

Master Lesson Plan

for

Surface Areas and Volumes

Board	Standard	Subject	Chapter	Language
NCERT	STD IX	Mathematics	Surface Areas and Volumes	English

CURRICULAR GOALS	CG-5: Derives and uses formulae to calculate areas of plane figures, and surface areas and volumes of solid objects
COMPETENCIES AS PER NCF/NIPUN BHARAT	C-5.2: Visualises and uses mathematical thinking to discover formulae to calculate surface areas and volumes of solid objects (cubes, cuboids, spheres, hemispheres, right circular cylinders/cones, and their combinations
SDG(Sustainable Development Goals)	SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Technology aids	PPTs and Worksheets
Learning Teaching Materials (LTM)	A cone and the sector of a circle, Coconut shell, spherical lemon/onion (2), knife
Inter-disciplinary Connections	The surface tension topic of physics is related with surface area of sphere through an interesting aside
Cross-Cutting Themes	Values and Dispositions: VC_Choose Your Thoughts Technology in Education: PowerPoint Presentations

MS_Objectives-Surface Areas and Volumes

Objective: Teacher will be able to get an overview of the Asset objectives in the MLP of the chapter Surface Areas and Volumes.

[Notes to the teacher: This asset lays down the proposed plan for transacting this chapter. It states asset objectives of the MLP. This asset is for teacher's reference and need not be taught to the students]

The students will be able to

- relate to solid figures in the real world and appreciate the connection between plane figures and solids
- explain the concept of the curved surface area of a cone
- demonstrate that the surface area of a sphere is four times the area of a circle with the same radius
- explain the formula for curved and total surface area of a hemisphere
- solve the questions related to the surface area of combined shapes
- appreciate the interplay of surface tension (physics) and surface area of sphere (maths) in nature
- explain the formula for volume of a cylinder and cone
- infer the relationship between volume of hemisphere and volume of cylinder with diameter and height both equal to the diameter of hemisphere
- solve the questions related to volume of cuboid, cylinder, cone and sphere
- relate Physics and Mathematics through an enjoyable video of how the density of an irregular object can be measured through a non-invasive method
- develop a positive approach to life.

Time to teach	Asset type	Theme	Sub Theme
5 minutes	Main Script	Surface Area & Volume	Curved and Total surface area of a cone Curved and Total surface area of a Cylinder Curved and Total surface area of a sphere Lateral and Total surface area

			Surface area of a combination of solids Volume Volume of (a Cuboid, Cube & Cuboid) Volume of a combination of solids Volume of sphere and hemisphere Volume of right circular cone and cone
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Sri Sathya Sai Central Trust

DD_Planes and Solids

Objective: The students will be able to relate to solid figures in the real world and appreciate the connection between plane figures and solids.

Notes to the teacher: The teacher may introduce the topic by asking the students to list plane figures and solid shapes. Then the teacher may proceed further with the following real-life examples. Some questions, pertaining to each context, have been given. Teachers could elicit answers from the students establishing their connection in daily life contexts and finally leading them on to the importance of having to learn about calculating surface areas and volumes of solid shapes.

A historical masterpiece

The Taj Mahal, a huge white marble mausoleum built by the Mughal emperor Shah Jahan in memory of his deceased beloved wife Mumtaz Mahal, is one of the most famous buildings in the world and one of the main icons of India. Have you ever wondered how this masterpiece with different shapes was created?

[Notes to the teacher: The teacher can ask the students to identify the different solid shapes from the picture of the Taj Mahal.

Ans: Cylinder, cone, hemisphere]

So in design and construction, surface areas have to be known for each shape, so that accordingly, frames can be built, stones can be procured and costs can be estimated.



Tajmahal: commons.wikimedia.org/wiki/File:Taj_Mahal.png
Attribution: Suraj rajiv

Telescope Protection

We use telescopes to view distant objects. As telescopes are usually placed in an open field, we would like to build a tent around it, for protection against direct sunlight and rain.

The question that comes up is

- What size tent should we use, so that the telescope can rotate freely in the tent ?
- What would the tent builder have to know -
 - a) Size of the Telescope
 - b) How much space it would occupy

Right, so he calculates that and then accordingly chooses the dimensions of the tent so that it can hold that.



Telescope images – Original Creation (OC)

Industrial Capacity

We all have cooking gas cylinders in our house. Each new cylinder, when it comes from the distributor, has the same quantity of compressed natural gas. Have you ever wondered

- How does the oil and gas industry manage to fill each cylinder to the same capacity day after day?

- How does the industry determine the total number of cylinders to be filled in a day?
What should be the flow rate of the gas?

You may have watched it on TV or visited some factories. Steel industries, pharma industries, chemical industries, water packaging industries and many others use huge containers, barrels and cauldrons. Industrial processes will require them to know the quantity to be produced and accordingly design and choose the size of the manufacturing equipment.

Photos of a natural gas plant



Plant - flickr.com/photos/129143611@N03/15795187250
Attribution: Kitmondo Marketplace Glycerin Plant Line

So as you have just seen, learning about surface areas and volumes has great relevance in our day to day life right from situations within our home to many more contexts in the real world. Fasten your seatbelts as we take you through this exciting journey through the topic 'Surface Areas and Volumes'.

Time to teach	Asset type	Theme	Sub Theme
5 minutes	Day-to-day Relevance	Surface Area & Volume	Solid figures

MS_Surface area of cone

Objective: Students will be able to explain the concept of the curved surface area of a cone.

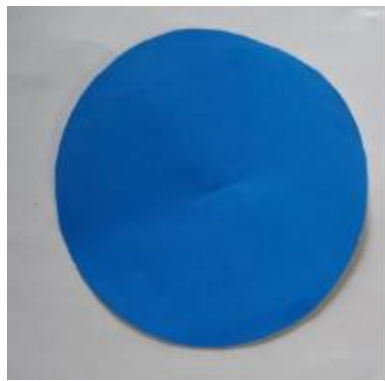
Teaching Aids: PPT

Teaching Learning Material (TLM): A cone and the sector of a circle

What do you need?: Two sheets of thick coloured paper, compass, scissor, sellotape

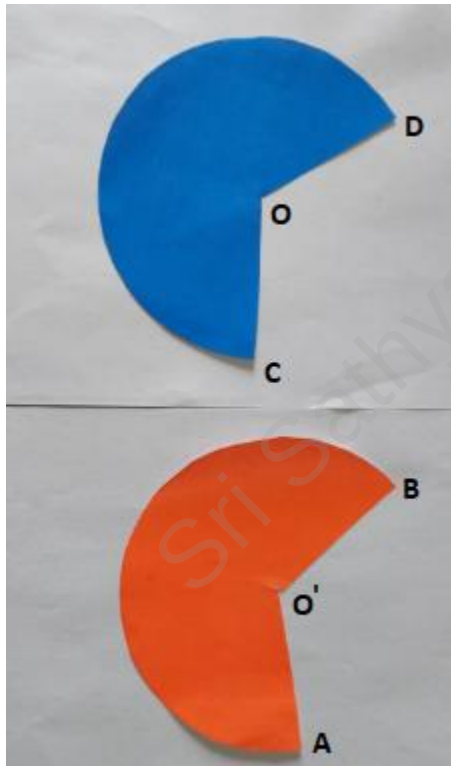
Get ready:

1) Cut two circles of radius 10 cm as shown in the figure.



Source: Self clicked photos - OC

2) In both circles mark sectors of angle 120° and cut minor sectors as shown in the figure.



Source: Self clicked photo - OC

Notes to the teacher: The teacher starts the class by asking any two students to come forward and gives the following instructions to make a cone using one of the two sectors.

1) Choose any one sector say $AO'B$

2) Bring one cut end AO' of the sector over to the other end BO' in a cone shape.

3) Hold the two edges together and make sure that the lower ridge of both sides overlap evenly and tape the two sides.



With this, the sector takes the desired cone shape.

Source: Self clicked - OC

[Notes to the teacher: The teacher may explain the parts of the cone using the TLM as follows.]

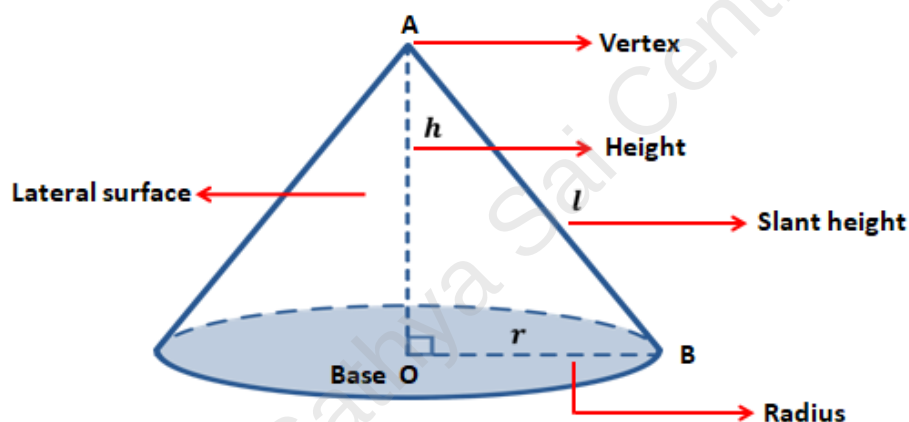


Image Source: Cone: pixabay.com/vectors/cone-solid-rectangular-symmetry-148003/

Attribution: OpenClipart-Vectors

Surfaces and vertex: A right circular cone has two surfaces, a flat circular base and a curved lateral surface. The curved lateral surface meets at a point called the vertex of the cone. In the figure above, A is the vertex of the cone.

