi = \frac{22}{7}$.

Q1. 2 cubes each of volume 64 cm^3 are joined end to end. Find the surface area of the resulting cuboid.

Sol. Given, the volume of each cube is 64 cm^3.

Let each side of the cube be a cm.



$\because$ Volume of cube = (Side)^3

$\therefore$ $64 = a^3$ [given]

$\Rightarrow$ $a = 4$ cm

When two cubes are joined end to end, then we get a cuboid whose length, $l = (4+4) = 8$ cm, breadth, $b = 4$ cm and height, $h = 4$ cm.

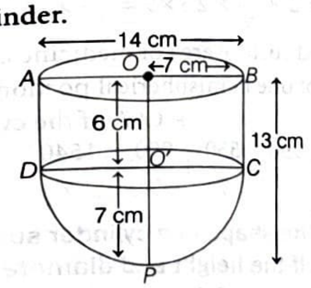
Now, surface area of the resulting cuboid

$= 2(lb + bh + hl) = 2(8 \times 4 + 4 \times 4 + 4 \times 8)$

$= 2(32 + 16 + 32) = 2(80) = 160 \text{ cm}^2$

Q2. A vessel is in the form of a hollow hemisphere mounted by a hollow cylinder. The diameter of the hemisphere is 14 cm and the total height of the vessel is 13 cm. Find the inner surface area of the vessel. CBSE 2024 (Standard)

Sol. Here, vessel is a combination of a hollow hemisphere and a hollow cylinder.



For cylindrical portion,

Diameter $= AB = DC = 14$ cm

$\therefore$ Radius $= OB = O'C = O'P$

$= \frac{AB}{2} = \frac{14}{2} = 7$ cm

Total length of vessel, $PO = 13$ cm

$\therefore$ Length of cylinder, $OO' = PO - O'P = 13 - 7 = 6$ cm

For hemispherical portion,

Radius of hemisphere = Height of hemisphere = 7 cm

Now, the inner surface area of the vessel

= Curved surface area of cylinder + Curved surface area of hemisphere

$= 2\pi rh + 2\pi r^2$

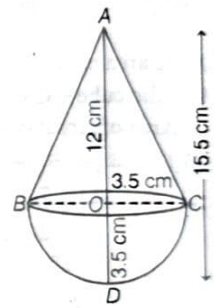
$= 2 \times \frac{22}{7} \times 7 \times 6 + 2 \times \frac{22}{7} \times (7)^2$

$= 2 \times 22 \times 6 + 2 \times 22 \times 7$

$= 44(6+7) = 44 \times 13 = 572 \text{ cm}^2$

Q3. A toy is in the form of a cone of radius 3.5 cm mounted on a hemisphere of same radius. The total height of the toy is 15.5 cm. Find the total surface area of the toy. CBSE 2020 (Basic), CBSE 2024 (Standard)

Sol. Here, toy is a combination of a hemisphere and a cone.



Given, total height of toy,

$AD = 15.5$ cm

For hemispherical portion,

Radius, $OC = OD = OB = 3.5$ cm

For conical portion,

Height, $OA = AD - OD$

$= 15.5 - 3.5 = 12$ cm

and radius = 3.5 cm

Now, total surface area of the toy

= Curved surface area of cone + Curved surface area of hemisphere

$= \pi rl + 2\pi r^2 = \pi r\sqrt{h^2 + r^2} + 2\pi r^2$ $\quad [\because l = \sqrt{h^2 + r^2}]$

$= \frac{22}{7} \times 3.5 \times \sqrt{(12)^2 + (3.5)^2} + 2 \times \frac{22}{7} \times (3.5)^2$

$= 11\sqrt{144 + 12.25} + 22 \times 3.5$

$= 11\sqrt{156.25} + 11 \times 7$

$= 11(12.5) + 77$

$= 137.5 + 77 = 214.5 \text{ cm}^2$

Sol. Here, the given wooden toy rocket is combination of a cone and a cylinder.

For conical portion,

Diameter $=6$ cm

$\therefore$ Radius, $r_1 = \frac{6}{2}$ cm $= 3$ cm

Height, $h_1 = 4$ cm

Then, slant height, $l = \sqrt{(3)^2 + 4^2}$ $\quad [\because l = \sqrt{r^2 + h^2}]$

$= \sqrt{9+16} = \sqrt{25} = 5$ cm

For cylindrical portion,

Diameter $= 4$ cm

$\therefore$ Radius, $r_2 = \frac{4}{2}$ cm $= 2$ cm

Height, h_2 = Total height of rocket – Height of cone

$= 24 - 4$ $\quad [\because$ total height of rocket $= 24$ cm$]$

$= 20$ cm

Here, we have to find the area of the rocket painted with orange and yellow colours separately.

Since, radius of base of cone is larger than radius of base of cylinder and cone is mounted on cylinder.

$\therefore$ Area to be painted orange

= Curved surface area of cone

+ Area of base of cone – Area of base of cylinder

[$\because$ area of base of cylinder is common in area of base of cone]

$= \pi r_1 l + \pi r_1^2 - \pi r_2^2$

$= 3.14 \times 3 \times 5 + 3.14 \times (3)^2 - 3.14 \times (2)^2$

$= 3.14\,[15+9-4]$

$= 3.14 \times 20$

$= 62.8\ \text{cm}^2$

Now, area to be painted yellow

= Curved surface area of cylinder

+ Area of base of cylinder

$= 2\pi r_2 h_2 + \pi r_2^2$

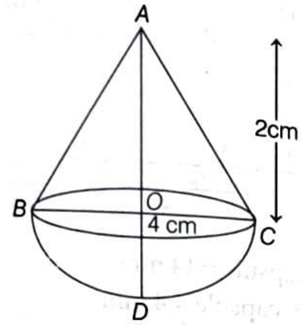
$= 2 \times 3.14 \times 2 \times 20 + 3.14 \times (2)^2$

$= 3.14\,[80+4] = 3.14 \times 84 = 263.76\ \text{cm}^2$

Example 7. A solid toy is in the form of a hemisphere surmounted by a right circular cone. The height of the cone is 2 cm and the diameter of the base is 4 cm. Determine the volume of the toy.

CBSE 2024 (Basic)

Sol. Given, height of cone $(h) = OA = 2$ cm and diameter of cone $= 4$ cm



So, radius $= r = \frac{\text{Diameter}}{2} = \frac{4}{2} = 2$ cm

Now, volume of toy = Volume of cone + Volume of hemisphere

Volume of cone $= \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \frac{22}{7} \times (2)^2 \times 2$

$= \frac{176}{21}\ \text{cm}^3$

and volume of hemisphere $= \frac{2}{3}\pi r^3$

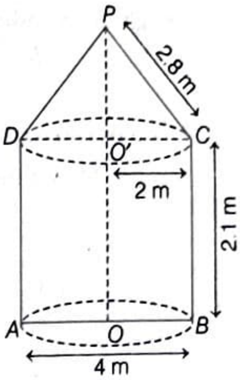
$= \frac{2}{3} \times \frac{22}{7} \times (2)^3$

$= \frac{352}{21}\ \text{cm}^3$

$\therefore$ Volume of toy $= \frac{176}{21} + \frac{352}{21} = \frac{528}{21}$

$= 25.14\ \text{cm}^3$

Sol. Given that tent is a combination of a cylinder and a cone.



For conical portion,
Slant height, $l = 2.8$ m
Radius, r = Radius of cylinder
$= \frac{\text{Diameter}}{2} = \frac{4}{2} = 2$ m

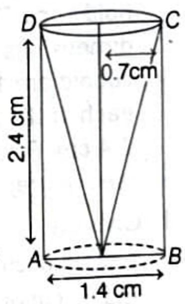
For cylindrical portion,
Radius, $r = \frac{4}{2} = 2$ m
Height, $h = 2.1$ m

$\therefore$ Required surface area of the tent
= CSA of cone + CSA of cylinder
$= \pi r l + 2\pi r h = \pi r (l + 2h)$
$= \frac{22}{7} \times 2 \times (2.8 + 2 \times 2.1)$
$= \frac{44}{7}(2.8 + 4.2)$
$= \frac{44}{7} \times 7 = 44 \text{ m}^2$

Now, cost of the canvas of the tent at the rate of ₹ 500 per m^2
= Surface area × Cost per $m^2 = 44 \times 500 =$ ₹ 22000

Q8. From a solid cylinder whose height is 2.4 cm and diameter 1.4 cm, a conical cavity of the same height and same diameter is hollowed out. Find the total surface area of the remaining solid to the nearest cm².

