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CHAPTER NOTES

Surface Areas and Volumes Class 10 Notes | CBSE Maths Chapter 12

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Hi, I am **Ira**. I teach this syllabus all day, so **Surface Areas and Volumes** is very much my home ground.

Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Surface Areas and Volumes simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Surface Areas and Volumes Class 10 Notes | CBSE Maths Chapter 12

Surface Areas and Volumes is Chapter 12 of CBSE Class 10 Maths. In Class IX you learnt the surface areas and volumes of the basic solids: the cuboid, cube, cylinder, cone, sphere and hemisphere. This chapter uses those same formulas on objects made by joining two of them, such as a capsule (a cylinder with two hemispherical ends), a toy (a cone on a hemisphere), a tent (a cone on a cylinder) or a block with a hollow scooped out of it.

The chapter has two parts: the surface area of a combination of solids, and the volume of a combination of solids. Board questions in this chapter are word problems about everyday objects. You score by spotting which basic solids make up the object, deciding which surfaces stay visible, and then carrying the arithmetic through with the correct value of π and correct units.

Quick Answer - Surface Areas and Volumes

Break every object into basic solids: cuboid, cylinder, cone, sphere, hemisphere. For **surface area**, add only the surfaces that are visible. Surfaces that are joined together disappear, so the total surface area is the sum of the visible surface areas of its parts. For **volume**, join the solids together. Volume of a solid = sum of the volumes of the parts. For surface area add the inner curved surface that was cut.



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All Key Formulas at a Glance

Solid	Curved or lateral surface area	Total surface area	Volume
Cuboid (l, b, h)	$2h(l + b)$	$2(lb + bh + hl)$	lbh
Cube (edge a)	$4a^2$	$6a^2$	a^3
Cylinder (r, h)	$2\pi rh$	$2\pi r(h + r)$	$\pi r^2 h$
Cone (r, h, slant height l)	πrl	$\pi r(l + r)$	$(1/3)\pi r^2 h$
Slant height of a cone	$l = \sqrt{r^2 + h^2}$		
Sphere (r)	$4\pi r^2$	$4\pi r^2$	$(4/3)\pi r^3$
Hemisphere (r)	$2\pi r^2$		
Combined solid: surface area	Sum of t		
Combined solid: volume	Sum of t		



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Key Concepts

1. The Basic Solids and Their Form

Every object in this chapter is built from the basic solids. To handle a toy, a tent or a capsule, you need to know the formulas. Short forms are used throughout the chapter. Curved Surface Area.

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Solid	CSA or lateral surface	TSA	Volume
Cuboid, length l , breadth b , height h	$2h(l + b)$	$2(lb + bh + hl)$	lbh
Cube, edge a	$4a^2$	$6a^2$	a^3
Right circular cylinder, radius r , height h	$2\pi rh$	$2\pi r(h + r)$	$\pi r^2 h$
Right circular cone, radius r , height h , slant height l	πrl	$\pi r(l + r)$	$(1/3)\pi r^2 h$
Sphere, radius r	$4\pi r^2$	$4\pi r^2$	$(4/3)\pi r^3$
Hemisphere, radius r	$2\pi r^2$	$3\pi r^2$	$(2/3)\pi r^3$

Slant height of a cone. The height h , the radius r and the slant height l form a right-angled triangle with l as the hypotenuse. So $l = \sqrt{h^2 + r^2} = \sqrt{169} = 13$ cm. Many questions give h and r .

Where the hemisphere formulas come from. The curved surface area of a hemisphere is half of $4\pi r^2$, that is $2\pi r^2$. A solid hemisphere has a flat circular base. Its area is $2\pi r^2 + \pi r^2 = 3\pi r^2$. Its volume is half of $(4/3)\pi r^3$, that is $(2/3)\pi r^3$.

2. Breaking a Combined Solid into Basic Solids

The NCERT chapter starts with a truck car with a hemispherical dome. A test tube is a cylinder with a hemispherical bottom. The key is to break the combined solid into basic solids. **problem into smaller problems you have solved.**

Step 1: Name the parts. Read the question carefully. Look for words like "hemispherical dome" or "cylindrical body" means placed on top of.

Step 2: Match the shared measurements. Usually the basic solids share the same radius. In the NCERT example, the radius of the hemisphere is the same as the radius of the cylinder.



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Step 3: Split the heights and lengths. The total height of an object is the sum of the heights of its parts. The height of a hemisphere is its radius. So:

- A top 5 cm tall, made of a cone on a hemisphere of radius 1.75 cm, has a cone of height $5 - 1.75 = 3.25$ cm.
- A capsule 14 mm long with diameter 5 mm has two hemispheres of radius 2.5 mm, so its cylindrical part is $14 - 2 \times 2.5 = 9$ mm long.
- A vessel of total height 13 cm made of a hemisphere of diameter 14 cm and a cylinder has a cylinder of height $13 - 7 = 6$ cm.

