



CBSE 10th

TEEVRA EDUTECH PVT. LTD.

Surface Areas and Volume

Exercise-13.5

Q.1 A copper wire, 3 mm in diameter, is wound about a cylinder whose length is 12 cm, and diameter 10 cm, so as to cover the curved surface of the cylinder. Find the length and mass of the wire, assuming the density of copper to be 8.88 g per cm^3 .

Sol: It can be observed that 1 round of wire will cover 3 mm height of cylinder

$$\text{Number of rounds} = \frac{\text{Height of cylinder}}{\text{Diameter of wire}} = \frac{12}{0.3} = 40 \text{ Round}$$

Length of wire required in 1 round = Circumference of base of cylinder

$$= 2\pi r = 2\pi \times 5 = 10\pi$$

Length of wire in 40 rounds = $40 \times 10\pi$

$$= \frac{400 \times 22}{7} = \frac{8000}{7}$$

$$= 1257.14 \text{ cm} = 12.57 \text{ m}$$

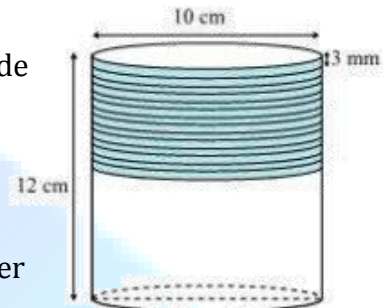
$$\text{Radius of wire} = \frac{0.3}{2} = 0.15 \text{ cm}$$

Volume of wire = Area of cross – section of wire \times Length of wire

$$= \pi(0.15)^2 \times 1257.14 = 88.898 \text{ cm}^3$$

Mass = Volume \times Density

$$= 88.898 \times 8.88 = 789.41 \text{ gm}$$



Q.2 A right triangle whose sides are 3 cm and 4 cm (other than hypotenuse) is made to revolve about its hypotenuse. Find the volume and surface area of the double cone so formed. (Choose value of π as found appropriate.)

Sol: The double cone so formed by revolving this right-angled triangle ABC about its hypotenuse is shown in the figure.

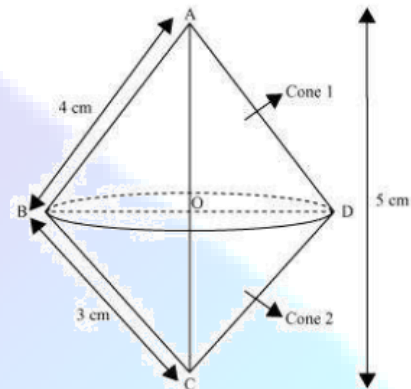
$$\text{Hypotenuse } AC = \sqrt{3^2 + 4^2} = \sqrt{25} = 5\text{cm}$$

$$\text{Area of } \triangle ABC = \frac{1}{2} \times AB \times AC$$

$$\frac{1}{2} \times AC \times OB = \frac{1}{2} \times 4 \times 3$$

$$\frac{1}{2} \times 5 \times OB = 6$$

$$OB = \frac{12}{5} = 2.4\text{ cm}$$



Volume of double cone = Volume of cone 1 + Volume of cone 2

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

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

$$\frac{1}{3} \times 3.14 \times (2.4)^2 (5)$$

$$= 30.14 \text{ cm}^3$$

Surface area of double cone = Surface area of cone 1 + Surface area of cone 2

$$\pi r l_1 + \pi r l_2$$

$$= \pi r [4 + 3] = 3.14 \times 2.4 \times 7$$

$$= 52.75 \text{ cm}^2$$

Q.3 A cistern, internally measuring 150 cm × 120 cm × 110 cm, has 129600 cm³ of water in it. Porous bricks are placed in the water until the cistern is full to the brim. Each brick absorbs one-seventeenth of its own volume of water. How many bricks can be put in without overflowing the water, each brick being 22.5 cm × 7.5 cm × 6.5 cm?

Sol: Volume of cistern = $150 \times 120 \times 110 = 1980000 \text{ cm}^3$

Volume to be filled in cistern = $1980000 - 129600 = 1850400 \text{ cm}^3$

Let n numbers of porous bricks were placed in the cistern.

Volume of n bricks = $n \times 22.5 \times 7.5 \times 6.5$

$$= 1096.875n$$

As each brick absorbs one-seventeenth of its volume, therefore, volume absorbed by

these bricks = $\frac{n}{17}(1096.875)$

$$1850400 + \frac{n}{17}(1096.875) = (1096.875)n$$

$$1850400 = \frac{16n}{17}(1096.875)$$

$$n = 1792.41$$

Therefore, 1792 bricks were placed in the cistern.