Sol. Given, diameter of cylinder



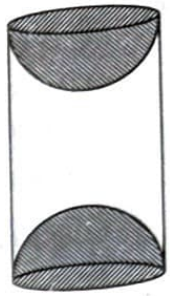
= Diameter of conical cavity
= 1.4 cm
$\therefore$ Radius of cylinder
= Radius of conical cavity
$= \frac{\text{Diameter}}{2} = \frac{1.4}{2} = 0.7$ cm

Height of the cylinder
= Height of the conical cavity
= 2.4 cm

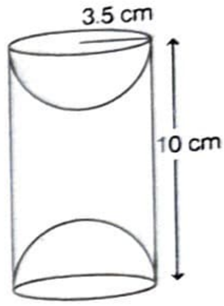
$\therefore$ Slant height of the conical cavity,
$l = \sqrt{h^2 + r^2} = \sqrt{(2.4)^2 + (0.7)^2}$
$= \sqrt{5.76 + 0.49}$
$= \sqrt{6.25} = 2.5$ cm

Now, TSA of remaining solid
= CSA of conical cavity + CSA of cylinder
+ Area of the base of the cylinder
$= \pi r l + 2\pi r h + \pi r^2$
$= \pi r (l + 2h + r)$
$= \frac{22}{7} \times 0.7 \times (2.5 + 2 \times 2.4 + 0.7)$
$= 22 \times 0.1 \times (2.5 + 4.8 + 0.7)$
$= 2.2 \times 8$
$= 17.6 \approx 18 \text{ cm}^2$

Q9. A wooden article was made by scooping out a hemisphere from each end of a solid cylinder, as shown in adjacent figure. If the height of the cylinder is 10 cm and its base is of radius 3.5 cm, then find the total surface area of the article.



Sol. Given, wooden article is a combination of a cylinder and two hemispheres.



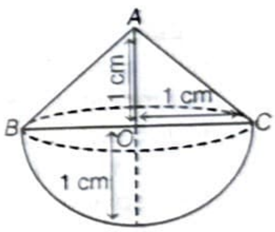
Here, height of the cylinder, $h = 10$ cm
Clearly, Radius of base of the cylinder
= Radius of hemisphere, $r = 3.5$ cm
Now, required TSA of the wooden article = 2 × CSA of one hemisphere
+ CSA of cylinder
$= 2 \times (2\pi r^2) + 2\pi r h = 2\pi r (2r + h)$
$= 2 \times \frac{22}{7} \times 3.5 \times (2 \times 3.5 + 10)$
$= \frac{22}{7} \times 7 \times (7 + 10) = 22 \times 17 = 374 \text{ cm}^2$

EXERCISE 12.2

Unless stated otherwise, take $\pi = \frac{22}{7}$

Q1. A solid is in the shape of a cone standing on a hemisphere with both their radii being equal to 1 cm and the height of the cone is equal to its radius. Find the volume of the solid in terms of π. CBSE 2024 (Basic)

Sol. Given, solid is a combination of a cone and a hemisphere.

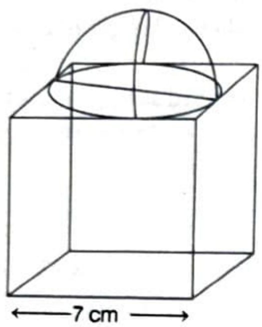


Also, radius of the cone, r
= Radius of the hemisphere
= 1 cm
Height of the cone, $h = 1$ cm
$\therefore$ Required volume of the solid
= Volume of the cone
+ Volume of the hemisphere
$= \frac{1}{3}\pi r^2 h + \frac{2}{3}\pi r^3 = \frac{1}{3}\pi (1)^2 (1) + \frac{2}{3}\pi (1)^3$
$= \frac{\pi}{3} + \frac{2}{3}\pi = \frac{(\pi + 2\pi)}{3} = \frac{3\pi}{3} = \pi \text{ cm}^3$

Q2. Rachel, an engineering student, was asked to make a model shaped like a cylinder with two cones attached at its two ends by using a thin aluminium sheet. The diameter of the model is 3 cm and its length is 12 cm.
If each cone has a height of 2 cm, find the volume of air contained in the model that Rachel made. (Assume the outer and inner dimensions of the model to be nearly the same.)

Q4. A cubical block of side 7 cm is surmounted by a hemisphere. What is the greatest diameter the hemisphere can have? Find the surface area of the solid.

Sol. Given, a cubical block is surmounted by a hemisphere. Therefore, diameter of hemisphere must be equal to the side of cubical block and it is the greatest diameter of hemisphere.



For cubical portion,

Edge = 7 cm

For hemispherical portion,

Diameter = 7 cm

$\therefore$ Radius, $r = \frac{7}{2}$ cm

Now, required surface area of solid

= TSA of the cube + CSA of hemisphere − Area of circular base of hemisphere.

$$= 6 \times (\text{Edge})^2 + 2\pi r^2 - \pi r^2$$

$$= 6 \times (7)^2 + 2 \times \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2} - \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2}$$

$$= 294 + 11 \times 7 - \frac{11 \times 7}{2}$$

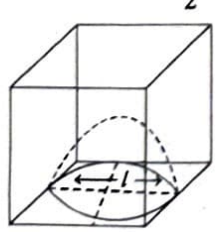
$$= 294 + 77 - \frac{77}{2}$$

$$= 371 - 38.5 = 332.5 \text{ cm}^2$$

Q5. A hemispherical depression is cut-out from one face of a cubical wooden block such that the diameter *l* of the hemisphere is equal to the edge of the cube. Determine the surface area of the remaining solid.

Sol. Given, side of the cube = Diameter of the hemisphere = l units

$\therefore$ Radius of the hemisphere, $r = \frac{l}{2}$ units



Now, required surface area of the remaining solid

= TSA of the cube + CSA of hemisphere − Area of circular base of hemisphere

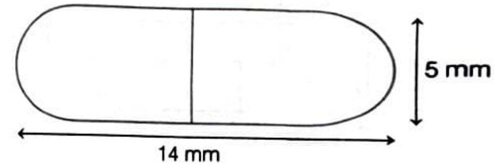
$$= 6 \times (\text{Edge})^2 + 2\pi r^2 - \pi r^2$$

$$= 6 \times l^2 + 2\pi \times \left(\frac{l}{2}\right)^2 - \pi\left(\frac{l}{2}\right)^2$$

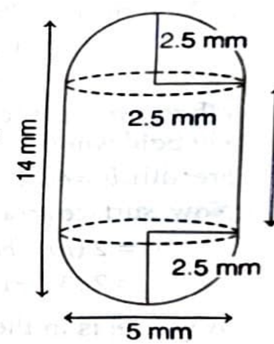
$$= 6l^2 + 2\pi \times \frac{l^2}{4} - \pi\frac{l^2}{4} = 6l^2 + \pi\frac{l^2}{4}$$

$$= \frac{l^2}{4}(\pi + 24) \text{ sq units}$$

Q6. A medicine capsule is in the shape of a cylinder with two hemispheres stuck to each of its ends (see below figure). The length of the entire capsule is 14 mm and the diameter of the capsule is 5 mm. Find its surface area.



Sol. Given that medicine capsule is a combination of two hemispheres and one cylinder.



Also, given diameter of the capsule = 5 mm

$\therefore$ Radius $= \frac{5}{2} = 2.5$ mm

and length of the capsule = 14 mm

$\therefore$ Length of the cylindrical portion = 14 − (2.5 + 2.5) = 9 mm

Now, CSA of one hemispherical portion

$$= 2\pi r^2 = 2 \times \frac{22}{7} \times 2.5 \times 2.5 = \frac{275}{7} \text{ mm}^2$$

and CSA of the cylindrical portion

$$= 2\pi rh = 2 \times \frac{22}{7} \times 2.5 \times 9 = \frac{22}{7} \times 45 = \frac{990}{7} \text{ mm}^2$$

Now, required surface area of medicine capsule

= 2 × CSA of one hemispherical portion + CSA of the cylindrical portion

$$= 2 \times \frac{275}{7} + \frac{990}{7} = \frac{550}{7} + \frac{990}{7} = \frac{1540}{7} = 220 \text{ mm}^2$$

Q7. A tent is in the shape of a cylinder surmounted by a conical top. If the height and diameter of the cylindrical part are 2.1 m and 4 m respectively, and the slant height of the top is 2.8 m, then find the area of the canvas used for making the tent. Also, find the cost of the canvas of the tent at the rate of ₹ 500 per m^2.

[Note The base of the tent will not be covered with canvas.] **CBSE 2016**

Hence, the volume of wood in the entire stand

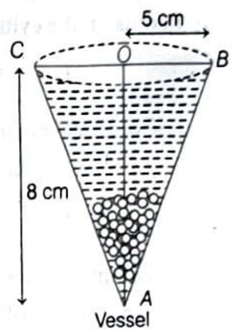
$= $ Volume of cuboid − Volume of 4 conical depressions

$= 525 - \frac{22}{15} = 525 - 1.47$

$= 523.53 \text{ cm}^3$

Q5. A vessel is in the form of an inverted cone. Its height is 8 cm and the radius of its top, which is open, is 5 cm. It is filled with water upto the brim. When lead shots, each of which is a sphere of radius 0.5 cm are dropped into the vessel, one-fourth of the water flows out. Find the number of lead shots dropped in the vessel.

Sol. Here, a cone and spherical lead shots are given. Since, lead shots are dropped into the vessel, so the water which flows out from the vessel is equal to the volume of lead shots.



Given, height of the vessel, $h = 8$ cm and radius of the vessel, $r = 5$ cm.

