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Class: 10
Subject: Math's
Topic: Surface areas and volumes
No. of Questions: 25

Q.1 Two cubes each of volume 64 $cm^3$ are joined end to end. Find the surface area and volume of the resulting cuboid.

Sol: Let the each edge be x cm.
V=64 $cm^3$
$x^3$= 64
x= 4 cm
Dimensions of cuboid so formed:
l= 4 + 4= 8 cm
b= 4 cm, h= 4 cm
Surface area= 2(lb + bh + hl)
=2(8 * 4+ 4*4+ 8 *4)= 160 $cm^2$
Volume= l * b * h= 8 * 4 * 4= 128 $cm^3$.

Q.2 The diameter of a metallic sphere is 6 cm. The sphere is melted and drawn into a wire of uniform cross-section. If the length of the wire is 36 cm, find its radius.
(CBSE-2013)

Sol: Diameter of sphere= 6 cm
Radius of sphere= 3 cm
Volume= 4/3 * π * $3^3$= 36 π $cm^3$.
Let the radius of wire be r cm
Also given length of wire= 36 cm
Volume of wire= π $r^2$ * 3600
Volume of wire= Volume of sphere
π $r^2$ * 3600= 36 π
$r^2$= 36 π/ 3600 π= 1/100
r= 1/10 cm= 1 mm

Q.3 If the diameter of cross-section of a wire is decreased by 5%. How much percent will the length be increased so that the volume remains the same?

Sol: Let r be the radius and h be the length of wire.
Volume = π $r^2$ h……..(1)
5% of diameter= 5/100 * 2r= r/10
New diameter= 2r – r/10= 19r/10
New radius= 19r/20
Let the new length be $h_1$.
Volume= π(19r/20)$^2$ $h_1$……(2)

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From (1) and (2)
$\pi r^2 h = \pi (19r/20)^2 h_1$.
$h = 361/400\ h_1$
$h_1 = 400/361\ h$
Increase in length= $h_1 - h = 400h/361 - h = 39h/361$
Percentage increase= $(h_1 - h)/h * 100 = 39h/h * 100 = 10.8\%$

Q.4 A metallic sphere of radius 4.2 cm is melted and recast into the shape of a cylinder of radius 6 cm. Find the height of the cylinder.

Sol: Let the height of cylinder be h cm.
Volume of cylinder= Volume of sphere
$\pi * 6^2 * h = 4/3 * \pi * (4.2)^3$
$h = (4 * 4.2 * 4.2 * 4.2)/ 3 * 6 * 6$
h= 2.744 cm

Q.5 A solid sphere of radius 3 cm is melted and then cast into small spherical balls each of diameter 0.6 cm. Find the number of balls thus obtained.

Sol: Let the number of balls be x
Volume of solid sphere= $4/3\ \pi r^3 = 4/3\pi 3^3 = 36\ \pi$
Radius of spherical ball= 0.6/2= 0.3 cm
Volume= $4/3\ \pi (0.3)^3 = 36/1000\ \pi\ cm^3$
Volume of x spherical balls= $36\pi/1000\ x\ cm^3$.
Volume of the solid sphere= Volume of x spherical balls
$36\ \pi = 36\ \pi/1000\ x$
x= 1000

Q.6 A right circular cone is 3.6 cm high and radius of its base is 1.6 cm. It is melted and recast into a right circular cone with radius of its base as 1.2 cm. Find its height.

Sol:

| | First cone | Second Cone |
|---|---|---|
| Radii | $r_1$= 1.6 cm | $r_2$= 1.2 cm |
| Height | $h_1$= 3.6 cm | $h_2$= ? |
| Volumes | $V_1$ | $V_2$ |

$V_1 = V_2$
$1/3\ \pi r_1^2 h_1 = 1/3\ \pi r_2^2 h_2$
$r_1^2 h_1 = r_2^2 h_2$
$h_2 = r_1^2 h_1 / r_2^2 = (1.6 * 1.6 * 3.6)/ 1.2 * 1.2 = 6.4$ cm

Q.7 A conical vessel whose internal radius is 5 cm and height 24 cm is full of water. The water is emptied into a cylindrical vessel with internal radius 10 cm. Find the height to which the water rises.