Radius: The radius of the circular base is called the radius of the cone. In the figure, O is the centre and OB is the radius of the base. The length of the segment OB is the radius of the cone and is denoted by r .

Height: The distance from the vertex to the centre of the circular base is called height of the cone and is denoted by h .

In the figure, AO is the height of the cone.

Slant height: The distance from the vertex to any point on the circumference of the base is called slant height of the cone, denoted by l . In the figure, AB is the slant height of the cone.

Using Pythagoras theorem, l , h and r are related by $l^2 = h^2 + r^2$

[Notes to the teacher: The teacher can start the class by showing the cone prepared and the remaining sector of the circle of radius 10 cm with central angle 120° and explains that the sector of same size and shape is used to make the cone. Then she may pose the following questions.]

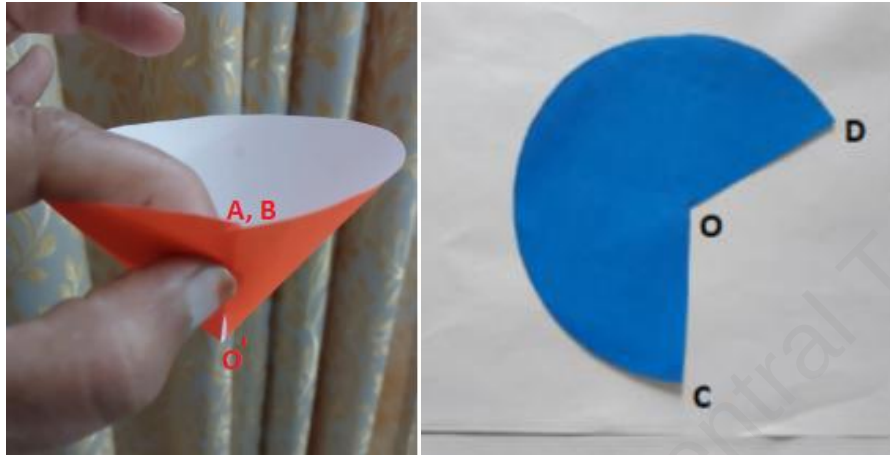


Image Source: Orange Cone: Self clicked - OC

Blue Image: Created using PPT shapes

What is the circumference of the base of the cone?

Expected answer: The circumference of the base of the cone is the length of the arc CD in major sector COD .

If radius of the cone is r , then what is the length of arc CD in major sector COD ?

Expected answer: Length of arc CD is circumference of the base of the cone $2\pi r$.

Can you relate lateral surface area of the cone to the area of sector (major) COD ?

Expected answer: Lateral surface area of the cone is equal to the area of the major sector COD .

When you prepare a cone using sector COD , what is the distance of any point on arc CD from the centre O ?

Expected answer: The distance of any point on arc CD from the centre O is equal to the slant height or lateral height l of the cone.

Lateral surface area of a cone:

[Notes to the teacher: The teacher can explain, the lateral surface area of the cone is equal to the area of the sector COD . So, let us find the area of sector COD as follows]

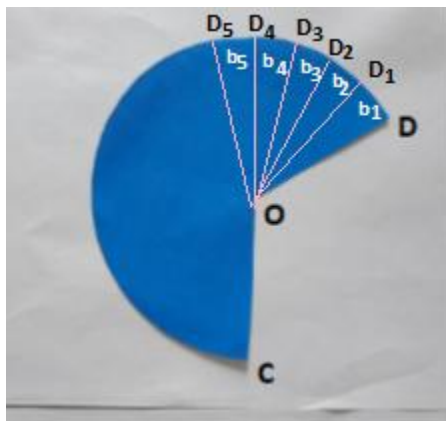


Image Source: OC

Cut sector COD into hundred or thousand small sectors of arc lengths $b_1, b_2, b_3, \dots$

When the number of sectors increase, every sector can be considered as an isosceles triangle

Consider the first sector DOD_1

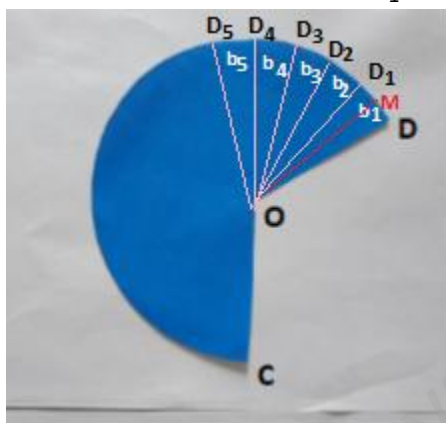


Image Source: OC

The area of sector DOD_1 is almost equal to the area of $\triangle DOD_1$

The area of $\triangle DOD_1 = \frac{1}{2} \times b_1 \times OM$ where OM is the height of the triangle.

But the height OM is equal to lateral height l of the cone.

Thus, the area of sector $DOD_1 = \frac{1}{2} \times b_1 \times l$

Similarly, the area of sector $D_1OD_2 = \frac{1}{2} \times b_2 \times l$

The area of sector $D_2OD_3 = \frac{1}{2} \times b_3 \times l$ and so on.

The area of sector COD

= the area of sector DOD_1 + the area of sector D_1OD_2 + the area of sector D_2OD_3 =

$$\frac{1}{2} \times b_1 \times l + \frac{1}{2} \times b_2 \times l + \frac{1}{2} \times b_3 \times l \dots$$

$$= \frac{1}{2} l (b_1 + b_2 + b_3 + \dots) \quad (1)$$

But $b_1 + b_2 + b_3 + \dots =$ Length of arc $CD =$ circumference of the base of the cone, $2\pi r$.

Thus, the area of sector $COD = \frac{1}{2} l \times 2\pi r = \pi r l$

Total Surface area of a cone:

[Notes to the teacher: The teacher may pose the following leading questions to obtain a formula to find the total surface area of the cone]

How many surfaces does a cone have?

Expected answer: A cone has two surfaces, a flat circular base and a curved lateral surface

What is the lateral surface area of a cone?

Expected answer: The lateral surface area of a cone is $\pi r l$ where r is its base radius and l is its slant height.

What is the area of the circular base?

Expected answer: The area of the circular base is πr^2

What is the total surface area of the cone?

Expected answer: The total surface area of the cone = Area of the circular base + its lateral surface area = $\pi r^2 + \pi r l = \pi r(r + l)$

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Main Script	Surface Area & Volume	Curved and Total surface area of a cone Lateral and Total surface area Right circular cone

QA_Cylinder Cone Surface Area

Objective: Students will be able to solve questions related to curved and total surface area of cylinder and cone.

Teaching Aids: Worksheet

I. Choose the correct answer

1. If the radius of the cylinder is doubled and height is halved, then the curved surface area of the cylinder will

a) Increase b) Decrease c) Remain same d) none

2. Total surface area of a cone is

a) $\pi r l + 2\pi r^2$ b) $\pi r (l + r)$ c) $2\pi r l + \pi r^2$ d) None

3) Total surface area of a cylinder is

a) $2\pi r(r + h)$ b) $2\pi r h$ c) $2\pi r l$ d) none

Answers:

1) c

Curved surface area of the cylinder = $2\pi r h$

If the radius of the cylinder is doubled and height is halved, then the curved surface area of the cylinder

$$= 2\pi \times 2r \times \frac{h}{2} = 2\pi r h$$

2) b

3) a

II. Answer the following questions

1. Find the total surface area of a cylinder of radius 7 cm and height 14 cm.

Solution:

Radius of the cylinder = 7 cm

Height of the cylinder = 14 cm

Total surface area of the cylinder = $2\pi r (r + h)$

$$= 2 \times \frac{22}{7} \times 7(7 + 14) = 924 \text{ cm}^2$$

2. Curved surface area of a right circular cylinder is 440 cm^2 and radius of the base of the cylinder is 10 cm , find its height.

Solution:

Radius of the base of the cylinder = 10 cm

Curved surface area of a right circular cylinder = $2\pi rh = 440 \text{ cm}^2$

$$\Rightarrow 2 \times \frac{22}{7} \times 10 \times h = 440$$

$$\Rightarrow h = 7 \text{ cm}$$

The height of the right circular cylinder is 7 cm .

3) The height of a cone is 16 cm and its base radius is 12 cm . Find the curved surface area of the cone (Use $\pi = 3.14$).