Q.4 In one fortnight of a given month, there was a rainfall of 10 cm in a river valley. If the area of the valley is 7280 km^2 , show that the total rainfall was approximately equivalent to the addition to the normal water of three rivers each 1072 km long, 75 m wide and 3 m deep.

Sol: Area of the valley = 7280 km^2

If there was a rainfall of 10 cm in the valley then amount of rainfall in the valley = Area of the valley \times 10 cm

Amount of rainfall in the valley = $7280 \text{ km}^2 \times 10 \text{ cm}$

$$= 7280 \times (1000)\text{m}^2 \times \frac{10}{100} \text{ m} = 7280 \times 10^5 \text{m}^3$$

$$= 7.28 \times 10^8 \text{m}^3.$$

Length of each river, $l = 1072 \text{ km} = 1072 \times 1000 \text{ m} = 1072000 \text{ m}$

Breadth of each river, $b = 75 \text{ m}$

Depth of each river, $h = 3 \text{ m}$

Volume of each river = $l \times b \times h$

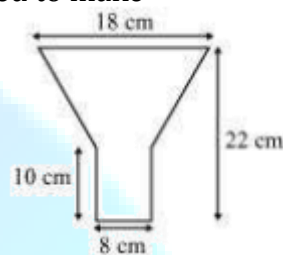
$$= 1072000 \times 75 \times 3 \text{ m}^3$$

$$= 2.412 \times 10^8 \text{m}^3$$

$$\begin{aligned}
 \text{Volume of three such rivers} &= 3 \times \text{Volume of each river} \\
 &= 3 \times 2.412 \times 10^8 \text{m}^3 \\
 &= 7.236 \times 10^8 \text{m}^3
 \end{aligned}$$

Thus, the total rainfall is approximately same as the volume of the three rivers.

Q.5 An oil funnel made of tin sheet consists of a 10 cm long cylindrical portion attached to a frustum of a cone. If the total height is 22 cm, diameter of the cylindrical portion is 8 cm and the diameter of the top of the funnel is 18 cm, find the area of the tin sheet required to make the funnel (see the given figure).



Sol: Radius (r_1) of upper circular end of frustum part = $\frac{18}{2} = 9 \text{ cm}$

Radius (r_2) of lower circular end of frustum part = Radius of circular end of cylindrical part

$$= \frac{8}{2} = 4 \text{ cm}$$

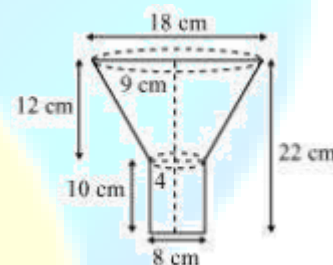
Height (h_1) of frustum part = $22 - 10 = 12 \text{ cm}$

Height (h_2) of cylindrical part = 10 cm

$$\text{Slant height (l) of frustum part} = \sqrt{(r_1 - r_2)^2 + h^2} = \sqrt{(9 - 4)^2 + (12)^2} = 13 \text{ cm}$$

Area of tin sheet required = CSA of frustum part + CSA of cylindrical part

$$\begin{aligned}
 &= \pi(r_1 + r_2)l + 2\pi r_2 h_2 \\
 &= \frac{22}{7} \times (9 + 4) \times 13 + 2 \times \frac{22}{7} \times 4 \times 10 \\
 &= \frac{22}{7} [169 + 80] = \frac{22 \times 249}{7} \\
 &= 782 \frac{4}{7} \text{ cm}^2
 \end{aligned}$$



Q.6 Derive the formula for the curved surface area and total surface area of the frustum of cone.

Sol: Let ABC be a cone. A frustum DECB is cut by a plane parallel to its base.

Let r_1 and r_2 be the radii of the ends of the frustum of the cone and h be the height of the frustum of the cone.

In $\triangle ABG$ and $\triangle ADF$, $DF \parallel BG$

$\therefore \triangle ABG \sim \triangle ADF$

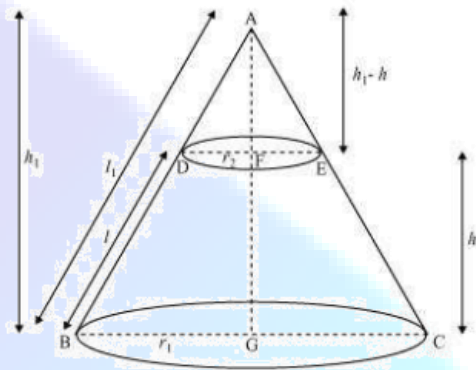
$$\frac{DF}{BG} = \frac{AF}{AG} = \frac{AD}{AB}$$

$$\frac{r_2}{r_1} = \frac{h_1 - h}{h_1} = \frac{l_1 - l}{l_1}$$

$$\frac{r_2}{r_1} = 1 - \frac{h}{h_1} = 1 - \frac{l}{l_1} \Rightarrow 1 - \frac{l}{l_1} = \frac{r_2}{r_1}$$

$$\frac{l}{l_1} = 1 - \frac{r_2}{r_1} = \frac{r_1 - r_2}{r_1}$$

$$\frac{l}{l_1} = \frac{r_1 - r_2}{r_1} \Rightarrow l_1 = \frac{r_1 l}{r_1 - r_2}$$