Step 4: Decide what is asked. Paint, colour, canvas, cloth, polish or sheet metal means surface area. Water, air, juice, syrup, wood, iron or capacity means volume. Once you know this, choose which surfaces or volumes to add or subtract.

3. Surface Area of Solids Joined To

When two solids are joined, the faces that are pressed together disappear from the outside, so they are not part of the surface area. **the surfaces you can still see.**

The tanker (cylinder with two hemispheres). The curved surfaces of the two hemispheres and the curved surface of the cylinder. The two circular ends of the cylinder are covered by the hemispheres and the two circular ends of the cylinder are not visible.

TSA of new solid = CSA of one hemisphere + CSA of cylinder + CSA of other hemisphere

With common radius r and cylinder length h

The toy (cone on a hemisphere). The flat circular base of the cone is pressed together and vanishes. The visible surfaces are the curved surface of the cone and the curved surface of the hemisphere.

TSA of the toy = CSA of hemisphere + CSA of cone

The NCERT text points out that the total surface area is the sum of the surface areas of the cone and the hemisphere. The two circular bases of the cone and the hemisphere are not visible.

A hemisphere on a cube. This case is different. The flat circular base of the hemisphere is pressed together and vanishes. The visible surfaces are the four side faces of the cube and the curved surface of the hemisphere. The top face of the cube is not visible, and the curved surface of the hemisphere is added. So



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Surface area = TSA of cube – base area of hemisphere + CSA of hemisphere = $6a^2 - \pi r^2 + 2\pi r^2 = 6a^2 + \pi r^2$

For a cube of edge 5 cm with a hemisphere of diameter 4.2 cm (NCERT Example 2), this gives $150 + (22/7) \times 2.1 \times 2.1 = 150 + 13.86 = 163.86 \text{ cm}^2$. The greatest hemisphere that fits on a cube of edge a has diameter a.

A cone resting on a narrower cylinder (the rocket). When the base of the cone is wider than the cylinder below it, a ring of the cone's base stays visible. Its area is $\pi r^2 - \pi r'^2$, where r is the cone radius and r' the cylinder radius. The visible parts of the cone are then its CSA plus this ring.

The tent (cone on a cylinder). Canvas covers the curved wall of the cylinder and the curved top of the cone. The base is the ground, so it has no canvas. Canvas area = $2\pi rh + \pi rl = \pi r(2h + l)$.

Object	Visible surfaces	Surface area
Capsule or tanker	2 hemispheres	$2 \times \frac{4}{3}\pi r^2$
Cone on hemisphere (toy, top)	Cone's CSA and hemisphere's CSA	$\pi r^2 + 2\pi rh + 2\pi r^2$
Hemisphere on cube	Cube's TSA minus base area of hemisphere plus hemisphere's CSA	$6a^2 - \pi r^2 + 2\pi r^2$
Tent (open at the ground)	Cylinder's CSA and cone's CSA	$2\pi rh + \pi rl$
Two cubes of edge a joined	A cube's TSA minus two base areas	$10a^2$



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4. Surface Area After Scooping or Drilling

Sometimes a shape is cut out of a solid in such a way that a new surface is created. For example, if you drill a hole through a block, a conical cavity drilled into a cylinder, or a spherical cavity drilled into a sphere, new surfaces are created. This happens when you scoop a cavity out of a solid.

- 1. The flat area of the opening (a circle) is removed.
- 2. The inner curved surface of the cavity is added.

So the surface area of the remaining solid is the original surface area minus the area of the flat opening plus the area of the inner curved surface. This surprises many students.

Hemisphere scooped from a cube face. If the diameter of the hemisphere equals the edge l of the cube, $r = l/2$. Surface area = $6l^2 - \pi r^2 + 2\pi r^2 = 6l^2 + \pi r^2 = 6l^2 + \pi l^2/4 = (l^2/4)(\pi + 24)$.

Conical cavity in a cylinder, same height and same diameter. The top circle of the cylinder is removed completely because the cone base covers it. What remains is the curved surface of the cylinder, its bottom circle, and the inside of the cone. Surface area = $2\pi rh + \pi r^2 + \pi rl$.

Hemisphere scooped from each end of a cylinder. Both circular ends vanish, and two hemispherical hollows appear. Surface area = $2\pi rh + 2 \times 2\pi r^2 = 2\pi r(h + 2r)$.

The bird-bath. NCERT Example 4 describes a cylinder with a hemispherical depression at one end. Its total surface area is taken as CSA of cylinder + CSA of hemisphere = $2\pi rh + 2\pi r^2 = 2\pi r(h + r)$. The depression has the same radius as the cylinder, so no flat ring is left at the top: the curved hollow takes the place of the top circle.

Inner surface area. A hollow vessel has an inside and an outside. When a question asks for the inner surface area, use the inner dimensions. A hollow hemisphere with a hollow top is shaped as a hollow hemisphere with a hollow top. The top is open and has no surface.