Solution:

Height of the cone = $h = 16 \text{ cm}$

Base radius of the cone $r = 12 \text{ cm}$

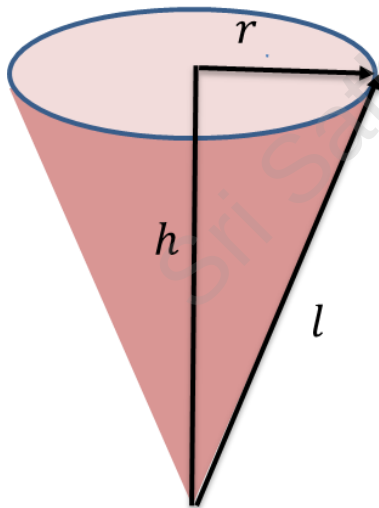


Image Source: Using PPT shapes

By applying Pythagoras Theorem, $l^2 = h^2 + r^2$

$$l^2 = 16^2 + 12^2 = 400$$

$$l = \sqrt{400} = 20 \text{ cm}$$

So, curved surface area of the cone = $\pi r l = 3.14 \times 12 \times 20 \text{ cm}^2 = 753.6 \text{ cm}^2$

4. The curved surface area of a right circular cylinder of height 14 cm is 110 cm^2 . Find the diameter of the base of the cylinder.

Solution:

Height of the cylinder $h = 14 \text{ cm}$

Curved surface area of cylinder = 110 cm^2

Diameter of cylinder $d = 2r$

The curved surface area of cylinder = $2\pi r h = \pi d h = 110 \text{ cm}^2$

$$\pi \times d \times 14 = 110$$

$$\frac{22}{7} \times d \times 14 = 110$$

$$d = 2.5 \text{ cm}$$

The diameter of the cylinder is 2.5 cm.

III. A metal pipe is 140 cm long. The inner diameter of a cross-section is 6 cm, the outer diameter being 7 cm. Find its

(i) inner curved surface area

(ii) outer curved surface area

(iii) total surface area

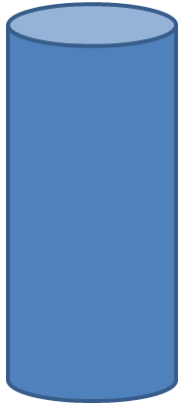


Image Source: Using PPT shapes

Solution:

(i) Length of the metal pipe = 140 cm.

Given inner diameter of cross-section = 6 cm

Radius of inner cross-section = $\frac{6}{2} = 3$ cm

Inner curved surface area of the metal pipe = $2\pi rh = 2 \times \frac{22}{7} \times 3 \times 140 = 2 \times 22 \times 3 \times 20 = 2640$ cm²

(ii) Length of the metal pipe = 140 cm,

Outer diameter of pipe = 7 cm

Outer radius of the pipe = $\frac{7}{2} = 3.5$ cm

Outer surface area of the metal pipe =

$$= 2\pi rh = 2 \times \frac{22}{7} \times 3.5 \times 140$$

$$= 44 \times 3.5 \times 20 = 3080 \text{ cm}^2$$

(iii) Total surface area of the metal pipe is equal to the sum of inner curved surface area, outer curved surface area and area of two edges of the pipe.

Area of circular rings at top and bottom of the pipe = 2 (Area of the outer circle – area of the inner circle)

$$= 2(\pi R^2 - \pi r^2) = 2\pi(R^2 - r^2)$$

$$= 2 \times \frac{22}{7} (3.5^2 - 3^2)$$

$$= 20.42 \text{ cm}^2$$

Total surface area of the pipe = Inner curved surface area + Outer curved surface area + Area of two circular edges of the pipe.

$$= 2640 + 3080 + 20.42 = 5740.42 \text{ cm}^2$$

IV. The slant height and base diameter of a cone are 15 m and 14 m respectively. Find the cost of whitewashing its curved surface at the rate of Rs. 110 per 100 m²

Solution:

Slant height of the cone = $l = 15 \text{ m}$

Diameter of the cone = 14 m

Radius of the cone = $\frac{14}{2} = 7 \text{ m}$

Curved surface area of cone = $\pi r l = \frac{22}{7} \times 7 \times 15 = 330 \text{ m}^2$

Cost of whitewashing 100 m² area = Rs. 110

Cost of whitewashing 1 m² area = $\frac{110}{100} = \text{Rs } 1.1$

∴ Cost of whitewashing 330 m² area = $1.1 \times 330 = \text{Rs. } 363$

V. What length of tarpaulin 4 m wide will be required to make a conical tent of height 12 m and base radius 5 m? Assume that the extra length of material that will be required for stitching margins and wastage in cutting is approximately 20 cm. (use $\pi = 3.14$)

Solution:

Let r , h and l be the radius, height and slant height of the tent, respectively.

Height (h) of conical tent = 12 m

Radius (r) of base of tent = 5 m

Slant height (l) of tent = $\sqrt{r^2 + h^2} = \sqrt{5^2 + 12^2} = 13$

Curved Surface area of conical tent = $\pi r l = (3.14 \times 5 \times 13) \text{ m}^2$

= approximately 204 m²

Let the length of tarpaulin sheet required be $L \text{ m}$.

Length of material that will be required for stitching margins and wastage in cutting is 20 cm

(or 0.2m)

So, the actual length of material used will be $(L - 0.2 \text{ m})$.

Width of tarpaulin = 4 m

Area of sheet = Curved Surface Area of the tent

$$[(L - 0.2) \times 4] \text{ m}^2 = 204 \text{ m}^2$$

$$L - 0.2 = 51$$

$$L = 51.2 \text{ m.}$$

The length of the required tarpaulin sheet will be 51.2 m .

VI. A metallic toy is in the shape of a cylinder whose top is conical as shown in the figure.

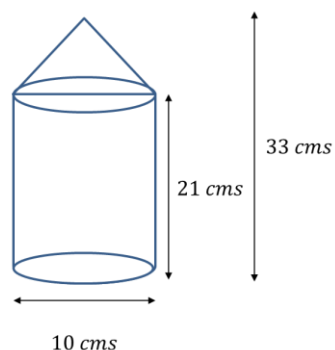


Image Source: Using PPT shapes

The diameter of the base of the cylinder is 10 cm and its height 21 cm . The total height of the toy is 33 cm . Find the cost of silver plating the lateral surface of the toy at the rate Rs 20 per 100 cm^2 .

Solution:

Total height of the toy = 33 cm

Height of the cylindrical part = 21 cm

Height of the conical part = $33 - 21 = 12 \text{ cm}$

Diameter of base of cylinder = 10 cm

$$\text{Radius} = \frac{10}{2} = 5 \text{ cm}$$

$$\text{Curved surface area of the cylinder} = 2\pi rh = 2 \times \frac{22}{7} \times 5 \times 21 = 660 \text{ cm}^2$$

$$\text{Slant height of the cone} = \sqrt{r^2 + h^2} = \sqrt{5^2 + 12^2} = 13 \text{ cm}$$

$$\text{Curved surface area of the cone} = \pi rl = \frac{22}{7} \times 5 \times 13 = 204.28 \text{ cm}^2$$

Area of silver plating used = CSA of conical part + CSA of cylindrical part = $\pi r l = \frac{22}{7} \times 5 \times 13 = 204.28 + 660 = 864 \text{ cm}^2$

Cost of 100 cm^2 silver plating = ₹ 20

Cost of 864.28 cm^2 silver plating = $(20 \times 864.28) \div 10 = ₹ 172.85$.

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Questions to Assess	Surface Area & Volume	Surface area of a combination of solids

SA_Surface area of sphere

Objective: Students will be able to demonstrate that the surface area of a sphere is four times the area of a circle with the same radius.

Teaching Aids: PPT

Aim: To derive the formula for surface area of a sphere from the area of a circle through an activity.

Resources Required: Each student team will require the following resources for this activity.

- Tennis ball - 1
- Divider - 1
- A4 size sheet of paper - 2
- Measuring scale 15cm - 1
- Nail/Pin - 2
- Thread roll - 1
- Craft glue - 1
- Pair of scissors - 1

Setting for the Activity: Indoor

Type of Activity: Hands-on activity

Preparation of Activity: Please ask the student teams to bring the resources required for the activity. The activity can be done in teams with a maximum of four students to enable active participation of all team members.

Role of the Teacher: Facilitator and Observer

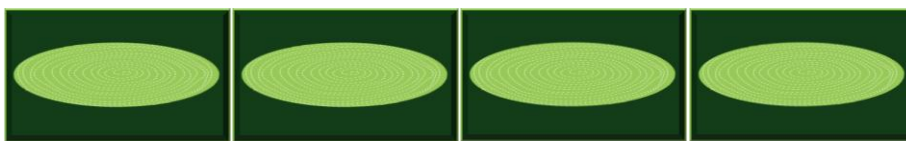
Procedure:

1. Measure the diameter of the ball using a divider.
2. Draw a horizontal straight line on the paper of the same length as the length measured by the divider.
3. Construct a circle with the horizontal line as the diameter.
4. Similar to step 3, construct 3 more circles of the same diameter.
5. Place a nail/pin at the top of the ball as shown.