∴ Volume of water filled in a vessel

$= $ Volume of cone

$= \frac{1}{3} \times \pi \times r^2 \times h$

$= \frac{1}{3} \times \frac{22}{7} \times 5 \times 5 \times 8$

$= \frac{4400}{21} \text{ cm}^3$

Also, radius of a spherical lead shot = 0.5 cm

∴ Volume of one spherical lead shot $= \frac{4}{3} \times \pi \times r^3$

$= \frac{4}{3} \times \frac{22}{7} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{11}{21} \text{ cm}^3$

Let n be the number of lead shots dropped in the vessel, then according to the question,

$n \times$ Volume of one spherical lead shot

$= \frac{1}{4} \times$ Volume of water filled in a vessel

$\Rightarrow \quad n \times \frac{11}{21} = \frac{4400}{21} \times \frac{1}{4}$

$\Rightarrow \quad n \times 11 = 1100$

$\Rightarrow \quad n = 100$

Hence, required number of lead shots is 100.

Q6. A solid iron pole consists of a cylinder of height 220 cm and base diameter 24 cm, which is surmounted by another cylinder of height 60 cm and radius 8 cm. Find the mass of the pole, given that 1 cm³ of iron has approximately 8 g mass. [Use $\pi = 3.14$]

Sol. Here, the given solid is a combination of two cylinders.

Given, height of the first cylinder, $h_1 = 220$ cm

and radius of the first cylinder, $r_1 = \frac{24}{2} = 12$ cm

Height of the second cylinder, $h_2 = 60$ cm

and radius of the second cylinder, $r_2 = 8$ cm

Now, volume of iron pole

$= $ Volume of first cylinder + Volume of second cylinder

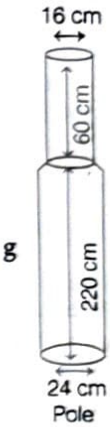
$= \pi r_1^2 h_1 + \pi r_2^2 h_2 = \pi (r_1^2 h_1 + r_2^2 h_2)$

$= 3.14 (144 \times 220 + 64 \times 60)$

$[\because r_1 = 12 \text{cm}, h_1 = 220 \text{ cm and } r_2 = 8 \text{cm}, h_2 = 60 \text{ cm}]$

$= 3.14 (31680 + 3840) = 3.14 \times 35520$

$= 111532.8 \text{ cm}^3$



$\because 1 \text{ cm}^3$ of iron pole has approximately mass = 8 g

$= \frac{8}{1000} \text{ kg} \quad \left[\because 1\text{g} = \frac{1}{1000} \text{ kg}\right]$

$\therefore \quad 111532.8 \text{ cm}^3$ iron has approximately mass

$= 111532.8 \times \frac{8}{1000}$

$= \frac{892262.4}{1000} = 892.26 \text{ kg}$

Q7. A solid consisting of a right circular cone of height 120 cm and radius 60 cm standing on a hemisphere of radius 60 cm is placed upright in a right circular cylinder full of water such that it touches the bottom. Find the volume of water left in the cylinder, if the radius of the cylinder is 60 cm and its height is 180 cm.

Sol. Given, solid is a combination of a cone and a hemisphere and it is placed into a right circular cylinder.

Height of the cylinder, $h = 180 \text{ cm} = 1.8$ m $\quad \left[\because 1 \text{ cm} = \frac{1}{100} \text{ m}\right]$

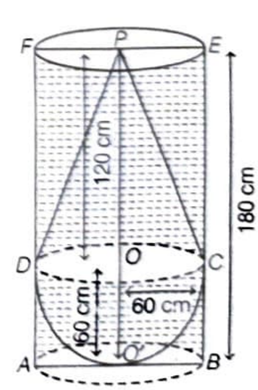
Radius of the cylinder,

$r = 60 \text{ cm} = 0.6$ m

∴ Volume of water filled in a right circular cylinder $= \pi r^2 h$

$= \frac{22}{7} \times 0.6 \times 0.6 \times 1.8$

$= \frac{14.256}{7} \text{ m}^3$



For conical portion,

Height, $h_1 = 120 \text{ cm} = 1.2$ m

Radius, $r_1 = 60 \text{ cm} = 0.6$ m

For hemispherical portion,

Radius, $r_2 = 60 \text{ cm} = 0.6$ m

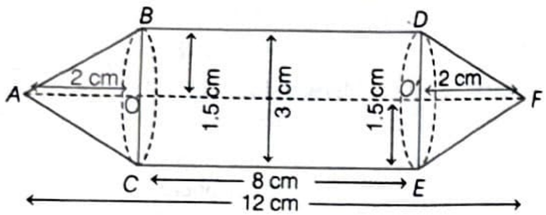
Sol. Given, model is a combination of a cylinder and two cones. Clearly, volume of the air will be equal to the sum of the volumes of two cones and one cylinder.

We have, diameter of the model, $BC = ED = 3\text{ cm}$

$\therefore$ Radius of cone = Radius of cylinder, $r = \frac{3}{2} = 1.5\text{ cm}$

Length of cone, $h_1 = 2\text{ cm}$

Total length of the model, $AF = 12\text{ cm}$



$\therefore$ Length of the cylinder, $OO' = AF - (AO + O'F)$

$= 12 - (2 + 2) = 8\text{ cm} = h_2$

Now, volume of the air inside the model

= Volume of air inside (cone + cylinder + cone)

$= \left(\frac{1}{3}\pi r^2 h_1 + \pi r^2 h_2 + \frac{1}{3}\pi r^2 h_1\right)$

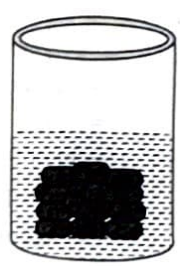
$= \frac{1}{3}\pi r^2 (h_1 + 3h_2 + h_1)$

$= \frac{1}{3} \times \frac{22}{7} \times 1.5 \times 1.5\,(2 + 3 \times 8 + 2)$

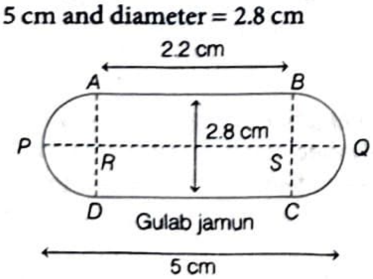
$= \frac{22}{7} \times \frac{2.25}{3} \times (2 + 24 + 2)$

$= \frac{22}{7} \times 0.75 \times 28 = 22 \times 3 = 66\text{ cm}^3$

Q3. A gulab jamun, contains sugar syrup up to about 30% of its volume. Find approximately how much syrup would be found in 45 gulab jamuns, each shaped like a cylinder with two hemispherical ends with length 5 cm and diameter 2.8 cm (see figure).



Sol. Given, one gulab jamun is a combination of a cylinder and two hemispheres. Here, total length of one gulab jamun = 5 cm and diameter = 2.8 cm



$\therefore$ Radius of cylindrical part = Radius of hemispherical part

$= r = \frac{2.8}{2} = 1.4\text{ cm}$

Height of cylindrical part,

$h = PQ - (PR + SQ) = 5 - (1.4 + 1.4)$

$= 5 - 2.8 = 2.2\text{ cm}$

$\therefore$ Volume of one gulab jamun

$= 2 \times$ Volume of hemispherical part + Volume of cylindrical part

$= 2 \times \left[\frac{2}{3}\pi r^3\right] + \pi r^2 h = \frac{4}{3}\pi r^3 + \pi r^2 h$

$= \pi r^2 \left[\frac{4r}{3} + h\right] = \frac{22}{7} \times 1.4 \times 1.4 \left[\frac{4}{3} \times 1.4 + 2.2\right]$

$= \frac{22}{7} \times \frac{14}{10} \times \frac{14}{10}\left[\frac{4}{3} \times \frac{14}{10} + \frac{22}{10}\right]$

$= 22 \times \frac{1}{5} \times \frac{7}{5}\left[\frac{28}{15} + \frac{11}{5}\right] = \frac{154}{25} \times \frac{61}{15} = \frac{9394}{375}\text{ cm}^3$

Now, volume of 45 gulab jamuns

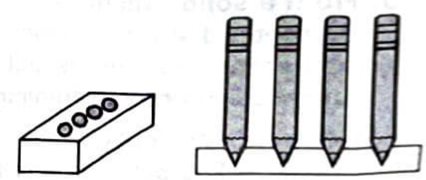
$= 45 \times \frac{9394}{375} = \frac{3 \times 9394}{25} = \frac{28182}{25} = 1127.28\text{ cm}^3$

Since, one gulab jamun contains sugar syrup upto about 30% of its volume.

Hence, quantity of syrup found in 45 gulab jamuns

$= 1127.28 \times \frac{30}{100} = 1127.28 \times \frac{3}{10} = 338.184 \approx 338\text{ cm}^3$

Q4. A pen stand made of wood is in the shape of a cuboid with four conical depressions to hold pens. The dimensions of the cuboid are 15 cm × 10 cm × 3.5 cm. The radius of each of the depressions is 0.5 cm and the depth is 1.4 cm. Find the volume of wood in the entire stand (see figure).