Sol: Let $r_1$=radius of conical vessel= 5cm
$h_1$=Height of the conical vessel= 24 cm

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$r_2$= radius of the cylindrical vessel= 10 cm
Suppose water risesupto height of $h_2$ cm in the cylinder.
Volume of water in conical vessel= Volume of water in cylindrical vessel
$1/3\ \pi\ r_1^2\ h_1 = \pi\ r_2^2\ h_2$.
$r_1^2\ h_1 = 3\ r_2^2\ h_2$
$5 * 5 * 4 = 3 * 10 * 10 * h_2$
$h_2$= 2 cm

Q.8 The dimensions of a metallic cuboid are: 100 cm * 80 cm * 64 cm. It is melted and recast into a cube. Find the surface area of the cube.

Sol: Volume of metallic cuboid= $11 * 80 * 64\ cm^3 = 512000\ cm^3$
Since the metallic cuboid is ,melted and recasted into a cube.
Volume of the metallic cuboid= Volume of the cube
Let the length of each edge of the recasted cube is a cm. then,
Volume of cube= Volume of cuboid
$a^3 = 512000$
$a^3 = 8^3 * 10^3$
a = 80 cm
Surface area of the cube= $6\ a^2\ cm^2 = 38400\ cm^2$.

Q.9 A glass cylinder with diameter 20 cm has water to a height of 9 cm. A metal cube of 8 cm edge is immersed in it completely. Calculate the height by which water will rise in the cylinder. (Take π= 3.142)

Sol: Suppose the water rises by h cm
Radius= 10 cm
Volume of the water displaced= Volume of the cube of edge 8 cm
$\pi\ r^2 h = 8^3$
$3.142 * 10^2 * h = 8 * 8 * 8$
$h = 8 * 8 * 8 / 3.142 * 10 * 10$= 1.6 cm

Q.10 A cylindrical pipe has inner diameter of 7 cm and water flows through it at 192.5 liters per minute. Find the rate of flow in kilometers per hour.

(CBSE-2013)

Sol: Volume of water that flows per hour= (192.50 * 60) liters
= $(192.50 * 60 * 1000)\ cm^3$…… (1)
Inner diameter of pipe= 7 cm
Inner radius of pipe= 7/2 cm= 3.5 cm
Let h be the length of the column of water that flows in one hour.
Water column forms a cylinder of radius 3.5 cm and height h cm
Volume of water that flows in one hour= Volume of cylinder
= $22/7 * (3.5)2 * h\ cm^3$ …..... (2)
From (1) and (2),
$22/7 * 3.5 * 3.5 * h = 192.50 * 60 * 1000$
$h = 192.50 * 60 * 1000 * 7 / 22 * 3.5 * 3.5$= 300000 cm= 3 Km

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Q.11 Water is flowing at the rate of 3km/hr through a circular pipe of 20 cm internal diameter into a circular cistern of diameter 10 m and depth 2 m. In how much time will the cistern be filled?

(CBSE-2008)

Sol: Suppose the cistern is filled in x hours. Since water is flowing at the rate of 3 km/hr. Therefore,
Length of the water column in x hours= 3x km= 3000x meters.
The water column forms a cylinder,
r= 20/2 cm= 10 cm= 1/10 m and h= height (length) = 3000x meters
Volume of water that flows in the cistern in x hours= $\pi r^2 h$= (22/7 * 1/10 * 1/10 * 3000x) $m^3$
Volume of cistern= 22/7 * 5 * 5 * 2 $m^3$
Volume of water that flows in cistern in x hours= Volume of the cistern
22/7 * 1/10 * 1/10 * 3000x= 22/7 * 5 * 5 * 2
x= 5 * 5 * 2 * 10 * 10/3000= 5/3 hours= 1 hour 40 minutes.

Q.12 Water is flowing at the rate of 7 m per second through a circular pipe whose internal diameter is 2 cm into a cylindrical tank the radius of whose base is 40 cm. Determine the increase in the water level in 1/2 hour.

(CBSE-2013)

Sol: Rate of flow of water= 7m/sec= 700 cm/sec
Length of the water column in 1/2 hours= (700 * 30 * 60) cm
Internal radius of circular pipe= 1 cm
Water column forms a cylinder of radius 1 cm and length= (700 * 30 * 60) cm
Volume of the water that flows in the tank in 1/2 hr= 22/7 * 1 * 1 * 700 * 30 * 60 $cm^3$.....(1)
Let h be the rise in the level of water in the tank.
Volume of water in tank= 22/7 * 40 * 40* h $cm^2$..... (2)
From (1) and (2)
22/7 * 40 * 40 * h= 22/7 * 1 * 1 * 700 * 30 * 60
h= 787.5 cm

Q.13 The rain water from a roof of 22 m * 20 m drains out into a cylindrical vessel having diameter of base 2 m and height 3.5 m. if the vessel is just full, find the rain fall in cm.