Image Source: Tennis ball: pixabay.com/vectors/tennis-ball-yellow-sport-game-2025095/
Attribution: OpenClipart-Vectors
Pin: pixabay.com/illustrations/bug-marker-pen-pointer-brooch-2997212/
Attribution: cripi

6. Tie one end of the thread to the nail/pin.
7. Paste glue on the surface of the ball. We need to remove the thread later; so a little glue would be fine to hold the thread for the time being.
8. Keep rolling the thread around the pin until the entire circumference of the ball is covered by the thread.
9. Similar to step 5, use a nail at the bottom to ensure the thread covers the entire surface of the ball.
10. Once the thread covers the entire surface of the ball, cut the rest of the thread from the roll.
11. Paste glue inside the circles drawn in step 4.
12. Now, remove the thread from the ball and start placing the thread along the circumference, moving inside the circles drawn in step 4.
13. Complete filling the thread in each circle as shown



Thread Circles: [freepik.com/free-vector/multicolored-circles-background-template_714850.htm](https://www.freepik.com/free-vector/multicolored-circles-background-template_714850.htm)
 Attribution: freepik

Observation: Students note that the entire thread covering the surface of the sphere (ball) was enough to cover the four circles.

Follow-up activity:

Deriving the formula for surface area of sphere

Diameter of circle = Diameter of sphere

$\therefore$ Surface area of sphere = $4 \times$ Area of circle

If the diameter of the circle = D and radius $\frac{D}{2} = r$

$\Rightarrow$ **Surface area of sphere = $4\pi r^2$**

Conclusion: Students will be able to appreciate the relevance of the formula of surface area of a sphere through this activity.

Precautions: Use of nails, scissors and glue to be done under strict supervision of the teacher and in a safe environment.

Troubleshooting: The teacher should bring at least a set of resources for those students who don't have.

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Suggested Activity	Surface Area & Volume	Surface area of sphere

MS_Surface area of hemisphere

Objective: Students will be able to explain the formula for curved and total surface area of a hemisphere.

Teaching aids: PPT/TLM

Teaching Learning Material (TLM): Coconut shell, spherical lemon/onion (2), knife

Get Ready: Cut one lemon/onion into two equal halves.



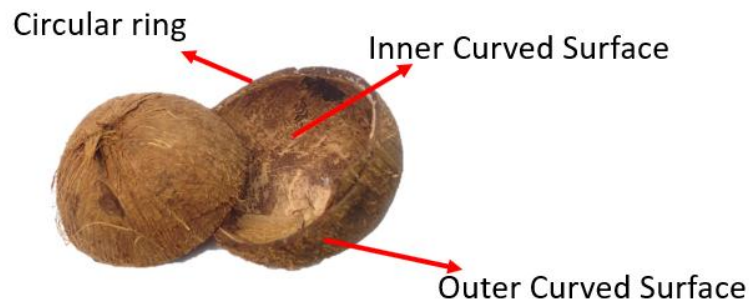
Coconut Shell - pixabay.com/photos/shell-coconut-coconut-shell-half-341565/ - Attribution: DMead

Lemon - pixabay.com/photos/lemon-fruit-vegetable-2121307/ - Attribution: varintorn

Onion - pixabay.com/photos/bulb-closeup-close-up-clove-color-1238341/ - Attribution: Shutterbug75

Notes to the teacher: Teacher may start the class by showing the coconut shell and asking the following questions to the students to help them understand the surfaces obtained when a hollow sphere is cut into two halves. Then she may give the conclusion.

How many surfaces do you get when a coconut shell (hollow sphere) is cut into two halves?
Can you identify them?



Coconut Shell - pixabay.com/photos/shell-coconut-coconut-shell-half-341565/ - Attribution: DMead

Expected answer: Two or three depending on whether students identify the ring of coconut shell between the curved surfaces. The teacher asks followup questions to help students understand the different surfaces.

Conclusion: When a hollow sphere is cut into two parts, you will get two curved surfaces and an extra plane surface, a circular ring between the curved surfaces.

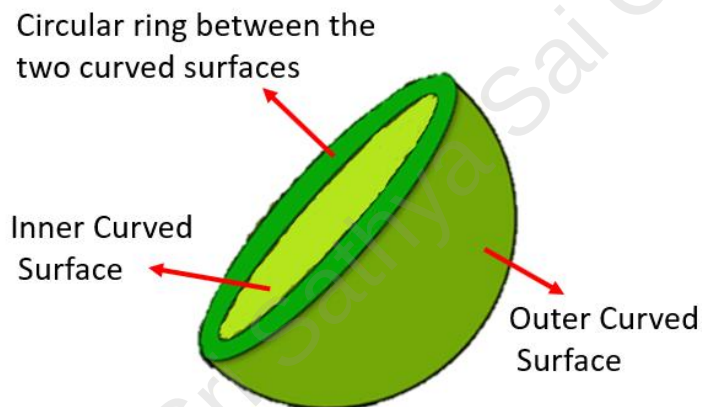
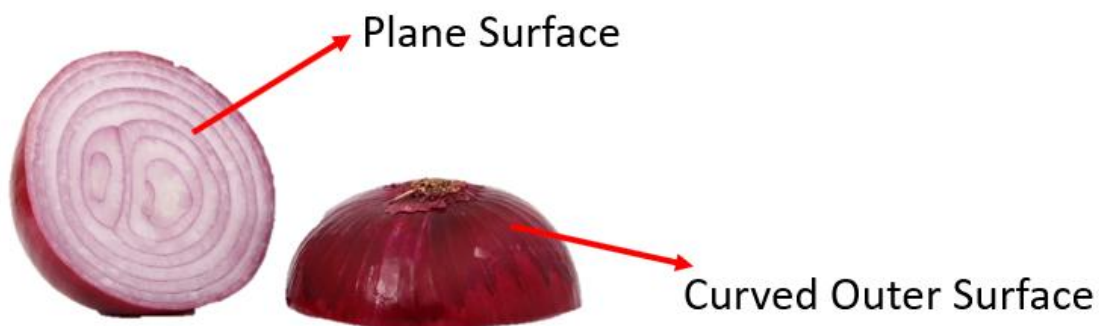


Image: OC

Hemisphere of a solid sphere:

[Notes to the teacher: The teacher may show the hemisphere obtained by cutting the spherical shape (onion/lemon) into two equal halves and ask the following questions]



Onion - pixabay.com/photos/bulb-closeup-close-up-clove-color-1238341/ - Attribution: Shutterbug75

What is the radius of the hemisphere obtained?

Expected answer: We obtained this hemisphere by cutting the solid sphere straight through the middle OR along a plane passing through the origin. Thus, the radius of the hemisphere is equal to the radius of the sphere, r .

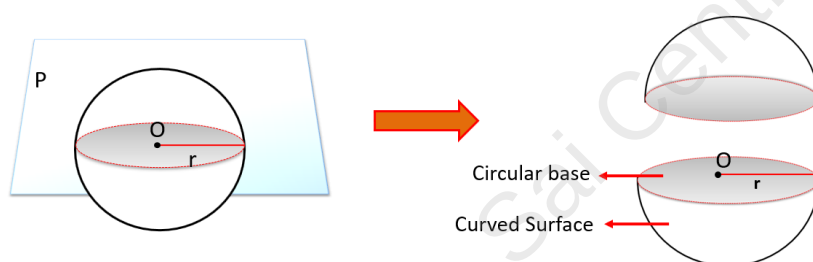


Image: OC

How many surfaces do we get when we cut a solid sphere?

Expected answer: 2. One curved surface and a circular plane surface (base).

What is the curved surface area of the hemisphere?

[Notes to the teacher: The teacher may show the spherical onion/lemon (whole sphere) and give the following hint. Imagine that the radius of this sphere is r . If you peel this onion, its surface area is the measure of the peel. Now the teacher may show the halve of the onion and explain, the curved surface area of this hemisphere is the area of the peel of half onion.]

Expected answer: The surface area of a sphere is $4\pi r^2$.

The curved surface area of the hemisphere is the area of half of the surface area of a sphere. Hence the curved surface area of hemisphere is $2\pi r^2$.

What is the area of the base of the hemisphere?

Expected answer: The base of the hemisphere is a circle of radius r . Thus area of the base is πr^2 .

What about the total surface area (TSA)?

The total surface area of the hemisphere = Curved surface area + base area or area of plane surface.

$$= 2\pi r^2 + \pi r^2 = 3\pi r^2$$

Did you know that the Great Stupa at Sanchi is a hemispherical dome with a cuboidal structure mounted on it?



Sanchi Stupa - flickr.com/photos/azwegers/9840063416 - Attribution to Arian Zweegers

If the radius of the hemispherical dome is 14 m find the area of cloth required to cover the hemispherical dome.

Suggested answer:

The radius of the hemisphere $(r) = 14\text{ m}$

The area of cloth required to cover the hemispherical dome = $2\pi r^2 = 2 \times \frac{22}{7} \times 14 \times 14 = 1232\text{ sq m}$

Time to teach	Asset type	Theme	Sub Theme
10 minutes	Main Script	Surface Area & Volume	Curved and Total surface area of a sphere

QA_Area sphere hemisphere

Objective: Students will be able to solve the questions related to the surface area of combined shapes.

Teaching Aids: Worksheet

Notes to the teacher: Teacher may present the questions and allow the students to write or say the answers before revealing them.