5. Volume of Solids Joined Together

The NCERT text makes a clear contrast. For two parts, because some surface disappears when they are joined, the space taken by each part is still inside the combined solid.

Volume of the combined solid = sum of the volumes of the individual solids.



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Object	Volume
Cone on hemisphere, common radius r , cone height h	$(1/3)\pi r^2 h + (2/3)\pi r^3 = (1/3)\pi r^2(h + 2r)$
Cylinder with two hemispherical ends, cylinder length h	$\pi r^2 h + (4/3)\pi r^3$
Cylinder with a cone at each end, cone height h'	$\pi r^2 h + 2 \times (1/3)\pi r^2 h'$
Cuboid with a half cylinder on top (shed)	$l b h + (1/2)\pi r^2 l$
Cylinder on a larger cylinder (iron pole)	$\pi R^2 H + \pi r^2 h$

Two hemispheres make a sphere. In a capsule or a gulab jamun, the two hemispherical ends together have volume $(4/3)\pi r^3$. Writing it this way saves one step.

The half cylinder in a shed. In NCERT Example 5, the diameter is the 7 m width of the shed and h is the length of the shed. Its volume is $(1/2)\pi r^2 h$.

Illustration. A solid is a cone standing on a hemisphere. The radius of the cone equals its radius. Volume = $(1/3)\pi(1)^2 h$.

6. Volume After Removal, Capacity

When part of a solid is removed, or part of a container is used, the same idea appears in several forms.

Remaining material. A wooden pen stand is in the shape of a cuboid with a hemispherical open end. Its volume is $4 \times$ volume of one cone.

Actual capacity. A glass looks like a cylinder with a hemispherical bottom. Its **apparent capacity** is the cylinder volume minus the volume of the raised hemisphere, $(2/3)\pi r^3$.

Space left over. The shed in Example 5 has a hemispherical roof. The workers take up space, so air left = total volume - volume of workers.



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Water left in a container. A solid is lowered into a cylinder full of water. The water that stays equals the cylinder volume minus the volume of the solid, because the solid pushes out (displaces) exactly its own volume of water.

Counting objects. Lead shots dropped into a cone full of water push out water. If one-fourth of the water flows out, the total volume of the shots equals one-fourth of the cone's volume.
Number of shots = volume that flowed out $\div$ volume of one shot.

Difference of volumes. In Example 7 a cylinder circumscribes a toy (the toy fits exactly inside it, touching it). The difference of volumes is the empty space: cylinder volume – toy volume.

Percentages and mass. If syrup fills 30% of a gulab jamun, syrup = $0.3 \times \text{volume}$. If 1 cm^3 of iron has a mass of about 8 g, mass = volume in $\text{cm}^3 \times 8 \text{ g}$.

7. Value of π , Units and Approximation

The exercises say "Unless stated otherwise for the answer "in terms of π ". Use exactly changes with the value of π .

- With $\pi = 22/7$, radii like 7, 3.5, 1.4 or 0.7 end.
- With $\pi = 3.14$, take π out as a common factor: $3.14 \times 20.25 = 63.585 \text{ cm}^2$.
- For an answer in terms of π , leave π as

Units. Convert every length to one unit before. 1.45 m and radius 30 cm, so use 145 cm and



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Quantity	Conversion
Length	1 m = 100 cm, 1 cm = 10 mm
Area	1 m ² = 10,000 cm ²
Volume	1 m ³ = 1,000,000 cm ³
Capacity	1 litre = 1000 cm ³ , 1 m ³ = 1000 litres
Mass	1 kg = 1000 g

Approximation. When a slant height is not a whole number, NCERT rounds it ($\sqrt{13.625} \approx 3.7$ cm in Example 1) and writes “approx.” with the answer. When a question says “to the nearest cm²”, round only the final answer.



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Formula and Theorem Sheet

Situation	Formula
Slant height of a cone	$l = \sqrt{r^2 + h^2}$
Cylinder with two hemispherical ends: surface area	$2\pi rh + 4\pi r^2 = 2\pi r(h + 2r)$
Cylinder with two hemispherical ends: volume	$\pi r^2 h + (4/3)\pi r^3$
Cone on hemisphere: surface area	$\pi rl + 2\pi r^2$
Cone on hemisphere: volume	$(1/3)\pi r^2 h + (2/3)\pi r^3$
Hemisphere on a cube of edge a: surface area	$6a^2 + \pi r^2$
Hemisphere scooped from a cube face: area	
Tent (cone on cylinder, no base): canvas	
Cylinder with hemispherical depression (bath)	
Cylinder with conical cavity of same height and radius	
Hemisphere scooped from each end of a cylinder	
Actual capacity of a glass with raised hemispherical bottom	
Volume of any combined solid	
Number of small objects	