(CBSE-2010)

Sol: r= radius of cylindrical vessel= 1 m
H= Height of cylindrical vessel= 3.5 m
Volume of cylindrical vessel= $\pi r^2 h$= 22/7 * $1^2$ * 3.5 $m^3$= 11 $m^3$.
Let the rainfall be x m. then,
Volume of water= Volume of a cuboid of base 22 m * 20 m and height x meters
= (22 * 20 * x)$m^3$
Volume of the water= Volume of the cylindrical vessel
22 * 20 * x= 11

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x= 11/22 * 20= 1/40 m= 100/40 cm= 2.5 cm

Q.14 Water in a canal, 30 dm wide and 12 dm deep is flowing with velocity of 10km/hr. How much area will it irrigate in 30 minutes, If 8 cm of standing water is required for irrigation?

Sol: Width of the canal= 30 dm= 300 cm= 3 m
Depth of the canal= 12 dm= 120 cm= 1.2 m
Velocity of water= 10km/hr
Length of the water column formed in 1/2 hour= 5 km= 5000 m
Volume of water flowing in 1/2 hour= Volume of the cuboid of length 5000 m, width 3 m and depth 1.2 m.
Volume of water flowing in 1/2 hour= 5000 * 3 * 1.2 $m^3$= 18000 $m^3$.
Suppose x $m^2$ area is irrigated in 1/2 hour. Then,
x * 8/100= 18000
x= 1800000/8 $m^2$
x= 225000 $m^2$.

Q.15 The cost of painting the total outside surface of a closed cylindrical oil tank at 60 paise per sq. dm is Rs. 237.60. the height of the tank is 6 times the radius of the base of the tank. Find its volume correct to two decimal places.

Sol: Let r dm be the radius of the base and h dm be the height of the cylindrical tank.
h= 6r
Total surface area= $2\pi r(r + h)= 2 \pi r(r + 6r)= 14 \pi r^2$.
Cost of painting= Rs. $14 \pi r^2 * 60100$= Rs. $42/5 \pi r^2$.
It is given that the cost of painting is Rs. 237.60
$42/5 \pi r^2$= 237.60
$42/5 * 22/7 * r^2$= 237.60
r= 3 dm
h= 6r= 6 * 3= 18 dm
Volume of cylinder= $\pi r^2 h= \pi * 3 * 3 * 18$ $dm^3$
= 22/7 * 9 * 18= 509.14 $dm^3$.

Q.16 Determine the ratio of the volume of a cube to that of a sphere which will exactly fit inside the cube.

Sol: Let the radius of sphere be r units.
Length of each edge of the cube= 2r units
Let $V_1$ and $V_2$ be the volumes of the cube and sphere respectively. Then,
$V_1= (2r)^3$ and $V_2= 4/3 \pi r^3$
$V_1/V_2= 8r^3/ 4/3 \pi r^3= 6/\pi$
$V_1:V_2= 6 : \pi$

Q.17 Two solid right circular cones have the same height. The radii of their bases are $r_1$ and $r_2$. They are melted and recast into a cylinder of same height. Show that the radius of the base of the cylinder is $\sqrt{(r_1^2 + r_2^2)/3}$.

Sol: Let h be the height of the two given cones.

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Let R be the radius of the cylinder. It is given that the cylinder is also of height h.
Volume of cylinder= Sum of the volumes of two cones.
$\pi R^2 h = 1/3\ r_1^2\ h + 1/3\ \pi\ r_2^2\ h$
$\pi\ R^2\ h = 1/3\ \pi\ h\ (r_1^2 + r_2^2)$
$R^2 = 1/3\ (r_1^2 + r_2^2)$
$R = \sqrt{(r_1^2 + r_2^2)/3}$.

Q.18 A circular tent is cylindrical upto a height of 3 m and conical above it. If the diameter of the base is 105 m and the slant height of the conical part is 53 m, find the total canvas used in making the tent.

(CBSE-2004)

Sol: Total canvas used= Curved surface area of cylinder + curved surface area of cone
Total canvas used= $( 2 * 22/7 * 52.5 * 3 + 22/7 * 52.5 * 53)\ m^2$ [as $S = 2\pi rh + \pi rl$]
Total canvas used= $9735\ m^2$

Q.19 Find the volume of the largest right circular cone that can be cut out of a cube whose edge is 9 cm.

Sol: The base of the right circular cone will be the circle inscribed in a face of the cube and its height will be equal to an edge of the cube.

r= Radius of the base of the cone= 9/2 cm
h= Height of cone= 9 cm
Volume of the cone= $1/3\ \pi\ r^2\ h = 1/3 * 22/7 * 9/2 * 9/2 * 9\ cm^3 = 190.93\ cm^3$.