I) Choose the correct answer

1) Surface area of a sphere of radius 'r' is given by _____

a) $2\pi r^2$

b) $3\pi r^2$

c) πr^2

d) $4\pi r^2$

Solution: d) $4\pi r^2$

2) Curved surface area of hemisphere of radius 'r' is equal to _____

a) $2\pi r^2$

b) πr^2

c) $3\pi r^2$

d) $4\pi r^2$

Solution: a) $2\pi r^2$

3) Total surface area of a hemisphere of radius 'r' is equal to _____

a) $2\pi r^2$

b) $4\pi r^2$

c) $3\pi r^2$

d) πr^2

Solution: c) $3\pi r^2$

4) The surface areas of two spheres are in the ratio of 4: 9. The ratio of their volumes is

a) 4:3

b) 32:64

c) 8:27

d) 16:9

Solution: c) 8:27

Explanation:

Given information

The surface area of two spheres are in the ratio of 4:9

Formula used

Surface area of sphere = $4\pi r^2$

Volume of sphere = $\frac{4}{3}\pi r^3$

Calculation

Let the radius of the first sphere = R

The radius of second sphere = r

Ratio of surface areas of spheres = $\frac{4\pi R^2}{4\pi r^2} = \frac{R^2}{r^2} = \frac{4}{9}$

From the above,

Thus, the ratio of volumes of the spheres = $\frac{\frac{4}{3}\pi R^3}{\frac{4}{3}\pi r^3} = \frac{R^3}{r^3} = \left(\frac{2}{3}\right)^3 = \frac{8}{27}$ ■

5) If the diameter of a sphere is doubled, how does its surface area change?

- a) It increases two times
- b) It increases three times
- c) It increases four times
- d) It increases eight times

Solution: c) It increases four times

Explanation:

Given information

Diameter of a sphere is doubled

Formula used

Surface area of sphere = $4\pi r^2$

Calculation

Let the initial and final radius of the sphere be r and R

From the given information, $\frac{r}{R} = \frac{1}{2}$

Ratio of the areas = $\frac{4\pi r^2}{4\pi R^2} = \frac{r^2}{R^2} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$ ■

Thus, surface area increases by four times.

II) The radius of a hemisphere is ' r ' cm. A cylinder of the same radius is placed on the top of the hemisphere. If the height of the cylinder is equal to its radius, and the total height of the shape is 21 cm,

- a) Find ' r '
- b) Find the curved surface area of the shape
- c) If the shape has a circular top of same radius, find its total surface area

Solution:

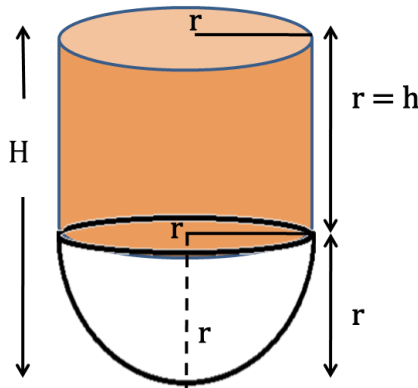
Given information

Radius of hemisphere = Radius of cylinder = r cm

Cylinder is placed on top of the hemisphere

Height of the cylinder = $h = r \text{ cm}$

Total height = $H = h + r = 2r = 21 \text{ cm}$



Formula used

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

Curved surface area of cylinder = $2\pi r h$

Top area of cylinder = πr^2

Calculation

Part a

From the given information,

$$2r = 21$$

$$r = 10.5 \text{ cm}$$

Thus the radius $r = 10.5 \text{ cm}$

Part b

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

$$\text{Curved surface area of the shape} = 2\pi r^2 + 2\pi r h$$

Since $h = r$, we have

$$\text{Curved surface area of the shape} = 2\pi r^2 + 2\pi r^2 = 4\pi r^2$$

Substituting the value of $r = 10.5 \text{ cm}$ we have,

$$\text{Curved surface area of the shape} = 4\pi r^2 = 4 \times \frac{22}{7} \times 10.5^2 = 1386 \text{ cm}^2$$

Part c

Total surface area of the shape with circular top = Curved surface area of hemisphere + Curved surface area of cylinder + circular base area at the top

$$\text{Total surface area of the shape} = 2\pi r^2 + 2\pi r h + \pi r^2$$

Since $h = r$, this can be simplified since as

$$2\pi r^2 + 2\pi r^2 + \pi r^2 = 5\pi r^2$$

Substituting the value of $r = 10.5 \text{ cm}$ we have,

$$\text{Total surface area of the shape} = 5\pi r^2 = 5 \times \frac{22}{7} \times 10.5^2 = 1732.5 \text{ cm}^2$$

III) The internal and external diameters of a hollow hemispherical vessel are 40 cm and 42 cm respectively. Find the cost of painting its outer and inner curved surfaces (ignore the edge) at the rate of ₹ 1 per 100 cm².

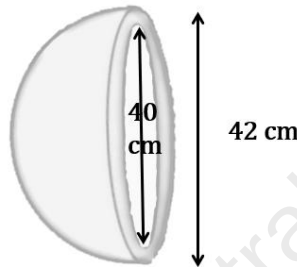
Solution:

Given information

Internal diameter of hollow hemisphere = $d = 40 \text{ cm}$

External diameter of hollow hemisphere = $D = 42 \text{ cm}$

Rate of painting = ₹ 1 per 100 cm²



Formula used

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

Calculation

Internal radius of hollow hemisphere = $r = \frac{d}{2} = \frac{40}{2} = 20 \text{ cm}$

External radius of hollow hemisphere = $R = \frac{D}{2} = \frac{42}{2} = 22 \text{ cm}$

Area to be painted = Outer curved surface area + Inner curved surface area = $2\pi r^2 + 2\pi R^2$

Substituting the values of r and R we have,

Area to be painted = $2\pi r^2 + 2\pi R^2 = 2 \times \frac{22}{7} \times 20^2 + 2 \times \frac{22}{7} \times 22^2 = 5556.6 \text{ cm}^2$

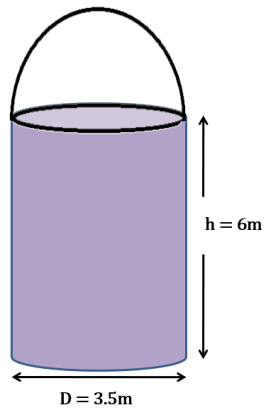
Cost of painting at ₹ 1 per 100 cm² = $\frac{5556.6}{100} \times 1 = ₹ 55.57$

IV) A storage tank consists of a cylinder with a hemispherical top. If the diameter of the cylinder is 3.5 m, and its height is 6 m, find the cost of painting its outside surface at the rate of ₹ 10/m².

Solution:

Given information

Storage tank is in the shape of a cylinder with hemispherical top



Diameter of the cylinder $= D = 3.5 m$

Height of the cylinder $h = 6 m$

Rate of painting $= ₹ 10/m^2$

Formula used

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

Curved surface area of cylinder $= 2\pi rh$

Calculation

Radius of the hemisphere $=$ Radius of the cylinder $= \frac{D}{2} = r = \frac{3.5}{2} = \frac{7}{4} m$

Surface area of the tank $=$ Curved surface area of the cylinder $+$ Curved surface area of the hemisphere $= 2\pi rh + 2\pi r^2$

$$= 2 \times \frac{22}{7} \times \frac{7}{4} \times 6 + 2 \times \frac{22}{7} \times \frac{7^2}{4} = 66 + 19.2 = 85.2 m^2$$

The cost of painting its outside surface at the rate of $₹ 10/m^2 = ₹ 85.2 \times 10 = ₹ 852$

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Questions to Assess	Surface Area & Volume	Curved and Total surface area of a sphere Surface area of a combination of solids Surface area of sphere

IA_Why water drop is spherical

Objective: Students will be able to appreciate the interplay of surface tension (physics) and

surface area of sphere (maths) in nature.

Teaching aids: PPT

Notes to the teacher: Teacher to ask the questions and enable student discussions on possible answers.

Have you observed a water droplet closely? What is its shape?

Expected answer: Spherical.



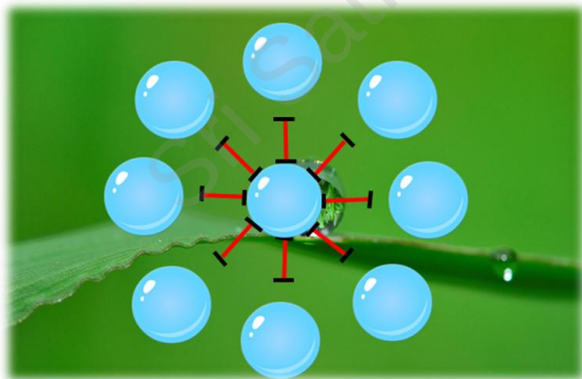
Raindrop: pixabay.com/photos/waterdrop-raindrop-drops-fibers-4335781/ - Attribution: Didgeman

Have you ever wondered why water drops are spherical in shape?

There is a force of attraction called cohesive force, between the molecules of the same substance.

The water molecules on the surface of the drop are pulled towards the inner water molecules, by this cohesive force, resulting in surface tension of the drop.

The surface tension leads the water drop to form a shape with minimum surface area, a sphere.



Leaf drop: pixabay.com/photos/gout-water-herb-rain-nature-wet-2986817/ - Attribution: ju1959jjj

Water Drop: pixabay.com/vectors/water-drop-blue-round-circle-575495/ - Attribution: OpenClipart-Vectors

But why not any other shape?