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Important Definitions

- **Combination of solids:** a solid formed by joining two or more basic solids, such as a cylinder with two hemispheres at its ends.
- **Curved Surface Area (CSA):** the area of only the curved part of a solid, leaving out its flat faces.
- **Total Surface Area (TSA):** the area of the whole outer surface of a solid, curved and flat parts together.
- **Lateral surface area:** for a cuboid or cube, the area of the four side faces, leaving out the top and bottom.
- **Volume:** the amount of space a solid occupies, measured in cubic units such as cm^3 or m^3 .
- **Capacity:** the amount a hollow container can hold, found from its inner dimensions.
- **Apparent capacity:** the capacity a container seems to have from its outer shape, before allowing for any part that takes up space inside it.
- **Hemisphere:** one half of a sphere, cut by a plane through its center. The distance from the center to the surface is the radius.
- **Slant height of a cone:** the distance from the apex to the edge of the base, $l = \sqrt{r^2 + h^2}$.
- **Surmounted:** placed on top of. "A cylinder surmounted by a hemisphere".
- **Depression or cavity:** a hollow scooped out of the inner surface.
- **Circumscribe:** a solid circumscribes another solid if it is outside and touches it. A cylinder circumscribing a cone-on-



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Solved Examples (NCERT)

Example 1: The playing top (NCERT)

Question: Rasheed got a playing top (lattu) with a hemispherical top of radius 5 cm and a cylindrical stem of radius 3.5 cm. The entire top is 5 cm in height. Find the area he has to colour. (Take $\pi = 22/7$)

Solution: Radius $r = 3.5/2 = 1.75$ cm. TSA of the toy = CSA of hemisphere + CSA of cone.

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$$\text{CSA of hemisphere} = 2\pi r^2 = 2 \times (22/7) \times 1.75 \times 1.75 = 19.25 \text{ cm}^2.$$

$$\text{Height of cone} = \text{height of top} - \text{radius of hemisphere} = 5 - 1.75 = 3.25 \text{ cm}.$$

$$\text{Slant height } l = \sqrt{(1.75^2 + 3.25^2)} = \sqrt{(3.0625 + 10.5625)} = \sqrt{13.625} \approx 3.7 \text{ cm}.$$

$$\text{CSA of cone} = \pi r l = (22/7) \times 1.75 \times 3.7 = 5.5 \times 3.7 = 20.35 \text{ cm}^2.$$

$$\text{Area to colour} = 19.25 + 20.35 = \mathbf{39.6 \text{ cm}^2 \text{ (approx.)}}$$

Example 2: The decorative block (NCERT Example 2)

Question: A decorative block is made of a cube of edge 5 cm with a hemisphere of diameter 4.2 cm fixed on top. Find the total surface area of the block. (Take $\pi = 22/7$)

Solution: TSA of cube = $6 \times 5 \times 5 = 150 \text{ cm}^2$. The circle where the hemisphere sits is hidden, and the hemisphere's curved surface is added.

$$\text{Surface area} = 150 - \pi r^2 + 2\pi r^2 = 150 + \pi r^2$$

Example 3: The toy rocket (NCERT Example 3)

Question: A wooden toy rocket is a cone mounted on a cylinder. The cone has a height of 6 cm and the conical part is 6 cm high. The base of the cylinder has diameter 3 cm. The cone is painted with each colour. (Take $\pi = 3.14$)

Solution: Cone: $r = 2.5 \text{ cm}$, $h = 6 \text{ cm}$, $l = \sqrt{6^2 + 2.5^2} = 6.5 \text{ cm}$.
Cylinder: $r' = 1.5 \text{ cm}$, $h' = 26 - 6 = 20 \text{ cm}$.

The cone's base is wider than the cylinder's base.
CSA of cone + base of cone – base of cylinder
 $\pi[16.25 + 6.25 - 2.25] = 3.14 \times 20.25 = \mathbf{63.585 \text{ cm}^2}$

$$\text{Yellow area} = \text{CSA of cylinder} + \text{one base of cylinder} = 2\pi r h + \pi r^2 = 2 \times 3.14 \times 1.5 \times 20 + 3.14 \times (1.5)^2 = 190.75 + 7.065 = \mathbf{197.815 \text{ cm}^2}.$$

Example 4: The bird-bath (NCERT Example 4)

Question: Mayank made a bird-bath in the shape of a cylinder. The height of the cylinder is 1.4 m. Find the area of the bird-bath. (Take $\pi = 22/7$)



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Solution: $h = 145 \text{ cm}$, $r = 30 \text{ cm}$. $\text{TSA} = \text{CSA of cylinder} + \text{CSA of hemisphere} = 2\pi rh + 2\pi r^2 = 2\pi r(h + r)$.

$$= 2 \times (22/7) \times 30 \times (145 + 30) = 2 \times (22/7) \times 30 \times 175 = 44 \times 30 \times 25 = 33000 \text{ cm}^2 = \mathbf{3.3 \text{ m}^2}$$

Example 5: The hollow vessel (Exercise 12.1, Q2)

Question: 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.