CSA of frustum DECB = CSA of cone ABC – CSA cone

$$\pi r_1 l_1 - \pi r_2 (l_1 - l)$$

$$\pi r_1 \left(\frac{l r_1}{r_1 - r_2} \right) - \pi r_2 \left[\frac{r_1 l}{r_1 - r_2} - l \right]$$

$$= \frac{\pi r_1^2 l}{r_1 - r_2} - \pi r_2 \left(\frac{r_1 l - r_1 l + r_2 l}{r_1 - r_2} \right)$$

$$\frac{\pi r_1^2 l}{r_1 - r_2} - \frac{\pi r_2^2 l}{r_1 - r_2} = \pi l \left[\frac{r_1^2 - r_2^2}{r_1 - r_2} \right]$$

$$\text{CSA of frustum} = \pi (r_1 + r_2) l$$

Total surface area of frustum + Area of upper circular end + Area of lower circular end

$$= \pi (r_1 + r_2) l + \pi r_2^2 + \pi r_1^2$$

$$= \pi \left[(r_1 + r_2) l + r_1^2 + r_2^2 \right]$$

Q.7 Derive the formula for the curved surface area and total surface area of the frustum of cone.

Sol: Let ABC be a cone. A frustum DECB is cut by a plane parallel to its base.

Let r_1 and r_2 be the radii of the ends of the frustum of the cone and h be

the height of the frustum of the cone.

In $\triangle ABG$ and $\triangle ADF$, $DF \parallel BG$

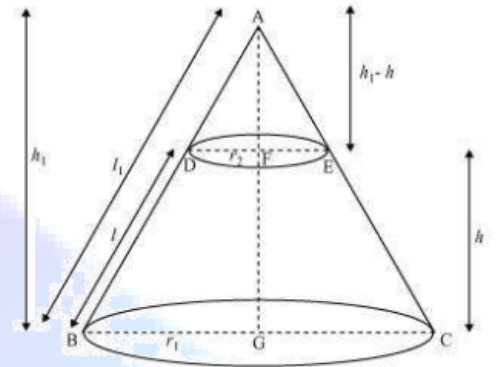
$\therefore \triangle ABG \sim \triangle ADF$

$$\frac{DF}{BG} = \frac{AF}{AG} = \frac{AD}{AB}$$

$$\frac{r_2}{r_1} = \frac{h_1 - h}{h_1} = \frac{l_1 - l}{l_1}$$

$$\frac{r_2}{r_1} = 1 - \frac{h}{h_1} \Rightarrow \frac{h}{h_1} = 1 - \frac{r_2}{r_1} = \frac{r_1 - r_2}{r_1}$$

$$\frac{h_1}{h} = \frac{r_1}{r_1 - r_2} \Rightarrow h = \frac{r_1 h_1}{r_1 - r_2}$$



Volume of frustum of cone = Volume of cone ABC – Volume of cone ADE

$$= \frac{1}{3} \pi r_1^2 h_1 - \frac{1}{3} \pi r_2^2 (h_1 - h)$$

$$= \frac{\pi}{3} [r_1^2 h_1 - r_2^2 (h_1 - h)]$$

$$= \frac{\pi}{3} \left[\left(\frac{hr_1}{r_1 - r_2} \right) - r_2^2 \left(\frac{hr_1}{r_1 - r_2} - h \right) \right]$$

$$= \frac{\pi}{3} \left[\left(\frac{hr_1^3}{r_1 - r_2} \right) - r_2^2 \left(\frac{hr_1 - hr_1 + hr_2}{r_1 - r_2} \right) \right]$$

$$= \frac{\pi}{3} h \left[\frac{hr_1^3}{r_1 - r_2} - \frac{hr_2^3}{r_1 - r_2} \right]$$

$$= \frac{\pi}{3} h \left[\frac{r_1^3 - r_2^3}{r_1 - r_2} \right]$$

$$= \frac{\pi}{3} h \left[\frac{(r_1 - r_2)(r_1^2 + r_2^2 + r_1 r_2)}{r_1 - r_2} \right]$$

$$= \frac{1}{3} \pi h [r_1^2 + r_2^2 + r_1 r_2]$$