Sol. Given, length of cuboid $(l) = 15\text{ cm}$,

breadth of cuboid $(b) = 10\text{ cm}$

and height of cuboid $(h) = 3.5\text{ cm}$

$\therefore$ Volume of cuboid $= l \times b \times h$

$= 15 \times 10 \times 3.5 = 525\text{ cm}^3$

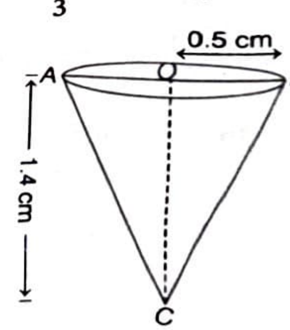
Also, radius of conical depression, $r = 0.5\text{ cm}$

and height of conical depression, $h = 1.4\text{ cm}$

$\therefore$ Volume of one conical depression $= \frac{1}{3}\pi \times r^2 \times h$

$= \frac{1}{3} \times \frac{22}{7} \times 0.5 \times 0.5 \times 1.4$

$= \frac{22}{3} \times \frac{1}{2} \times \frac{1}{2} \times \frac{2}{10} = \frac{11}{30}\text{ cm}^3$



Now, volume of 4 conical depressions = 4 × Volume of one conical depression

$= 4 \times \frac{11}{30} = \frac{22}{15}\text{ cm}^3$

REVIEW EXERCISE
Including Competency Based Questions

Part I

Multiple Choice Questions

1. Figure 1 below is a solid cuboid made of unit cubes. Figure 2 is obtained after removing some unit cubes from figure 1. Competency Based Question

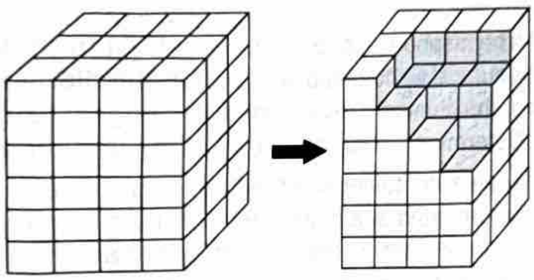


Fig. 1 Fig. 2

(Note The figures are not to scale.)

Based on the figures shown above, the surface area of the cuboid in Figure 1 is .... the surface area of the solid in Figure 2.

(a) less than
(b) more than
(c) equal to
(d) cannot be concluded with the given information

2. A container with a grey hemispherical lid has radius R cm. In figure 1, it contains water upto a height of R cm. It is, then inverted as shown in figure 2. Competency Based Question

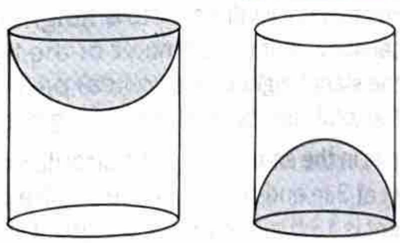


Fig. 1 Fig. 2

What is the height of water in figure 2?

(a) R cm (b) $\frac{5R}{3}$ cm (c) $2R$ cm (d) $\frac{7R}{3}$ cm

3. A surahi is the combination of NCERT Exemplar

(a) a sphere and a cylinder
(b) a hemisphere and a cylinder
(c) two hemispheres
(d) a cylinder and a cone

4. If the volume of a sphere is $\frac{11}{21}$ cm^3, then the radius of the sphere is CBSE 2024 (Basic)

(a) 2 cm (b) 4 cm (c) $\frac{1}{2}$ cm (d) $\frac{1}{4}$ cm

5. From a solid cube of side 14 cm, a sphere of maximum diameter is carved out. The radius of sphere is CBSE 2024 (Basic)

(a) 7 cm (b) 14 cm (c) $\frac{7}{2}$ cm (d) $\sqrt{14}$ cm

Assertion-Reason Type Questions

6. Assertion (A) The surface area of largest sphere that can be inscribed in a hollow cube of side a cm is πa^2 cm^2.

Reason (R) The surface area of a sphere of radius r is $\frac{4}{3}\pi r^3$. CBSE 2023 (Basic)

(a) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
(c) Assertion is correct but Reason is incorrect.
(d) Assertion is incorrect but Reason is correct.

7. Assertion (A) Total surface area of the toy is the sum of the curved surface area of the hemisphere and the curved surface area of the cone.

Reason (R) Toy is obtained by fixing the plane surfaces of the hemisphere and cone together. CBSE Sample Paper 2023 (Standard)

(a) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
(c) Assertion is correct but Reason is incorrect.
(d) Assertion is incorrect but Reason is correct.

$\therefore$ Volume of the solid

$= $ Volume of the cone + Volume of the hemisphere

$$= \frac{1}{3} \times \pi r_1^2 h_1 + \frac{2}{3} \pi r_2^3$$

$$= \frac{1}{3} \times \frac{22}{7} \times (0.6)^2 \times (1.2) + \frac{2}{3} \times \frac{22}{7} \times (0.6)^3$$

$$= \frac{22}{21} \times (0.6)^2 \; [1.2 + 2 \times 0.6] = \frac{22}{21} \times 0.36\,(1.2 + 1.2)$$

$$= \frac{22}{21} \times 0.36 \times 2.4 = \frac{19.008}{21} = \frac{6.336}{7} \text{ m}^3$$

Clearly, volume of water left in the cylinder

$=$ Volume of water filled in a right circular cylinder − Volume of the solid

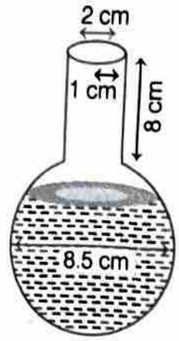
$$= \frac{14.256}{7} - \frac{6.336}{7} = \frac{7.92}{7}$$

$$= 1.131429 \text{ m}^3 \approx 1.131 \text{ m}^3$$

Note It When a solid is placed in the right circular cylinder full of water, then the volume of water which flows out from the cylinder will be equal to volume of solid. Thus, if we need to find the volume of water left in the cylinder, then we subtract the volume of the solid from volume of the cylinder filled with water.

Q 8. A spherical glass vessel has a cylindrical neck 8 cm long, 2 cm in diameter; the diameter of the spherical part is 8.5 cm. By measuring the amount of water it holds, a child finds its volume to be 345 cm^3. Check whether she is correct, taking the above as the inside measurements, and $\pi = 3.14$.

Sol. Given, spherical glass vessel is a combination of a sphere as its base and a cylinder as its neck.



For cylindrical portion,

Height of the cylinder, $h_1 = 8$ cm

Radius of the cylinder,

$$r_1 = \frac{2}{2} = 1 \text{ cm}$$

For spherical portion,

Radius of the sphere,

$$r_2 = \frac{8.5}{2} \text{ cm}$$

$\therefore$ Volume of water filled in a spherical glass vessel

$=$ Volume of the cylinder + Volume of the sphere

$$= \pi r_1^2 h_1 + \frac{4}{3} \pi r_2^3$$

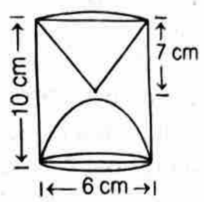
$$= 3.14 \times 1 \times 1 \times 8 + \frac{4}{3} \times 3.14 \times \frac{8.5}{2} \times \frac{8.5}{2} \times \frac{8.5}{2}$$

$$= 25.12 + \frac{1928.3525}{6}$$

$$= 25.12 + 321.39 = 346.51$$

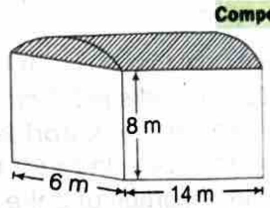
So, the correct answer is 346.51 cm^3.

17. A wooden article as shown in the figure was made from a cylinder by scooping out a hemisphere from one end and a cone from the other end. Find the total surface area of the article. **CBSE 2024 (Basic)**



18. A conical hole is drilled in a circular cylinder of height 15 cm and radius 8 cm, which has same height and same base radius. Find the total surface area after drilling of cone. [take $\pi = 3.14$]

19. A warehouse is used as a grannary. It is in the shape of a cuboid surmounted by a half- cylinder. The base of the warehouse is $6 \text{ m} \times 14 \text{ m}$ and its height is 8 m. Find the surface area of the non-cuboidal part of the warehouse. **Competency Based Question**

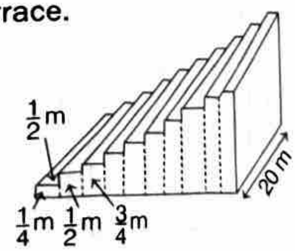


20. 50 circular plates, each of radius 7 cm and thickness 0.5 cm, are placed one above another to form a solid right circular cylinder. Find the total surface area and the volume of the cylinder so formed.

21. A building is in the form of a cylinder surmounted by a hemispherical vaulted dome and contains $41\frac{19}{21} \text{ m}^3$ of air. If the internal diameter of dome is equal to its total height above the floor. Find the height of the building. **NCERT Exemplar**

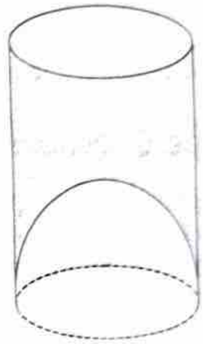
22. A rocket is in the form of a right circular cylinder closed at the lower end and surmounted by a cone with the same radius as that of the cylinder. The diameter and height of the cylinder are 6 cm and 12 cm, respectively. If the slant height of the conical portion is 5 cm, find the total surface area and volume of the rocket. [take $\pi = 3.14$] **NCERT Exemplar**

23. A small terrace at a hockey ground comprises of 10 steps each of which 20 m long and built of solid concrete. Each step has a rise of $\frac{1}{4}$ m and a tread of $\frac{1}{2}$ m. Calculate the total volume of concrete required to build the terrace.