Solution: $r = 7 \text{ cm}$. Height of the cylinder $= 13 - 7 = 6 \text{ cm}$. Inner surface $= \text{CSA of hemisphere} + \text{CSA of cylinder} = 2\pi r^2 + 2\pi rh = 2\pi r(r + h)$.

$$= 2 \times (22/7) \times 7 \times (7 + 6) = 44 \times 13 = \mathbf{572 \text{ cm}^2}$$

Example 6: Cone on a hemisphere

Question: A toy is in the form of a cone of radius. The total height of the toy is 15.5 cm

Solution: Height of cone $= 15.5 - 3.5 = 12 \text{ cm}$.

$$\text{TSA} = \pi rl + 2\pi r^2 = \pi r(l + 2r) = (22/7) \times 3.5$$

Example 7: Hemispherical depression

Question: A hemispherical depression is cut out from one end of a cube such that the diameter of the hemisphere is equal to the side of the cube. Find the surface area of the remaining solid.

Solution: Edge $= l$, radius of hemisphere $= l/2$.

$$\text{Surface area} = \text{TSA of cube} - \text{area of circular base of hemisphere} \\ 6l^2 - \pi(l/2)^2 = 6l^2 - \pi l^2/4.$$

$$\therefore \text{Surface area} = \mathbf{(l^2/4)(\pi + 24) \text{ square units}}$$



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Example 8: Air in the shed (NCERT Example 5)

Question: Shanta's shed is a cuboid surmounted by a half cylinder. The base of the shed is 7 m × 15 m and the cuboidal part is 8 m high. Find the volume of air the shed can hold. The machinery occupies 300 m³ and there are 20 workers, each occupying about 0.08 m³. How much air is then in the shed? (Take $\pi = 22/7$)

Solution: Cuboid: $15 \times 7 \times 8 = 840 \text{ m}^3$. Half cylinder: diameter 7 m ($r = 3.5 \text{ m}$), length 15 m.
Volume = $(1/2) \times (22/7) \times 3.5 \times 3.5 \times 15 = (1/2) \times 38.5 \times 15 = 288.75 \text{ m}^3$.

Volume of air in the empty shed = $840 + 288.75 = 1128.75 \text{ m}^3$.

Space taken = $300 + 20 \times 0.08 = 300 + 1.6 = 301.6 \text{ m}^3$. Air left = $1128.75 - 301.6 = \mathbf{827.15 \text{ m}^3}$.

Example 9: The juice glass (NCERT Example 6)

Question: A cylindrical glass has inner diameter 5 cm and height 10 cm, but its bottom has a raised hemispherical portion. Find the apparent capacity of the glass.

Solution: $r = 2.5 \text{ cm}$. Apparent capacity =

Volume of hemisphere = $(2/3)\pi r^3 = (2/3) \times \pi \times 2.5^3$

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

Example 10: Toy inside a cylinder

Question: A solid toy is a hemisphere surmounted by a cone. The diameter of the base is 4 cm. Find the volume of the toy. If a cylinder circumscribes the toy, find the difference of their volumes. (Take $\pi = 3.14$)

Solution: $r = 2 \text{ cm}$, cone height $h = 2 \text{ cm}$.

Volume of toy = $(2/3)\pi r^3 + (1/3)\pi r^2 h = (2/3) \times \pi \times 2^3 + (1/3) \times \pi \times 2^2 \times 2$
 $= 3.14 \times 8 = 25.12 \text{ cm}^3$.

The cylinder has radius 2 cm and height = 4 cm.
volume = $3.14 \times 2^2 \times 4 = 50.24 \text{ cm}^3$.

Difference = $50.24 - 25.12 = \mathbf{25.12 \text{ cm}^3}$.



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Example 11: Rachel's model (Exercise 12.2, Q2)

Question: 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.)

Solution: $r = 1.5$ cm. Cylinder length $= 12 - 2 - 2 = 8$ cm.

$$\text{Volume} = \pi r^2(8) + 2 \times (1/3)\pi r^2(2) = \pi r^2(8 + 4/3) = \pi \times 2.25 \times 28/3 = 21\pi.$$

$$= 21 \times 22/7 = \mathbf{66 \text{ cm}^3}$$

Example 12: Checking the glass vessel (Exercise 12.2, Q8)

Question: 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 its volume to be 345 cm^3 . Check whether its measurements, and $\pi = 3.14$.

Solution: Sphere: $r = 4.25$ cm. Volume $= (4/3)\pi r^3$.

Neck: $r = 1$ cm, $h = 8$ cm. Volume $= 3.14 \times r^2 \times h$.

Total $= 321.39 + 25.12 = 346.51 \text{ cm}^3$. She is wrong because the volume is not 345 cm^3 .



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Competency-Based Questions

For each assertion-reason item, choose from the following options:

1. Both Assertion (A) and Reason (R) are true.
2. Both A and R are true, but R is not the correct reason.
3. A is true, but R is false.
4. A is false, but R is true.