Q.20 A solid wooden toy is in shape of a right circular cone mounted on a hemisphere. If the radius of the hemisphere is 4.2 cm and the total height of the toy is 10.2 cm, find the volume of the wooden toy.

(CBSE-2012)

Sol: Let the radius be r of the hemisphere and h be the height of the conical part of the toy.
r= 4.2 cm
h= 10.2 – 4.2= 6 cm
Also, radius of base of the cone= 4.2 cm
Volume of the wooden toy= Volume of the conical part + Volume of the hemispherical part
$= (1/3\ \pi\ r^2\ h + 2\pi\ /3\ r^3)\ cm^3 = \pi r^3/3(h + 2r)\ cm^3$
$= 1/3 * 22/7 * 4.2 * 4.2 * (6 + 2 * 4.2) = 266.11\ cm^3$.

Q.21 A solid toy is in the form of a right circular cylinder with a hemispherical shape at one end and a cone at the other end. Their common diameter is 4.2 cm and the height of the cylindrical and conical portions are 12 cm and 7 cm respectively. Find the volume of the solid toy.

(CBSE- 2002)

Sol: Volume of the solid toy= Volume of the conical portion + Volume of the cylindrical portion + Volume of the hemispherical portion
$= 1/3\pi*(2.1)^2 * 7 + \pi * (2.1)^2 * 12 + 2/3 * \pi *(2.1)^3$

$= 1/3 * \pi * (2.1)^2 * 47.2 = \pi * 0.7 * 2.1 * 47.2$
$= 22/7 * 0.7 * 2.1 * 47.2 = 218.064\ cm^3$.

Q.22 From a right circular cylinder with height 10 cm and radius of the base 6 cm, a right circular cone of the same height and same base is removed. Find the volume of the remaining solid. Also, find the whole surface area.

(CBSE-2009)

Sol: Volume of the remaining solid= Volume of the cylinder – Volume of the cone
$\{\pi * 6^2 * 10 - 1/3 * \pi * 6^2 * 10\} cm^3 = (360\pi - 120\pi) cm^3 = 240\pi\ cm^3$
Slant height of the cone= $l = \sqrt{6^2 + 10^2} = 2\sqrt{34}\ cm^3$
Whole surface area= curved surface area of the cylinder + area of the base of the cylinder + curved surface area of the cone.
$= \{2\pi * 6 * 10 + \pi * 6 * 2\sqrt{34}\}\ cm^3 = (156 + 13\sqrt{34})\pi\ cm^3$

Q.23 A decorative block is made up of two solids- a cube and a hemisphere. The base of the block is cube with edge 5 cm, and the hemisphere fixed on the top has a diameter 4.2 cm. Find the total surface area of the block.

(CBSE-2009)

Sol: Surface area of decorative block= total surface area of the cube – base area of hemisphere + curved surface area of hemisphere.
$= (6 * 5 * 5 - \pi r^2 + 2\pi r^2)\ cm^2 = (150 + \pi r^2)\ cm^2$
$= \{150 + 22/7 * (2.1)^2\}\ cm^2$
$= (150 + 13.86) cm^2 = 163.86\ cm^2$

Q.24 If the radii of the circular ends of a conical bucket which is 45 cm high, are 28 cm and 7 cm, find the capacity of the bucket.

(CBSE-2004)

Sol: Bucket forms a frustum of a cone such that the radii of its circular ends are $r_1 = 28$ cm, $r_2 = 7$ cm and height h=45 cm.
Capacity of the bucket= $1/3\ \pi\ h(r_1^2 + r_2^2 + r_1 r_2) = 1/3 * 22/7 * 45(28^2 + 7^2 + 28 * 7)$
$= 48510\ cm^3$

Q.25 A bucket is in the form of a frustum of a cone and holds 28.490 liters of water. The radii of the top and bottom are 28 cm and 21 cm respectively. Find the height of the bucket.

(CBSE-2012)

Sol: Let the height of the bucket be h cm
$r_1 = 28$ cm and $r_2 = 21$ cm
V=Volume of the bucket= 28.490 liters= $28.490 * 1000\ cm^3 = 28490\ cm^3$
$1/3\ \pi\ h(r_1^2 + r_1 r_2 + r_2^2) = 28490$
$1/3 * 22/7 * h * (28^2 + 28 * 21 + 21^2) = 28490$
$h = (28590 * 21)/(22 * 1813)$ cm
h= 15 cm

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