24. A wooden article was made by scooping out a hemisphere from one face of a cubical wooden block. If each edge of cube is 10 cm and diameter of base of hemisphere is 7 cm, then find the volume of wooden article. **CBSE 2024 (Standard)**

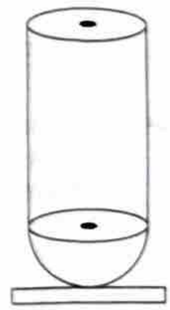
25. A juice seller was serving his customers using glasses as shown in figure. The inner diameter of the cylindrical glass was 5 cm but bottom of the glass had a hemispherical raised portion which reduced the capacity of the glass. If the height of a glass was 10 cm, find the apparent and actual capacity of the glass. [use $\pi = 3.14$] **CBSE 2019**



26. A spherical glass vessel has a cylindrical neck 7 cm long, 4 cm in diameter, the diameter of the spherical part is 21 cm. Find the quantity of water it can hold. $\left[\text{use } \pi = \frac{22}{7}\right]$

27. A vessel is in the form of a hemisphere bowl mounted by a hollow cylinder. The diameter of the hemisphere is 16 cm and the total of height of the vessel is 15 cm. Find the capacity of the vessel. $\left[\text{take } \pi = \frac{22}{7}\right]$

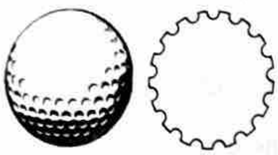
28. A trophy awarded to the best student in the class is in the form of a solid cylinder mounted on a solid hemisphere with the same radius and is made from some metal. This trophy is mounted on a wooden cuboid as shown in the figure. The diameter of the hemisphere is 21 cm and the total height of the trophy is 24.5 cm. Find the weight of the metal used in making the trophy, if the weight of 1 cm^3 of the metal is 1.2 g. $\left[\text{take } \pi = \frac{22}{7}\right]$ **Competency Based Question**



29. From a circular cylinder of diameter 14 cm and height 15 cm, a conical cavity of the same base radius and of the same height is hollowed out. Find the volume of the remaining solid. $\left[\text{take } \pi = \frac{22}{7}\right]$

Case Study Based Questions

8. A golf ball is spherical with about 300-500 dimples that help increase its velocity while in play. Golf balls are traditionally white but available in colours also. In the given figure, a golf ball has diameter 4.2 cm and the surface has 315 dimples (hemi-spherical) of radius 2 mm. **CBSE 2023 (Standard)**



Based on the above, answer the following questions.

(i) Find the surface area of one such dimple.

(ii) Find the volume of the material dug out to make one dimple.

(iii) Find the total surface area exposed to the surroundings.

Or

Find the volume of the golf ball.

Part II

Very Short Answer Type Questions

1. If two cubes of edge 5 cm, each are joined end-to-end, then find the surface area of the resulting cuboid.

2. If two solid hemispheres of same base of radius r are joined together along their bases, then find curved surface area of this new solid. **Competency Based Question**

3. A solid ball is exactly fitted inside the cubical box of side a. What is the volume of remaining space inside the cubical box?

4. From a circular cylinder of diameter 10 cm and height 12 cm, a conical cavity of the same base radius and of the same height is hollowed out. Find the volume of the remaining solid. [take, $\pi = 3.14$]

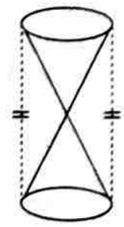
5. Find the volume of the largest right circular cone that can be cut-out from a cube of edge 4.2 cm. **NCERT Exemplar**

Short Answer Type Questions

6. Three cubes of volume 27 cm^3 each are joined end-to-end to form a solid. Find the surface area of the cuboid so formed.

7. Two cones with same base radius 8 cm and height 15 cm are joined together along their bases. Find the surface area of the shape so formed. **NCERT Exemplar**

8. An hour glass is made using identical double glass cones of diameter 10 cm each. If total height is 24 cm, then find the surface area of the glass used in making it. **Competency Based Question**



9. Three cubes each of side 15 cm are joined end-to-end. Find the total surface area of the resulting cuboid.

10. A hemispherical depression is cut out from one face of a cubical wooden block such that the diameter 4 units of the hemisphere is equal to the edge of the cube. Determine the surface area of the remaining solid.

11. A metal container is in the form of a cylinder surmounted by a hemisphere of the same radius. The internal height of the cylinder is 7 m and the internal radius of the cylinder is 3.5 m. Calculate the total surface area of the container. **CBSE 2024 (Standard)**

12. A solid is composed of a cylinder with hemispherical ends. If the whole length of the solid is 108 cm and the diameter of the hemispherical ends is 36 cm, find the cost of polishing the surface of the solid at the rate of 7 paise per sq cm. $\left[\text{use}\,\pi = \dfrac{22}{7}\right]$ **Competency Based Question**

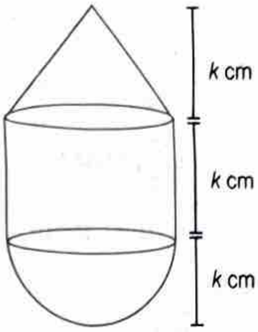
13. From a solid cylinder whose height is 15 cm and the diameter is 16 cm, a conical cavity of the same height and same diameter is hollowed out. Find the total surface area of remaining solid. [give your answer in terms of π] **CBSE 2020 (Basic)**

14. A circus tent is cylindrical upto a height of 4 m and conical above it. If the diameter of the base is 98 m and the slant height of the conical part is 33 m, then find the total canvas used in making the tent.

15. A tent is in the shape of a right circular cylinder upto a height of 3 m and conical above it. The total height of the tent is 13.5 m above the ground. Calculate the cost of painting the inner side of the tent at the rate of ₹ 2 per m^2, if the radius of the base is 14 m. **CBSE 2024 (Standard)**

16. A circus tent is made up using two different coloured cloth material. Red coloured material is used to make cylindrical part upto a height of 3 m and green coloured material to make conical part above it. If the diameter of the base is 105 m and slant height of the conical part is 53 m, find the red coloured material and green coloured material required.[assuming no stitching margins.] **Competency Based Question**

40. Shown below is a solid made of a cone, a cylinder and a hemisphere.



(**Note** The figure is not to scale.)

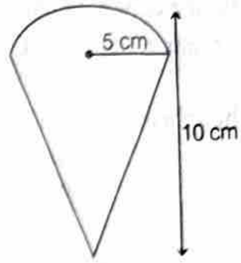
Prove that the total volume of the solid is twice the volume of the cylinder. **Competency Based Question**

41. Water is flowing at the rate of 15 km/h through a pipe of diameter 14 cm into a cuboidal pond which is 50 m long and 44 m wide. In what time will the level of water in pond rise by 21 cm?

What should be the speed of water, if the rise in water level is to be attained in 1 h?

CBSE Sample Paper 2023 (Standard)

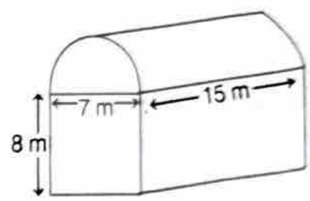
42. An ice-cream filled cone having radius 5 cm and height 10 cm is as shown in the figure. Find the volume of the ice-cream in 7 such cones. **CBSE 2023 (Basic)**



43. Neetu runs an industry in a shed which is in the shape of a cuboid surmounted by a half cylinder see in the figure. If the base of the shade is of dimension 7 m × 15 m and height of the cuboidal portion is 8 m. Find the volume of air that the shed can hold. Further suppose the machinery in the shed occupies a total space of 400 m^3 and there are 15 workers, each of whom occupy about 0.08 m^3 space on average. Then, how much air in the shed?

$\left[\text{take } \pi = \dfrac{22}{7}\right]$

Competency Based Question



HINTS & SOLUTIONS

Part I

1. (c) **Hint** We know, the surface area of any given object is the area or region occupied by the surface of the object.

Thus, both figures have equal surface area.

2. (b) **Hint** We know,

Volume of hemisphere $= \dfrac{2}{3}\pi r^3$

Volume of cylinder $= \pi r^2 h$

Let R be the radius of hemispherical lid and height of water and h be the height of cylinder.

∴ Volume of cylinder $= \pi R^2 h \text{ cm}^2$

and volume of hemisphere $= \dfrac{2}{3}\pi R^3$

Volume of water inside cylinder $= \pi R^2 \times R$

$$\pi R^3 = \pi R^2 h - \frac{2}{3}\pi R^3$$

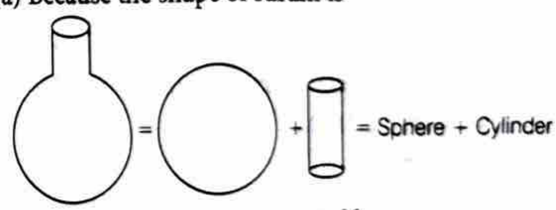
$$\Rightarrow \quad \pi R^2 h = \frac{2}{3}\pi R^3 + \pi R^3$$

$$\Rightarrow \quad \pi R^2 h = \frac{5\pi R^3}{3}$$

$$\Rightarrow \quad h = \frac{5R}{3}$$

Hence, the height of water when its is inverted is $\dfrac{5R}{3}$ cm.