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1. Case-based: The ice-cream cone

An ice-cream seller fills a wafer cone of radius 3 cm and height 4 cm with ice cream and adds a hemisphere of ice cream of the same radius on top. Take $\pi = 3.14$.

(a) Find the slant height of the cone. $l = \sqrt{9 + 16} = 5$ cm.

(b) Find the area of wafer used for the cone. The wafer is the curved surface: $\pi rl = 3.14 \times 3 \times 5 = 47.1$ cm².

(c) Find the total volume of ice cream. Cone: $(1/3)\pi(9)(4) = 12\pi$. Hemisphere: $(2/3)\pi(27) = 18\pi$. Total = $30\pi = 94.2$ cm³.

2. Case-based: The water tanker

A tanker's container is a cylinder 6 m long with a hemisphere of radius 1 m at each end. Take $\pi = 3.14$.

(a) Find how much water it can hold. Cylinder: $\pi r^2 h = 6\pi$. Hemisphere: $(4/3)\pi(1)^3$. Total = $6\pi + 4\pi/3 = 22\pi$ m³ = 22000 litres.

(b) Find the outer surface area to be painted.

(c) Find the cost of painting at ₹ 40 per m².

3. Case-based: The circus tent

A circus tent is a cylinder of radius 7 m and height 24 m and a conical top of radius 7 m and height 18 m. Take $\pi = 22/7$.

(a) Find the slant height of the conical top.

(b) Find the canvas needed (no canvas on the floor). $\pi r l + 2\pi r^2 = 682$ m². At ₹ 120 per m², the cost is ₹ 81840.

(c) Find the volume of air inside. $\pi r^2 h + (1/3)\pi r^2 h = 1694$ m³.



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4. Case-based: Marbles in a beaker

A cylindrical beaker of radius 4 cm has water in it. Glass balls of radius 1 cm are dropped in until the water level rises by 3 cm. No water spills.

(a) Find the volume of water pushed up. $\pi(4)^2(3) = 48\pi \text{ cm}^3$.

(b) Find the volume of one ball. $(4/3)\pi(1)^3 = 4\pi/3 \text{ cm}^3$.

(c) Find the number of balls. $48\pi \div (4\pi/3) = 48 \times 3/4 = 36$ balls.

5. Assertion-Reason

Assertion (A): The total surface area of a toy made by joining a cone and a hemisphere of equal radius is less than the sum of the total surface areas of the cone and the hemisphere.

Reason (R): When the two solids are joined, the base of the cone and the flat face of the hemisphere are hidden.

Answer: (a). Both statements are true. The total surface area of the toy is $\pi r^2 + \pi r^2 + 3\pi r^2$, because the two hidden circles

6. Assertion-Reason

Assertion (A): The volume of a solid formed by joining a cylinder and a cone is the sum of the volumes of the cylinder and the cone.

Reason (R): When two solids are joined, the total surface area is the sum of the surface areas of the two solids.

Answer: (b). Both are true. A is true because the volume of the solid is the sum of the volumes of the cylinder and the cone. R is true because the surface area of the solid is the sum of the surface areas of the cylinder and the cone.

7. Assertion-Reason

Assertion (A): When a hemisphere whose radius is equal to the radius of the cylinder is scooped out of the cylinder, the surface area of the remaining solid is less than the sum of the surface areas of the cylinder and the hemisphere.

Reason (R): Scooping removes a circle of area πr^2 from the cylinder and adds a hemisphere of surface area $2\pi r^2$.

Answer: (d). R is true. By R, the surface area of the remaining solid is the sum of the surface areas of the cylinder and the hemisphere minus the area of the circle removed. A is false.



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8. Assertion-Reason

Assertion (A): The slant height of a cone of radius 5 cm and height 12 cm is 13 cm.

Reason (R): The slant height of a cone is given by $l = r + h$.

Answer: (c). A is true: $l = \sqrt{(25 + 144)} = 13$ cm. R is false: the correct relation is $l = \sqrt{(r^2 + h^2)}$, and $r + h$ would give 17 cm.

9. Assertion-Reason

Assertion (A): The total surface area of a solid hemisphere of radius r is $3\pi r^2$.

Reason (R): The curved surface area of a hemisphere is $2\pi r^2$ and its flat face is a circle of area πr^2 .

Answer: (a). Both are true, and adding the two parts in R gives exactly A.

Important Questions for

1-Mark Questions

Q1. Find the total surface area of a solid hemisphere of radius 49 cm.

Answer: $3\pi r^2 = 3 \times (22/7) \times 49 = 462$ cm²

Q2. A cone and a cylinder have the same radius and height. Find the ratio of their volumes.

Answer: $(1/3)\pi r^2 h : \pi r^2 h = 1 : 3$.

Q3. Two cubes, each of edge 5 cm, are joined end to end. Find the surface area of the resulting cuboid.