The surface of water drops behaves like a stretched membrane, trying to cover minimum surface area. A sphere is the most compact shape with minimum surface area for a given volume.

Hence natural objects like bubbles and raindrops tend to have a spherical shape.

Time to teach	Asset type	Theme	Sub Theme
7 minutes	Interesting Asides	Surface Area & Volume	Surface area of sphere

MS_Volume of Cylinder and Cone

Objective: Students will be able to explain the formula for volume of a cylinder and cone.

Teaching aids: Video

Notes to the teacher: The teacher will explain through a combination of blackboard teaching, explanations and interactive demonstration.

Volume of a right circular Cylinder

Notes to the teacher:

Any object that has length, breadth and height is a three-dimensional figure or solid.

The measurement of the total space occupied by a solid is the volume of the solid.

Volume of an object is given by

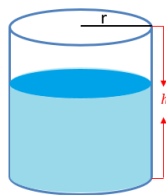
Volume = area of the base $\times$ height

A cylinder has a circular base

Area of the base = πr^2

Volume of a right circular cylinder = $\pi r^2 h$ — equation 1

where r is the radius of the base, h is the height of the cylinder.



Notes to the teacher: The teacher may choose to demonstrate how to measure the volume of a coke can. As an exercise the students can be encouraged to find cylindrical objects at home such as a candle, barrel, beaker, etc. and find the volume.

Capacity: Capacity is defined as the maximum amount of matter an object can hold. Hollow objects that are filled with air or liquid take the shape of the container. The total volume of the air or liquid that is accumulated inside a container is the capacity of the container.

Volume and Capacity:

Volume	Capacity
Solids and hollow objects have volume	Only hollow objects have capacity
Numerically equal to capacity	Numerically equal to volume
cubic unit. For example litres (l), cubic centimetre (cm^3)	cubic unit. For example litres (l), cubic centimetre (cm^3)

Volume of a right-circular cone: The formula for the volume of a cone may be deduced using at least one of the suggested activities below

Suggested Activity

The teacher may assist students to deduce the volume of the right circular cone

- a) showing the attached video demonstration

OR

- b) demonstrating the project below

Project

Materials Required

1. A hollow right-circular cone of known height and base radius
2. A hollow cylinder with open top having the same height and base radius as those of the cone
3. A packet of salt/sand

Procedure

Step 1: Take a hollow right-circular cone of a known height h and base radius r . Also, take a hollow right-circular cylinder of the same height h and base radius r such that it is open at the top and closed at the bottom.

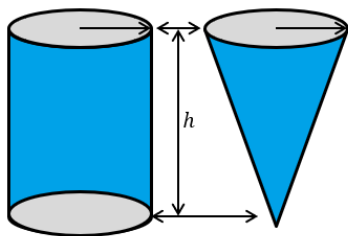


Image Source: PPT shapes

Step 2: Fill the cone with sand up to the brim

Step 3: Empty the cone into the cylinder.

Step 4: Repeat the process till the cylinder is filled.

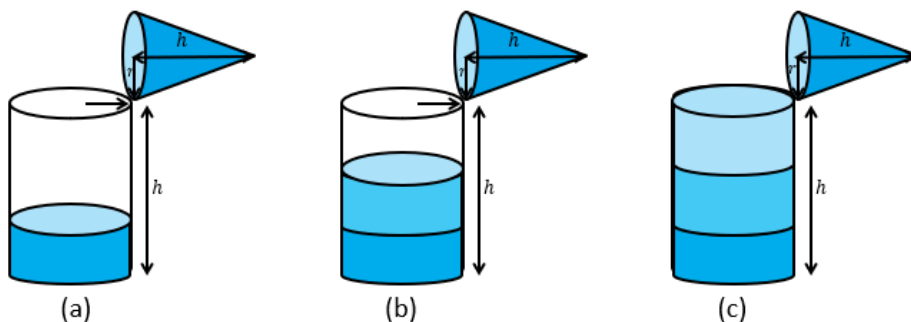


Image Source: PPT shapes

Follow up questions for the students:

How many times did we have to fill and empty the cone into the cylinder, before the cylinder is filled?

Ans: Three times.

Conclusion: For a cylinder and cone of same base radius r and the same height h

Volume of a right circular cone = $\frac{1}{3} \times \text{Volume of a right circular cylinder}$

$$= \frac{1}{3} \times \pi r^2 h \text{ (equation 1)}$$

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

A real-world Problem

A cone shaped grain hopper is 8 m tall and has a radius of 50 cm . It is filled up to the top/brim with wheat. The hopper pours the grain into a cylindrical barrel with diameter 100 cm and height 8 m . How many times will the hopper have to be filled to fill up the cylinder?

If the hopper pours the grain at the rate of $0.6\text{ cubic m/minute}$ how long will it take to fill the barrel?

Radius of the cylinder = Radius of the cone = 0.5 m

Volume of cone = 2.09 m^3

Height of the cone = Height of the cylinder = 8 m

Volume of cone = 2.09 m^3

Volume of cylinder = 6.28 m^3

The cone hopper will have to be refilled 3 times completely fill up the cylinder

To fill 0.6 m^3 the time taken is 60 sec

To fill 6.28 m^3 the time taken = $(60/0.6) \times 6.28$

= 628 sec

= 10.42 min

Time to teach	Asset type	Theme	Sub Theme
30 minutes	Main Script	Surface Area & Volume	Volume

MS_Volume of sphere

Objective: Students will be able to infer the relationship between volume of hemisphere and volume of cylinder with diameter and height both equal to the diameter of hemisphere.

Teaching aids: PPT

[Notes to the teacher: Given a hollow hemispherical bowl, the teacher can measure its diameter and make a cylindrical can with diameter and height both equal to the diameter of the bowl as follows.]

Resources required: a) Thin thread, scale, two sheets of thick coloured paper, pair of scissors, sellotape (to prepare the can)
b) Sand

Step 1: Measure the diameter of the bowl as follows.

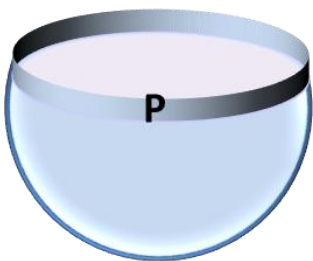


Image - OC

- Wind the thread from a point P on the circumference of the hemisphere.
- The thread ends at a point Q near P where it starts. Make a mark at Q.
- Now unwind the thread and cut it at Q and measure the length l cm of thread PQ using the scale.

[Notes to the teacher: The teacher may ask the students the following question which helps them to calculate the diameter of the hemisphere.

How can you obtain the diameter of the hemisphere using length l of PQ?

Expected answer: If the radius and diameter of the hemisphere are r cm and d cm respectively,

$$l = 2\pi r = \pi d$$

$$d = \frac{l}{\pi} = \frac{l}{\frac{22}{7}} = \frac{7l}{22}$$

Step 2: To make a can with diameter and height both equal to the diameter d of the bowl.

- Take the coloured paper, draw a rectangle ABCD of length $l = \pi d$ cm and breadth d cm on it and cut it along the sides as shown in the figure.

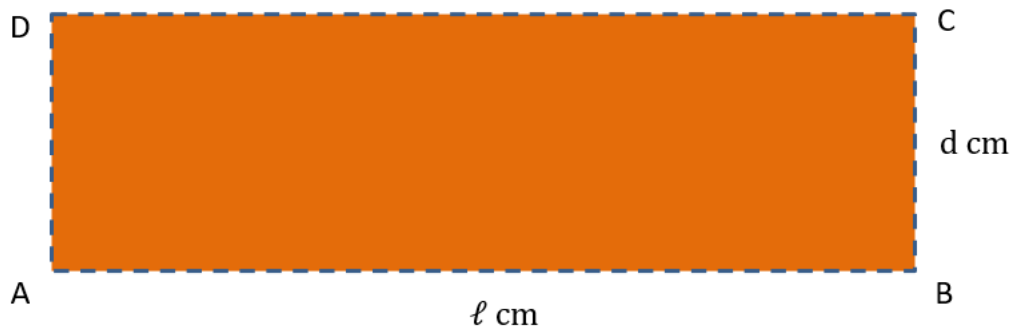


Image:- OC

- b) Curve it along the length AB in such a way that sides DA and CB coincide. Join these sides with the sellotape to get a right circular cylinder.
- c) Take another sheet of paper and draw a circle of radius r cm on it. Cut it along its circumference such that it fits in the bottom of the cylinder.
- d) Cover the bottom of the can with this circle using the sellotape.

The TLMs of a bowl with diameter d cm and a can of height and diameter d cm are ready.

Notes to the teacher: The teacher shows the activity to students prior to deriving the formula for volume of a hemisphere.

The teacher shows the hemispherical bowl and can to the students and explains:

Here is a bowl of diameter d cm.

The diameter and height of this can are equal to the diameter of the bowl, i.e. d cm.

Is there any relation between volumes of these two solid shapes?

Let's find out through this activity.

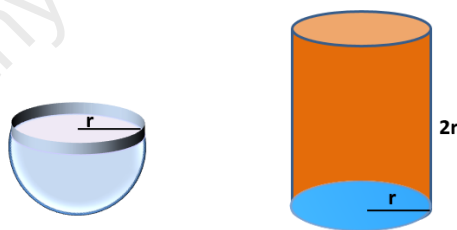


Image - OC

Now let's use this hemispherical bowl to fill the can with sand.