3. (a) Because the shape of surahi is



4. (c) Given, volume of a sphere $= \dfrac{11}{21}\text{cm}^3$ ...(i)

We know that volume of a sphere $= \dfrac{4}{3}\pi R^3$ ...(ii)

where, R is the radius of sphere.

$$\therefore \quad \frac{4}{3}\pi R^3 = \frac{11}{21} \quad \text{[from Eqs. (i) and (ii)]}$$

$$\Rightarrow \quad \frac{4}{3} \times \frac{22}{7} \times R^3 = \frac{11}{21} \Rightarrow R^3 = \frac{11 \times 21}{21 \times 88}$$

$$\Rightarrow \quad R^3 = \frac{1}{8} \Rightarrow R = \frac{1}{2}$$

Hence, the radius of the sphere is $\dfrac{1}{2}$ cm.

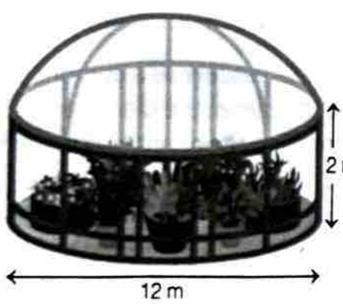
30. A solid is in the shape of a right-circular cone surmounted on a hemisphere the radius of each of them being 3.5 cm and the total height of the solid is 9.5 cm. Find the volume of the solid. **CBSE 2023 (Standard)**

31. From a solid cube of side 7 cm, a conical cavity of height 7 cm and radius 3 cm is hollowed out. Find the volume of the remaining solid. **NCERT Exemplar**

32. A pen stand made of wood is in the shape of a cuboid with four conical depressions and a cubical depression to hold the pens and pins, respectively. The dimensions of cuboid are 10 cm, 5 cm and 4 cm. The radius of each of the conical depressions is 0.5 cm and the depth is 2.1 cm. The edge of the cubical depression is 3 cm. Find the volume of the wood in the entire stand. **Competency Based Question**

Long Answer Type Questions

33. Dinesh is building a greenhouse in his farm as shown below. The base of the greenhouse is circular having a diameter of 12 m and it has a hemispherical dome on top.



(**Note** The image is not to scale.)

How much will it cost him to cover the walls and top of the greenhouse with transparent plastic, if the plastic sheet costs ₹ 77 per sq m? Show your steps.

$\left[\text{take, } \pi = \frac{22}{7}\right]$ **Competency Based Question**

34. A tent is in the shape of a cylinder surmounted by a conical top. If the height and radius of the cylindrical part are 3 m and 14 m respectively and the total height of the tent is 13.5 m, find the area of the canvas required for making the tent, keeping a provision of 26 m^2 of canvas for stitching and wastage. Also, find the cost of the canvas to be purchased at the rate of ₹ 500 per m^2. **CBSE Sample Paper 2023 (Standard)**

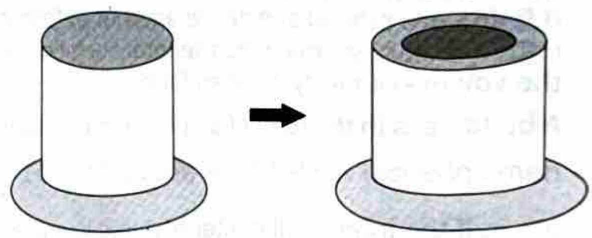
35. A solid is in the form of cone mounted on a hemisphere in such a way that the centre of the base of the cone just coincide with the centre of the base of the hemisphere. Slant height of the cone is l and radius of the base of the cone is $\frac{1}{2}r$, where r is the radius of the hemisphere. Prove that the total surface area of the solid is $\frac{\pi}{4}(11r + 2l)r$ sq unit.

36. Due to heavy floods in a state, thousands were rendered homeless. 50 schools collectively offered to the state government to provide place and the canvas for 1500 tents to be fixed by the government and decided to share their whole expenditure equally. The lower part of each tent is cylindrical of base radius 2.8 m and height 3.5 m, with conical upper part of same base radius but of height 2.1 m. If the canvas used to make the tents cost ₹ 120 per m^2, then find the amount shared by each school to set up the tents.

$\left[\text{take } \pi = \frac{22}{7}\right]$ **Competency Based Question**

37. The interior of a building is in the form of cylinder of diameter 4.3 m and 3.8 m height, surmounted by a cone whose vertical angle is a right angle.
(i) Find the area of the surface.
(ii) Also, find the volume of building. [Use $\pi = 3.14$] **CBSE 2019**

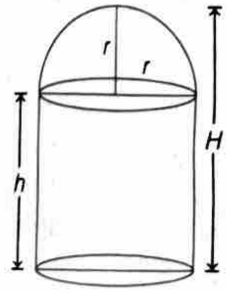
38. Shown below is a cake that Subodh is baking for his brother's birthday. The cake is 21 cm tall and has a radius of 15 cm. He wants to surprise his brother by filling gems inside the cake. In order to do that, he removes a cylindrical portion of cake out of the centre as shown. The piece that is removed is 21 cm tall.



If the cake weights 0.5 g per cubic cm and the weight of the cake that is left after removing the central portion is 6600 g, find the radius of the central portion that is cut. Show your steps.

$\left[\text{take } \pi = \frac{22}{7}\right]$ **Competency Based Question**

39. A building is in the form of a cylinder surmounted by a hemispherical dome (see the figure). The base diameter of the dome is equal to $\frac{2}{3}$ of the total height of the building. Find the height of the building, if it contains $67\frac{1}{21}$ m^3 of air. **CBSE 2023 (Standard)**



= 2 (Curved surface area of a cone)

[since, both cones are identical]

Ans. 855 cm^2 (approx.)

8. Hint Let l be the slant height of each cone given,

radius of each cone $= \frac{10}{2} = 5$ cm

and height of each cone $= \frac{24}{2} = 12$ cm

Now, we know that,

$$l = \sqrt{r^2 + h^2} \Rightarrow l = \sqrt{5^2 + 12^2} = 13 \text{cm}$$

$\therefore$ Total surface area of two cones $= 2(\pi rl + \pi r^2)$

Ans. 180π cm^2

9. Hint Do same as Example 1. **Ans.** 3150 cm^2

10. Hint SA of remaining solid

= TSA of cubical wooden block

+ CSA of hemisphere

− Area of circular base of hemisphere

Ans. $4(24 + \pi)$ sq units.

11. Hint TSA of container = TSA of cylinder

+ CSA of hemisphere

− Area of circular base of cylinder

Ans. 269.5 m^2

12. Hint Do same as Example 4. **Ans.** ₹ 855.36

13. Hint Do same as Question 8 of NCERT Folder Exercise 12.1. **Ans.** 440π cm^2

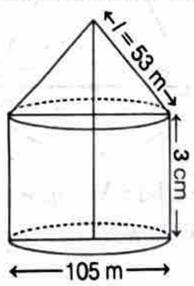
14. Hint Do same as Question 7 of NCERT Folder Exercise 12.1. **Ans.** 6314 m^2

15. Hint Required surface area

= CSA of cylinder + CSA of cone. **Ans.** ₹ 2068

16. Hint Red coloured material required

= Curved surface area of cylinder



and green coloured material required

= Curved surface area of cone

Ans. 990m^2 and 8745m^2

17. Hint Total surface area of the article

= CSA of cylinder + CSA of cone + CSA of hemisphere

Ans. 316.94 cm^2

18. Hint TSA $= 2\pi r(r + h) + \pi rl - \pi r^2$

$= 2\pi r^2 + 2\pi rh + \pi rl - \pi r^2$

$= 2\pi rh + \pi rl + \pi r^2$

Ans. 1381.6 cm^2

19. Hint Radius of cylinder,

$$r = \frac{\text{Breadth of cuboid}}{2}$$

$$= \frac{6}{2} = 3 \text{ m}$$

and height of cylinder = Length of cuboid = 14 m

$\therefore$ Surface area of the non cuboidal part

= Curved surface area of half cylinder

+ 2 × Area of one semi-circle.

Ans. $\frac{1122}{7}$ m^2

20. Hint Given, radius of cylinder formed, $r = 7$ cm

Also, we get, height of the cylinder formed, h

= Thickness of 50 plates

$= 50 \times 0.5 = 25$ cm

Ans. 1408 cm^2 and 3850cm^3

21. Hint Given, diameter of hemisphere = Diameter of cylinder = Height of building = H (say)

$\therefore$ Radius of hemisphere = Radius of cylinder

$= \frac{H}{2}$

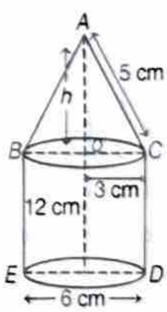
and height of cylinder $= H - \frac{H}{2} = \frac{H}{2}$

Now, Volume of building = Volume of hemisphere

+ Volume of cylinder

Ans. 4 m

22. Hint Rocket is the combination of a right circular cylinder and a cone.



$\therefore$ Total surface area of the rocket

= CSA of cylinder + CSA of cone

+ Base area of cylinder

and total volume of the rocket

= Volume of the cylinder + Volume of the cone

Ans. 301.44 cm^2 and 376.8 cm^3

5. (a) Given, length of a cube = 14 cm

Since, a sphere of maximum diameter is carved out from a solid cube.

$\therefore$ Diameter of the sphere = Length of cube

$= 14$ cm

Also, radius of the sphere $= \dfrac{\text{Diameter}}{2}$

$= \dfrac{14}{2} = 7$

Hence, the radius of the sphere is 7 cm.