Answer: The cuboid is 10 cm × 5 cm × 5 cm.

2-Mark Questions

Q4. 2 cubes each of volume 64 cm³ are joined end to end. Find the surface area of the resulting cuboid. (Exercise 12.1, Q1)

Answer: Edge = cube root of 64 = 4 cm, so the cuboid is 8 cm × 4 cm × 4 cm.
Surface area = $2(8 \times 4 + 4 \times 4 + 4 \times 8) = 128$ cm²



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Q5. 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. (Exercise 12.1, Q4)

Answer: The hemisphere must sit on a 7 cm face, so the greatest diameter is 7 cm ($r = 3.5$ cm).
Surface area = $6a^2 + \pi r^2 = 294 + (22/7) \times 12.25 = 294 + 38.5 = 332.5 \text{ cm}^2$.

Q6. 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 5 mm. Find its surface area. (Exercise 12.1, Q6)

Answer: $r = 2.5$ mm, cylinder length = $14 - 5 = 9$ mm. Surface area = $2\pi r(h + 2r) = 2 \times (22/7) \times 2.5 \times 14 = 220 \text{ mm}^2$.

Q7. 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 . (Exercise 12.2, Q1)

Answer: $(1/3)\pi(1)^2(1) + (2/3)\pi(1)^3 = \pi/3 + 2\pi/3 = \pi \text{ cm}^3$.

3-Mark Questions

Q8. A tent is in the shape of a cylinder surmounted by a conical part. The diameters of the cylindrical part are 2.1 m and 4 m respectively. The area of the canvas used for making the tent is 1415.75 m^2 . Find the cost of the canvas at the rate of ₹ 500 per m^2 . (Note that the base of the tent is circular. (Exercise 12.1, Q7)

Answer: $r = 2$ m. Canvas = $2\pi rh + \pi rl = \pi r(2h + r + l) = \pi r(2h + r + \sqrt{h^2 + r^2})$.
 $\text{Cost} = 44 \times 500 = ₹ 22,000$.

Q9. From a solid cylinder whose height is 10 cm, a right circular cone of the same height and same diameter is hollowed out. Find the total surface area of the hollowed cylinder to the nearest cm^2 . (Exercise 12.1, Q8)

Answer: $r = 0.7$ cm, $h = 2.4$ cm, $l = \sqrt{(0.4)^2 + (2.4)^2} = 2.48$ cm.
 $\pi r(2h + r + l) = (22/7) \times 0.7 \times (4.8 + 0.7 + 2.48) = 24.64 \text{ cm}^2$.

Q10. A wooden article was made by scooping out a hemisphere from each end of a solid cylinder. If the height of the cylinder is 10 cm, find the total surface area of the article. (Exercise 12.1, Q9)

Answer: Surface area = $2\pi rh + 2 \times 2\pi r^2 = 2\pi r(h + 2r) = 2 \times (22/7) \times 5 \times (10 + 10) = 374 \text{ cm}^2$.

Q11. A pen stand made of wood is in the shape of a cuboid with four semi-circular depressions on its top surface. The dimensions of the cuboid are 15 cm by 10 cm by 3 cm. The radius of each depression is 0.5 cm and the depth is 1.4 cm. Find the total surface area of the pen stand.



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(Exercise 12.2, Q4)

Answer: Cuboid = $15 \times 10 \times 3.5 = 525 \text{ cm}^3$. One cone = $(1/3) \times (22/7) \times 0.25 \times 1.4 = 0.3667 \text{ cm}^3$ (approx.). Four cones = 1.4667 cm^3 . Wood = $525 - 1.47 = 523.53 \text{ cm}^3$ (approx.).

5-Mark Questions

Q12. 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. (Exercise 12.2, Q3)

Answer: $r = 1.4 \text{ cm}$, cylinder length = $5 - 2.8 = 2.2 \text{ cm}$. Cylinder = $(22/7) \times 1.96 \times 2.2 = 13.552 \text{ cm}^3$. Two hemispheres = $(4/3) \times (22/7) \times 2.744 \approx 11.499 \text{ cm}^3$. One gulab jamun $\approx 25.051 \text{ cm}^3$. 45 of them $\approx 1127.28 \text{ cm}^3$. Syrup = 30% of $1127.28 \approx 338 \text{ cm}^3$ (approx.).

Q13. 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 up to 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. (Exercise 12.2, Q4)

Answer: Volume of water = $(1/3)\pi(25)(8)$: which equals the volume of the shots. One $(\pi/6) = 100$ lead shots.

Q14. A solid iron pole consists of a cylinder surmounted by another cylinder of height given that 1 cm^3 of iron has approximately

Answer: Lower cylinder = $3.14 \times 144 \times 22$ 12057.6 cm^3 . Total = 111532.8 cm^3 . Mass =

Q15. A solid consisting of a right circular hemisphere of radius 60 cm is placed upright touches the bottom. Find the volume of water 60 cm and its height is 180 cm. (Exercise 12.2, Q5)

Answer: Cylinder = $\pi(3600)(180) = 648000\pi$. Hemisphere = $(2/3)\pi(216000) = 144000\pi$. $22/7 \approx 1131428.57 \text{ cm}^3 \approx 1.131 \text{ m}^3$.