The teacher asks the students to observe how much sand is put in as she keeps pouring in full bowls of sand till the can is full. What did the students notice?

Notice that we need to empty the bowl thrice to fill the can with sand.

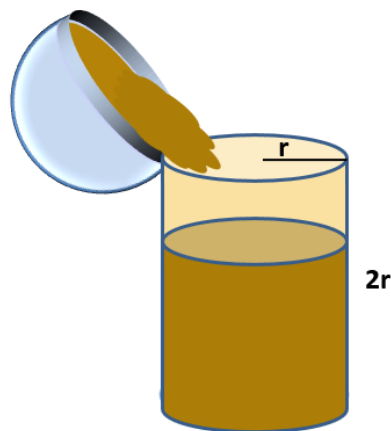


Image - OC

[Notes to the teacher: The teacher may ask the students the following questions to help them derive a formula to find the volume of a hemisphere]

a) From this activity, do you observe a relation between the volume of the hemisphere and volume of the cylinder?

Expected answer: Yes

What is that relation?

3 x Volume of the hemisphere = Volume of the cylinder

b) What is the volume of the cylinder?

Volume of the cylinder = $\pi r^2 h$ with height $h = 2r$

Thus volume of the cylinder = $\pi r^2 \times 2r$
 $= 2\pi r^3$

c) Now can you find the volume of the hemisphere and sphere of radius r ?

3 x Volume of the hemisphere = Volume of the cylinder = $2\pi r^3$

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

$\therefore$ Volume of the sphere = $2 \times \frac{2\pi r^3}{3} = \frac{4\pi r^3}{3}$

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Main Script	Surface Area & Volume	Volume of sphere and hemisphere

QA_Find volume

Objective: Students will be able to solve the questions related to volume of cuboid, cylinder,

cone and sphere.

Teaching Aids: Worksheet

[Notes to the teacher: Teacher may present the questions and allow the students to write or say the answers before revealing them.]

1. I) In the following questions, a statement of Assertion(A) is followed by a statement of Reason(R). Choose the correct option.

1) Assertion(A): If the surface area of the sphere is 2464 cm^2 then the volume is 11498.67 cm^3 .

Reason(R): The formula for the volume of a sphere is $\frac{4}{3}\pi r^3$ and the total surface area is $4\pi r^2$

- a) Both assertion(A) and reason(R) are true and reason(R) is a correct explanation for assertion(A)
- b) Both assertion(A) and reason(R) are true but the reason(R) is not a correct explanation for assertion(A)
- c) The assertion(A) is true but the reason(R) is false.
- d) The assertion(A) is false but the reason(R) is true.

Answer: (b) Both assertion(A) and reason(R) are true but the reason(R) is not a correct explanation for assertion(A)

2) Assertion(A): If the height of a cone is 15 cm and radius of its base is 8 cm then its slant height is 17 cm Reason(R): If height of a cone is h , its radius is r , then its slant height is $\sqrt{h^2 + r^2}$

- a) Both assertion(A) and reason(R) are true and reason(R) is a correct explanation for assertion(A)
- b) Both assertion(A) and reason(R) are true but the reason(R) is not a correct explanation for assertion(A)
- c) The assertion(A) is true but the reason(R) is false.
- d) The assertion(A) is false but the reason(R) is true.

Answer: (c) The assertion(A) is true but the reason(R) is false.

II) The radii of the internal and external surfaces of a hollow spherical shell are 8 cm and 10 cm respectively. If it is melted and recast into a solid cylinder of height 5 cm , what is the diameter of the cylinder?

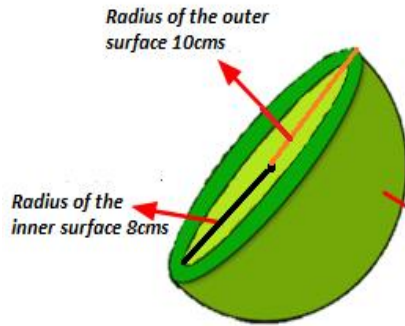


Image source: OC using PPT shapes, MS Paints

Solution: Volume of a hemisphere $\frac{2}{3} \pi r^3$

Volume of the hemispherical shell = Volume of the outer hemisphere – Volume of the inner hemisphere

$$= \frac{2}{3} \pi \times 10^3 - \frac{2}{3} \pi \times 8^3 = \frac{2}{3} \pi (10^3 - 8^3) = \frac{2}{3} \pi \times 488$$

Let radius of the cylinder be r , its height is 5

$$\text{Volume of the cylinder} = \pi r^2 h = \pi r^2 \times 5 = \frac{2}{3} \pi \times 488$$

$$\text{Dividing the equation by } \pi, r^2 \times 5 = \frac{2}{3} \times 488$$

$$r^2 = \frac{\frac{2}{3} \times 488}{5} = 65.06$$

$$r = \sqrt{65} = 8 \text{ approximately.}$$

The diameter of the cylinder = 16 cm approximately.

III) Sanjana is an entrepreneur who makes her own frozen yogurt treats in cone-shaped paper cups. She needs to determine the volume of the frozen yogurt treat in order to properly price her product. Given the radius of the cone-shaped paper cup as 6 cm and the height as 16 cm, what is the approximate volume of the frozen yogurt treat, to the nearest cubic centimetres?



Cone: pixabay.com/vectors/ice-creams-purple-cones-desserts-576743/ - Attribution: OpenClipart-Vectors

Solution: The volume of a cone is one-third the volume of the cylinder with the same radius and height.

Radius $r = 6 \text{ cm}$, Height $h = 16 \text{ cm}$

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

$$\frac{1}{3} \times \frac{22}{7} \times 6^2 \times 16 = 603.42 \text{ cm}^3 \text{ approximately}$$

The volume of the yogurt treat is approximately 603.42 cm^3

IV) The legs of a right triangle are 8 cm and 15 cm . Find the total surface area and the volume of the solid generated when the leg of length 8 cm is revolved about the side 15 cm .

Solution: When the leg of length 8 cm is revolved about the side 15 cm , a right circular cone is generated.

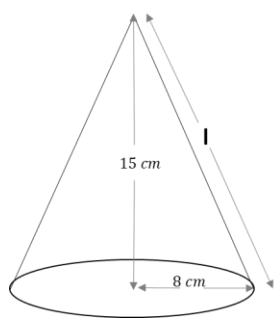


Image source: PPT shapes

The radius of the base equals the length of the side being revolved, which is 8 cm and its height is 15 cm .

Let l be the slant height of the cone.

$$\text{Then, } l^2 = r^2 + h^2$$

$$l^2 = 8^2 + 15^2$$

$$= 289$$

$$l = 17 \text{ cm}$$

$$\text{Total Surface area of the cone} = \pi r^2 + \pi r l$$

$$= \pi \times 8^2 + \pi \times 8 \times 17 = 64\pi + 136\pi$$

$$= 200\pi$$

$$= 200 \times 3.14 = 628 \text{ cm}^2$$

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

$$= \frac{1}{3}\pi \times 8^2 \times 15$$

$$= \frac{1}{3} \times 3.14 \times 64 \times 15$$

$$= 1004.8 \text{ cm}^3$$

V) Imagine you have a large silo with a cylindrical shape that has base radius of 3.5 m and a height of 5.6 m . You want to store bags of rice in the silo, and each bag requires 1.4 m^3 of space. How many full bags of rice can you store in the silo?



Silos: pixabay.com/photos/silo-tanks-blue-sky-blue-heaven-2133890/
Attribution: wolfgangvogt_lb

Solution:

$$r = 3.5\text{ m and } h = 5.6\text{ m}$$

$$\text{Volume of the silo} = \pi r^2 h$$

$$= \frac{22}{7} \times 3.5^2 \times 5.6$$

$$\text{Volume of each bag of rice} = 1.4\text{ m}^3$$

$$\text{No. of bags} = \frac{\text{volume of silo}}{\text{volume of rice bag}} = \frac{\frac{22}{7} \times (3.5)^2 \times 5.6}{1.4} = 154$$

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Questions to Assess	Surface Area & Volume	Volume of a combination of solids Volume of right circular cone and cone

IA_Crown Volume and Density - Sent to MM for Rework

Objective: Students will be able to relate Physics and Mathematics through an enjoyable video of how the density of an irregular object can be measured through a non-invasive method.

Teaching aids: Video

Notes to the teacher: In this chapter we have learnt how to measure the volume of regular objects such as cuboids, cubes, cylinders, cones and spheres.

Have you ever wondered how we would measure the volume of an irregular object such as a crown, ship or a nail?

Let us watch the video IA_Crown Volume and density.mp4, provided as an attachment.

Follow up questions:

1. What method did Archimedes use to calculate the volume of the crown?

Answer: Water displacement method. If the body is completely submerged, the volume of fluid displaced is equal to the volume of the body.

2. Do you think we could apply a similar philosophy to determine the volume of any other irregular object?

Answer: Yes. For example: You could measure the volume of a nail, or spectacles.