6. (c) Given, side of cube = a cm

$\Rightarrow$ Diameter of sphere = a cm

$\Rightarrow$ Radius of sphere $= \dfrac{a}{2}$ cm

We know that surface area of sphere $= 4\pi r^2$

$= 4\pi \times \dfrac{a}{2} \times \dfrac{a}{2}$

$= a^2 \pi \text{ cm}^2$

7. (a)

Total surface area (TSA) of toy

= CSA of hemisphere + CSA of cone

This is because the toy is obtained by joining the plane surfaces of hemisphere and cone.

8. Given, diameter of golf ball = 4.2 cm

Radius (R) = 2.1 cm

Radius of dimple (r) = 2 mm = 0.2 cm

(i) Surface area of each dimple $= 2\pi r^2$

$= 2 \times \pi \times 0.2 \times 0.2$

$= 0.08\, \pi \text{cm}^2$

(ii) Volume of material dug out to make 1 dimple

= Volume of 1 dimple (hemisphere)

$= \dfrac{2}{3}\pi r^3$

$= \dfrac{0.016\,\pi}{3} \text{cm}^3$

(iii) Total surface area exposed to surroundings

= Surface area of golf ball $-315 \times$ Area of circle

$+ 315 \times$ Surface area of a dimple

$= 4\pi R^2 - 315 \times \pi r^2 + 315 \times 2\pi r^2$

$= (17.64\pi - 12.6\pi + 25.2\pi) \text{ cm}^2$

$= 30.24\pi \text{ cm}^2$

Or

Volume of golf ball = Volume of sphere

$-$ Volume of 315 dimple

$= \dfrac{4}{3}\pi R^3 - 315 \times \dfrac{2}{3}\pi r^3$

$= \dfrac{\pi}{3}(37.044 - 5.04) \text{cm}^3$

$= 10.668\, \pi \text{ cm}^3$

Part II

1. **Hint** Do same as Example 1.

Ans. 250 cm^2

2. **Hint** We know that

Curved surface area of a hemisphere $= 2\pi r^2$

So, when two solids hemispheres of same base radius are joined together along their bases, then curved surface area of newly formed solid sphere $= 2 \times 2\pi r^2$

$= 4\pi r^2$

Ans. $4\pi r^2$ sq units

3. **Hint** Diameter of solid ball

= Length of edge of cubical box = a

$\therefore$ Volume of remaining space inside the box

= Volume of cubical box $-$ Volume of solid ball.

Ans. $\dfrac{a^3}{6}(6 - \pi)$ cu units

4. **Hint** Volume of remaining solid = Volume of cylinder

$-$ Volume of a conical cavity

Ans. 628 cm^3

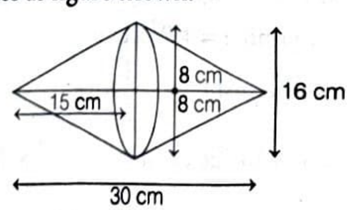
5. **Hint** Height of the cone = Edge of the cube = 4.2 cm

and diameter of the cone = Edge of cube = 4.2 cm

Ans. 19.404 cm^3

6. **Hint** Do same as Question 1 of NCERT Folder Exercise 12.1. **Ans.** 126 cm^2

7. **Hint** If two cones with same base and height are joined together along their bases, then the shape so formed looks likes as figure shown.



Given that radius of cone, $r = 8$ cm

and height of cone $h = 15$ cm

So, surface area of the shape so formed

= Curved area of first cone

+ Curved surface area of second cone

According to the question,
Volume of remaining solid

= Volume of cube – Volume of conical cavity

Ans. 277 cm^3

32. Hint Volume of the wood in the entire stand

= Volume of cuboid – 4 × Volume of each cone

–Volume of a cube

Ans. 170.8 cm^3

33. Hint Given, diameter of base of the greenhouse is circular = 12 m

radius = 6 m

Height of greenhouse cylindrical wall = 2 m

$\therefore$ CSA of the hemispherical roof $= 2 \times \pi \times 6^2 \text{ m}^2$

$= 72\pi \text{ m}^2$

and CSA of the cylindrical wall $= 2 \times \pi \times 6 \times 2 \text{ m}^2$

$= 24\pi \text{ m}^2$

TSA of the greenhouse to be covered $= 72\pi + 24\pi$

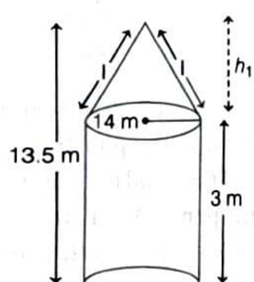
$= 96\pi \text{ m}^2$

The cost of the plastic sheet required to cover the entire greenhouse $= 96\pi \times 77 =$ ₹ 23232

34. Height of the cone, h_1 = Total height

– Height of cylinder

$= 13.5 - 3 = 10.5$ m



Radius of cone and radius of cylinder $r = 14$ m

Slant height l of cone $= \sqrt{h_1^2 + r^2} = \sqrt{(10.5)^2 + (14)^2}$

$= 17.5$ m

Curved surface area of cone $= \pi r l$

$= \pi \times 14 \times 17.5$

$= 245\ \pi \text{ m}^2$

Curved surface area of cylinder $= 2\pi r h_2$,

where h_2 is height of cylinder

$= 2\pi \times 14 \times 3 = 84\ \pi \text{ m}^2$

$\therefore$ Area of canvas required $= 245\pi + 84\pi + 26$

$= 245 \times \dfrac{22}{7} + 84 \times \dfrac{22}{7} + 26$

$= 770 + 264 + 26 = 1060 \text{ m}^2$

$\therefore$ Cost of canvas = ₹ (500 × 1060)

= ₹ 530000

35. Given, radius of base of cone $= \dfrac{r}{2}$,

slant height of cone $= l$

and radius of hemisphere $= r$

Total surface area of solid = TSA of hemisphere

$-2 \times$ Area of base of cone + TSA of cone

$$= 3\pi r^2 + \frac{\pi r}{2}\left(\frac{r}{2} + l\right) - 2\,\frac{\pi r^2}{4}$$

$$= 3\pi r^2 + \frac{\pi r^2}{4} + \frac{\pi r l}{2} - \frac{\pi r^2}{2}$$

$$= 3\pi r^2 + \frac{\pi r l}{2} - \frac{\pi r^2}{4}$$

$$= \frac{11}{4}\pi r^2 + \frac{\pi r l}{2}$$

$$= \frac{\pi r}{4}(11r + 2l) \text{ sq units.}$$

Hence proved.

36. Hint Canvas required for one tent

= Curved surface area of cylinder

+ Curved surface area of cone

So, canvas required for 1500 tents

= 1500 × canvas required for one tent.

Thus, cost of the canvas

= ₹ 120 × canvas required for 1500 tents

Hence, amount shared by each school

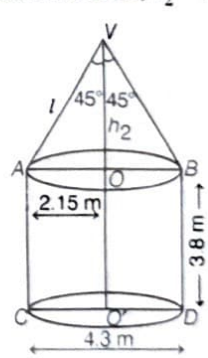
$= \dfrac{\text{cost of the canvas}}{50}$

Ans. ₹ 332640

37. (i) **Hint** Given,

Radius of base of cylinder, $r_1 = \dfrac{4.3}{2} = 2.15$ m

$\therefore$ Radius of base of a cone, $r_2 = 2.15$ m



Height of cylinder, $h_1 = 3.8$ m

In ΔVOA,

$\sin 45° = \dfrac{OA}{VA}$ $\left[\because \sin\theta = \dfrac{P}{H}\right]$

$\Rightarrow$ $VA = 3.04$ m

Clearly, ΔVOA in an isosceles triangle.

23. Hint It is clear from the figure, length = 20 m

and width = $\frac{1}{2}$ m of each step.

and height of Ist step which is in the bottom = $\frac{1}{4}$ m

$\therefore$ Height of second step = $2 \times \frac{1}{4} = \frac{1}{2}$ m

Height of third step = $3 \times \frac{1}{4} = \frac{3}{4}$ m

$\vdots \qquad \vdots$

Height of tenth step = $10 \times \frac{1}{4} = \frac{10}{4}$ m

Total volume of the concrete used

$$= 20 \times \frac{1}{2} \times \frac{1}{4} + 20 \times \frac{1}{2} \times \frac{2}{4} + 20 \times \frac{1}{2} \times \frac{3}{4} + \dots + 20 \times \frac{1}{2} \times \frac{10}{4}$$

[$\because$ Volume of cuboid = $l \times b \times h$]

$$= 20 \times \frac{1}{2} \times \frac{1}{4} [1 + 2 + 3 + \dots + 10]$$

$$= 20 \times \frac{1}{2} \times \frac{1}{4} \times \frac{10 \times 11}{2} \quad \left[\because 1 + 2 + \dots + n = \frac{n(n+1)}{2}\right]$$