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Common Mistakes and Ex

1. **Adding the TSAs of the parts.** For a co circles. Fix: list the visible surfaces first

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2. **Using the full height for the cone.** In a top 5 cm tall, the cone is 5 – r tall. Fix: subtract the hemisphere's radius (or other part heights) from the total height before anything else.
3. **Using h in place of l.** The CSA of a cone is πrl , with the slant height. Fix: if the question gives h, find $l = \sqrt{r^2 + h^2}$ first.
4. **Taking diameter as radius.** Questions usually give diameters (4.2 cm, 3.5 cm, 14 mm). Fix: halve every diameter and write $r = \dots$ on its own line.
5. **Forgetting the exposed circle on a cube.** With a hemisphere on a cube, the rest of the cube top is still visible. Fix: $6a^2 - \pi r^2 + 2\pi r^2$, not $5a^2 + 2\pi r^2$.
6. **Thinking a cavity lowers surface area.** A scooped hemisphere adds $2\pi r^2$ and removes only πr^2 . Fix: remove the flat opening, add the inner curved surface.
7. **Covering the base of a tent.** A tent stands on the ground. Fix: canvas = CSA of cylinder + CSA of cone only, as the NCERT question notes.
8. **Mixing units.** The bird-bath has 1.45 m and 30 cm. Fix: convert to one unit before substituting, then convert the final answer if asked ($33000 \text{ cm}^2 = 3.3 \text{ m}^2$).
9. **Wrong conversion of area or volume units.** Fix: square or cube the length factor.
10. **Using the wrong value of π .** Fix: read the question carefully. Examples 3, 6 and 7 and some exercise questions.
11. **Rounding too early.** Rounding the volume by 45 drifts the answer. Fix: keep two or three extra digits.
12. **Missing units or the final sentence.** Fix: always include units in the final answer. Check the question asked ("She is not correct" or "Find the area").



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Quick Revision Points

- Every object in this chapter is a combination of a cylinder, cone, sphere or hemisphere.
- TSA means Total Surface Area; CSA means Curved Surface Area.
- Slant height of a cone: $l = \sqrt{r^2 + h^2}$.
- Hemisphere: CSA $2\pi r^2$, TSA $3\pi r^2$, volume $\frac{2}{3}\pi r^3$.
- The height of a hemisphere equals its radius.
- Surface area of a combined solid: add or subtract the areas of the parts.
- The TSA of a combined solid is not the sum of the TSAs of its parts.

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- Tanker or capsule: $2\pi r(h + 2r)$. Cone on hemisphere: $\pi rl + 2\pi r^2$.
- Hemisphere on a cube: $6a^2 + \pi r^2$. The greatest hemisphere on a cube of edge a has diameter a .
- A wider cone on a narrower cylinder leaves a visible ring of area $\pi r^2 - \pi r'^2$.
- Tent canvas: $\pi r(2h + l)$; no canvas on the base.
- A cavity removes a flat opening and adds an inner curved surface.
- Volume of a combined solid = sum of the volumes of the parts.
- Removed or occupied parts are subtracted: remaining wood, actual capacity, air left, water left.
- Actual capacity of a glass with a raised hemisphere = $\pi r^2 h - (2/3)\pi r^3$.
- A submerged solid pushes out its own volume of water.
- Number of objects = volume to be filled $\div$ volume of one object.
- A cylinder circumscribing a cone-on-hemisphere has height $2r$.
- Two hemispherical ends together make a cylinder of length $2r$.
- Default $\pi = 22/7$ unless the question says otherwise.
- 1 litre = 1000 cm^3 ; $1 \text{ m}^3 = 1000 \text{ litres}$.
- Paint, canvas or sheet means area; water means volume.



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Weightage in Board Exams

Surface Areas and Volumes is Chapter 12 in the NCERT syllabus. It carries 6 marks in the board exams. The chapter is divided into 12 topics.

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Question type	What is usually asked
MCQ and Assertion-Reason	Hemisphere CSA and TSA, slant height, ratio of cone and cylinder volumes, surface area of two joined cubes, why TSAs cannot be added
Short answers	Capsule or toy surface area, hemisphere on a cube, cone-on-hemisphere volume in terms of π
Long answers	Tent canvas and cost, cavity problems, water left in a cylinder, counting lead shots, mass of a pole
Case-based	An everyday object (tanker, ice-cream cone, tent, glass) split into parts: find a dimension, a surface area and a volume

The marks go to the setup as much as the arithmetic. Write the parts, the slant height, the split heights and the formula before substituting. Do the arithmetic last. Do the exercise question first.



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