Attributions for the MM aids inserted in the Video:

1. Archimedes - maxpixel.net/Archimedes-Antique-Artwork-History-Design-Element -1275880
2. Claw - en.wikipedia.org/wiki/Claw_of_Archimedes#/media/File:Parigi_Griffe.jpg - Giulio Parigi
3. Water clock - commons.wikimedia.org/wiki/File:Water_Clock_%28PSF%29.png - Pearson Scott Foresman
4. Screw - pixabay.com/vectors/physics-archimedes--screw-4776763/ - macetin1975
5. Lever - maxpixel.net/Quarryman-Archimedes-Lever-Worker-148273
6. Balance - pixabay.com/vectors/scales-law-justice-balance-weight-303434/ - Clker-Free-Vector-Images
7. Cube and crown - PPT icons
8. Glass1 - pixabay.com/vectors/water-glass-half-full-drink-empty-305658/ - Clker-Free-Vector-Images
9. Video - youtube.com/watch?v=hUVmCA_eiyA - ARCHEMADIES KA NIYAM By NCERT Official
10. Music - youtube.com/watch?v=q_YSYIajp9U - Manh-Louis NGUYEN (Man

Time to teach	Asset type	Theme	Sub Theme
10 minutes	Interesting Asides	Surface Area & Volume	Volume Volume of a combination of solids

VC_Choose Your Thoughts

Objective: Students will be able to develop a positive approach to life.

Value Connection: Volume of any container is fixed, be it cylindrical or cuboid shaped. A vessel of one litre volume can hold one litre of a liquid and no more. The human mind is similar. The mind is said to be a bundle of thoughts! If we fill our mind with negative thoughts, there will be no room in it for positive thoughts. Self-control essentially guides us as to what thoughts we

choose to place in our mind.

Notes to the teacher: Please narrate the story below and encourage the students to consider the questions that follow. Possible answers given in brackets could help you guide the discussion.

Story:

Samir was sitting pensively staring at a glass of dirty water in front of him. That was his homework for the day! The teacher had asked him to figure out the best way to replace the dirty water in the glass with clean one. As he sat clueless, his younger brother Rohan came in, apparently in a zestful mood. “Hey brother, what seems to be the problem?”

Samir gave his brother a disinterested glance and said, “You wouldn’t understand”.

“Brother, that is not fair. Try me, please”, said his little brother.

Samir looked at him impatiently and said, “My teacher asked me to find out the best way to replace this dirty water with clean water. That is the challenge”.

Rohan was quick to offer a solution: “Pour out the dirty water, rinse the glass and fill it with fresh water! Simple, isn’t it?”

Samir dismissed his brother.

As he was thinking of the problem, Samir was watching their domestic help washing and rinsing clothes in the backyard. As the tap water poured into the bucket, soapy dirty water was flowing out. Eventually, the bucket had only clean water!

That was his Eureka moment; Samir had an answer!!

The next day in the class, Samir was able to give his solution to the teacher.

He told the class, “Look my friends, clean water, as it pours into the glass, displaces dirty water. The water would get cleaner and cleaner as the dirty water gets displaced. In due course, the clean water would have expelled all the dirty water! The glass would then have only clean water.”

The teacher was pleased and praised Samir for coming up with a good solution and added, “Now I would like all of you to think about this and see how it is relevant in our lives. Let us for a moment imagine our mind as the *glass* and our thoughts as the *water* in the glass. Negative thoughts, if any, (thoughts that are pessimistic and create a gloomy picture) could make this *water* dirty. The more we fill it with positive thoughts, the more our mind gets refreshed and renewed.”

Discussion Questions:

1. How can we distinguish between negative thoughts and positive thoughts?

Possible answer:

- positive thoughts reflect love, forgiveness, understanding, empathy and optimism, etc.
 - negative thoughts arise from fear, hatred, mistrust, pessimism, etc.
2. Do you think it is necessary to replace negative thoughts with positive thoughts?

Possible answer:

So long as negative thoughts are to caution us from the dangerous consequences of not following the rules, they can be useful. For example -

- ❖ wearing a helmet while riding a motorcycle (I might get head injury if I don't)
- ❖ wearing the seat belt while in a car (I have to protect myself from road accidents)
- ❖ looking both ways before crossing the street (Else, any vehicle can hit me).

Positive thinking is great, but up to a point. It can prove to be bad if positive thinking makes one unrealistic and carefree. For example -

- ❖ Going for an exam without sufficient preparation, thinking "I am sure I'll do well!"
- ❖ Saying "Nothing will happen" while driving recklessly (which can expose you to grave dangers).

3. Have you ever experienced negative thoughts arising in your mind? If so, how do you handle them?

(All answers are accepted without judgement)

4. Is it possible to replace negative thoughts with positive ones? If so, how?

Possible answer:

Yes, it is possible. Reading good books, watching the right shows, hearing uplifting stories and maintaining right friendships will help.

POINTS TO REFLECT UPON:

"A man is but the product of his thoughts. What he thinks, he becomes." – Mahatma Gandhi
 "Your mind is a powerful thing. When you fill it with positive thoughts, your life will start to change." Anonymous

Time to teach	Asset type	Theme	Sub Theme
12 minutes	Value Content	Peace	Self Control



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Annexure to Master Lesson Plan

What is the purpose of this Master lesson Plan?	This Master Lesson Plan (MLP) prepared by Sri Sathya Sai Vidya Vahini (SSSVV), covers the entire chapter for the given board. The MLP for the chapter given in the textbook is broken down into smaller modules known as assets. Any chapter can be taught using the 7 asset types in SSSVV methodology. Several different assets together complete the entire chapter. Depending on the requirement, each asset is supported by teaching aids such as animated presentation, audio, video, and learning aids such as worksheets. The MLP is for the teacher's preparation and the teaching aids are for use in the classroom.
How to use it?	You can prepare for your class with this MLP by following 3 simple steps: 1. Read your textbook; 2. Go through the information given in the assets (document & multimedia); 3. Prepare your teaching notes. Great! Now you are ready to transact the chapter.
Duration	Kindly note the duration given for each asset. Due care has been taken in planning the assets, to ensure the chapter is completed within the time specified by the Board. Note: Preparation time is not included in the asset duration. The teaching time depends on the duration of the teaching aids and is not impacted by the length of the MLP.
What is a 'Main Script' (MS) Asset?	The Main Script asset is there for explaining the main concepts of the chapter clearly. The information given in the textbook is simplified, organised and structured to give more clarity. Additionally, you may find a video or mnemonics or a graphic organiser to deepen the understanding of the concept.
How to teach using the MS asset?	Please use the blackboard, slides and interaction to develop the concept.
What is an 'Inquisitive Questions' (IQ) asset?	The Inquisitive Questions asset uses questions to promote higher order thinking like the n th why, what-if, new perspectives, cause-effect, and others, creating curiosity.
How to teach using the IQ asset?	You may use the questions to connect with the students, encourage exploration to engage them in the learning process. You may allow multiple responses and instead of rejecting any of the responses, ask why, before revealing the suggested answer or hints.
What is a 'Day to day Relevance' (DD) Asset?	The Day to Day Relevance asset helps students understand the practical relevance of every topic, making them eager participants in the classroom. If students connect the concepts to their environment, they would learn meaningfully without dislike or simply memorizing for exams.
How to teach using the DD	You may use the asset by asking questions about their experience and use it to establish why they are learning the topic. If necessary you may substitute with a

asset?	recent or local example.
What is an 'Interesting Aside' (IA) asset?	The Interesting Aside asset uses attention grabbing tidbits or anecdotes to bring joy and satisfy the child's hunger to know more. This is a quick/short asset intended to bring attention back to the main concept being taught.
How to teach using the IA asset?	You may use this asset to give a piece of interesting information relevant to the topic, without prolonged explanation/discussion. You may suggest appropriate books for further reading.
What is a 'Suggested Activity' (SA) Asset?	The Suggested Activity asset provides a detailed step by step procedure for the teacher to conduct a hands-on activity. This promotes Activity Based Learning.
How to teach using the SA asset?	You may use this asset to energise your students to learn by doing simple, fun-filled activities based on the topic. The asset includes - preparation, activity, and follow-up. You may engage the students in the preparation and follow-up stages to develop collaboration and responsibility. You could try it once, yourself, before the actual delivery to be more comfortable with it. Note: The duration mentioned in the asset is usually for the activity part only.
What is a 'Value Content' (VC) Asset?	The Value Content asset integrates Universal Human Values (such as empathy, inclusivity, respect for nature that translates into responsible behaviour) seamlessly into the curriculum, as the "End of education is character".
How to teach using the VC asset?	You may use this asset to engage with the students to bring out their innate values and connect with the intrinsic values in the topic/concept. The asset includes pointers on the specific pedagogical technique followed.
What is a 'Questions to Assess' (QA) asset?	The Questions to Assess asset uses an interactive approach to check learning of different types of learners, and provides feedback to the teacher for appropriate action. The questions cater to all the levels of Bloom's Taxonomy. Questions from 'Apply' level and above enable students to reflect on their learning.
How to teach using the QA asset?	You may go through the slides to understand its flow and know when to click for the answer (slides include suggested answers). While presenting in the class, you may display the question and encourage multiple responses, before revealing the answer. In some cases, this asset may include extra questions/worksheet that can be given as homework.