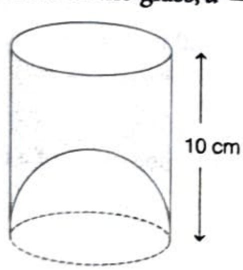
$$= 137.5 \text{ m}^3$$

24. Hint Volume of wooden article = Volume of cubical wooden block − Volume of hemisphere

Ans. 910.17 cm^3

25. Hint Given height of glass, $h = 10$ cm

and inner diameter of the glass, $d = 5$ cm



$\therefore$ Radius of glass, $r = \frac{5}{2}$ cm = 2.5 cm

Now, apparent capacity of glass

= Volume of cylindrical glass = $\pi r^2 h$

$= 3.14 \times (2.5)^2 \times 10 = 196.25 \text{ cm}^3$

Now, volume of hemisphere = $\frac{2}{3} \pi r^3$

$= \frac{2}{3} \times 3.14 \times (2.5)^3$

$= \frac{2}{3} \times 3.14 \times 15.625$

$= 32.71 \text{ cm}^3$

$\therefore$ The actual capacity of the glass

= Volume of cylindrical glass − Volume of hemisphere

$= 196.25 - 32.71 = 163.54 \text{ cm}^3$

26. Hint Quantity of water a spherical glass vessel can hold = Volume of cylindrical neck + Volume of spherical part

Ans. 4939 cm^3

27. Hint Capacity of the vessel = Volume of hemispherical bowl + Volume of the cylinder **Ans.** 2480.7619 cm^3

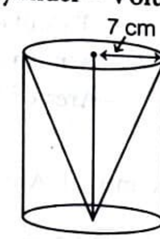
28. Hint Height of cylinder = Height of trophy − Radius of hemisphere

Volume of the metal used in the trophy
= Volume of cylinder + Volume of hemisphere

Weight of metal = Volume of the metal used in the trophy × 1.2 g

Ans. 8.7318 kg

29. Hint Volume of the remaining solid
= Volume of cylinder − Volume of cone

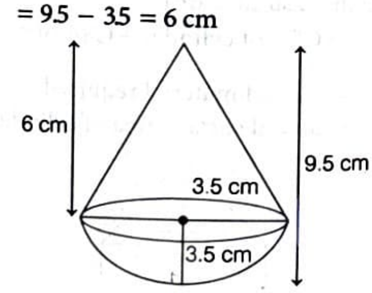


Ans. 1540 cm^3

30. Hint Radius of cone and hemisphere (r) = 3.5 cm

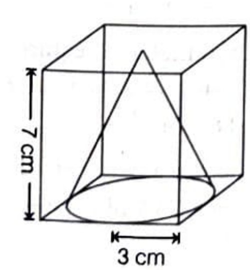
Height of cone (h) = Total height of the solid − Radius of hemisphere

$= 9.5 - 3.5 = 6$ cm



$\therefore$ Volume of the solid = Volume of cone + Volume of hemisphere **Ans.** 166.83 cm^3

31. Hint



Let v km/h be the speed of water.
Length of the water column in 1 h = v km

$$= (v \times 1000) \text{ m}$$

$\therefore$ Volume of water column $= \pi \times \left(\frac{7}{100}\right)^2 \times v \times 1000$

$$= \frac{22 \times 7 \times v}{10} \text{ m}^3$$

$\therefore$ $$\frac{22 \times 7 \times v}{10} = 50 \times 44 \times \frac{21}{100}$$

$\Rightarrow$ $$v = 30 \text{ km/h}$$

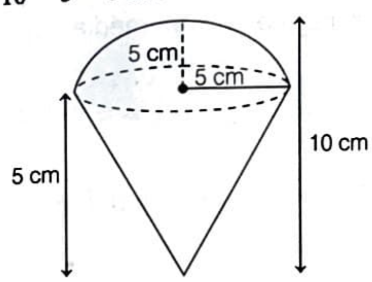
Hence, speed of water is 30 km/h.

42. Given, radius (r) of hemispherical part = 5 cm

Height of the conical part (h)

= Total height − Radius of hemispherical part

= 10 − 5 = 5 cm



$\therefore$ Volume of ice-cream in one cone

= Volume of hemispherical part + Conical part

$$= \frac{2}{3}\pi r^3 + \frac{1}{3}\pi r^2 h = \frac{1}{3}\pi r^2 (2r + h)$$

$$= \frac{1}{3} \times \frac{22}{7} \times 5^2 (10 + 5)$$

$$= \frac{22}{21} \times 25 \times 15 = 392.86 \text{ cm}^3$$

$\therefore$ The volume of the ice-cream in 7 such cones

$$= 7 \times 392.86$$

$$= 2750.02 \text{ cm}^3$$

43. **Hint** Required volume = Volume of the cuboid

$$+ \frac{1}{2} \times \text{Volume of the cylinder}$$

$$= \left[15 \times 7 \times 8 + \frac{1}{2} \times \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2} \times 15\right] \text{m}^3$$

$$= 1128.75 \text{ m}^3$$

Total space occupied by the machinery = 400 m^3

and total space occupied by the workers

$$= 15 \times 0.08 = 1.2 \text{ m}^3$$

$\therefore$ Total volume of the air, when there are machinery and workers = 1128.75 − 400 − 1.2

Ans. 727.55 m^3

$\therefore \quad VO = OA = 2.15$ m

$\therefore$ Height of cone, $h_2 = VO = 2.15$ m

Slant height of cone, $l = VA = 3.04$ m

Now, surface area of building

= Curved surface area of the cylindrical shape of building + Curved surface area of the conical shape of building

$= 2\pi r_1 h_1 + \pi r_1 l \qquad [\because r_1 = r_2]$

(ii) Volume of building

= Volume of cylindrical shape of building + Volume of conical shape of building

$= \pi r_1^2 h_1 + \frac{1}{3}\pi r_1^2 h_2 \qquad [\because r_1 = r_2]$

Ans. 71.83 m^2 and 65.56 m^3

38. Given, height of the cylindrical cake = 21 cm

height of the piece that is removed = 21 cm

Radius of cake = 15 cm

We know, volume of cylinder $= \pi r^2 h$

$$= \frac{22}{7} \times 15 \times 15 \times 21$$

$$= 14850 \text{ cm}^3$$

Weight of cake per 1 cm^3 = 0.5 g

Then, weight of cake per 14850 cm^3 = 14850 × 0.5

= 7425 g

Given, weight of the cake that is left after removing the central portion is 6600 g.

Thus, the weight of the portion removed = 7425 − 6600

= 825 g

The volume of portion removed $= \frac{825}{0.5} = 1650 \text{ cm}^3$

$\therefore$ Volume of the portion removed.

$$1650 \text{ cm}^3 = \pi r^2 \times 21$$

$$r^2 = \frac{1650 \times 7}{21 \times 22}$$

$$\Rightarrow \quad r^2 = 25 \Rightarrow r = 5 \text{ cm}$$

Hence, radius of the central portion that is cut is 5 cm.

39. **Hint** Let r be the radius of the hemispherical dome and total height of building be H m.

It is given that diameter of dome

$= \frac{2}{3} \times$ Total height of the building

$\Rightarrow \quad r = \frac{1}{3} H$ m

Let h m be the height of the cylinder.

$\therefore \quad h = H - r = \frac{2}{3} H$ m

Volume of the air inside the building = Volume of air inside the dome + Volume of air inside the cylinder

$$= \frac{2}{3}\pi r^3 + \pi r^2 h = \frac{8}{81}\pi H^3 \text{ m}^3$$

Given, volume of the air inside the building

$$= 67\frac{1}{21} \text{ m}^3$$

$$\therefore \quad \frac{8}{81}\pi H^3 = \frac{1408}{21}$$

Ans. 6 m

40. Given, radius of hemisphere = k cm

and height of cylinder = k cm

So, volume of cylinder $= \pi r^2 h = \pi k^3$ cm^3 ...(i)

Volume of cone $= \frac{1}{3}\pi r^2 h = \frac{1}{3}\pi k^3$

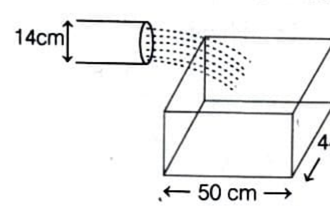
and volume of hemisphere $= \frac{2}{3}\pi r^3 = \frac{2}{3}\pi k^3$

Total volume of solid $= \pi k^3 + \frac{1}{3}\pi k^3 + \frac{2}{3}\pi k^3$

$= \pi k^3 + \pi k^3 = 2\pi k^3$ cm^3 ...(ii)

From Eqs. (i) and (ii), we get

The volume of solid = 2 × Volume of cylinder

41. 

Given, diameter of cylindrical pipe = 14 cm

⇒ Radius of cylindrical pipe (r) = 7 cm

Also, length of the pond (l) = 50 m,

Breadth of the pond (b) = 44 m,

Height of the water level in the pond (h) = 21 cm

Let t h be the time taken to raise the level of water by 21 cm.

Length of the water column in t h = $(15 \times t)$ km

$= 15000\, t$ m^3

Volume of water column that come out from cylindrical pipe in t h

$$= \pi \times \left(\frac{7}{100}\right)^2 \times 15000\, t$$

$\therefore$ Volume of water column

= Volume of cuboid with height h

$$\Rightarrow \pi \times \left(\frac{7}{100}\right)^2 \times 15000\, t = 50 \times 44 \times \frac{21}{100}$$

$$\Rightarrow \quad \frac{22}{7} \times \frac{7^2}{10} \times 15t = 22 \times 21$$

$$\Rightarrow \quad 7 \times 15t = 210 \Rightarrow t = 2h$$

Hence, in 2 h, level of water in pond rise by 21 cm.