Volume and Surface Area: exam practice

10 questions · 41 marks · worked solutions and markschemes

Name _____ Date _____ Score / 41

- Answer every question before you look at the solutions. They start after the last question, with the marks for each line: M for method, A for accuracy, R for reasoning.
- Online, with more practice: ibmathrevision.com/slai/volume-and-surface-area-exam-practice

1. **3 marks · Paper 1 style · calculator allowed**

A solid right square-based pyramid has a base side length of $10\ \text{m}$ and a vertical height of $12\ \text{m}$. Calculate the angle between one of the sloping triangular faces and the square base.

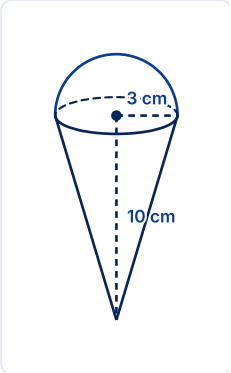
2. **3 marks · Paper 1 style · calculator allowed**

A spherical balloon has a volume of 288π cm^3. Calculate the exact radius of the balloon.

3. **3 marks · Paper 2 style · calculator allowed**

An ice cream is modelled as a cone of radius 3 cm and height 10 cm, with a hemisphere of radius 3 cm on top.

Find the total volume of the ice cream. **[3]**



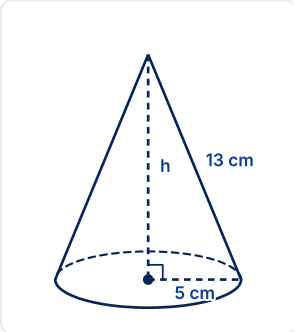
Cone (r = 3 cm, h = 10 cm) and hemisphere

4. **4 marks · Paper 2 style · calculator allowed**

A cylinder has a radius of r cm and a height of 12 cm. Its volume is equal to the volume of a sphere with a radius of 6 cm. Find the exact value of r.

5. **4 marks · Paper 2 style · calculator allowed**

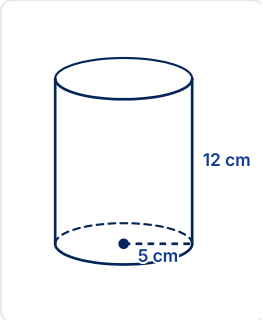
A right circular cone has a base radius of 5 cm and a slant height of 13 cm. Calculate the exact volume of the cone.



Radius 5 cm, slant 13 cm

6. **4 marks · Paper 2 style · calculator allowed**

A solid wooden cylinder has a radius of 5 cm and a height of 12 cm. Calculate its total surface area, giving your answer in the exact form $k\pi$, where k is an integer.

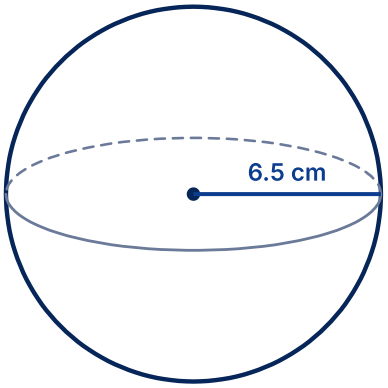


Radius 5 cm, height 12 cm

7. **4 marks · Paper 1 style · calculator allowed**

A solid sphere made of steel has a radius of $6.5\ \text{cm}$.

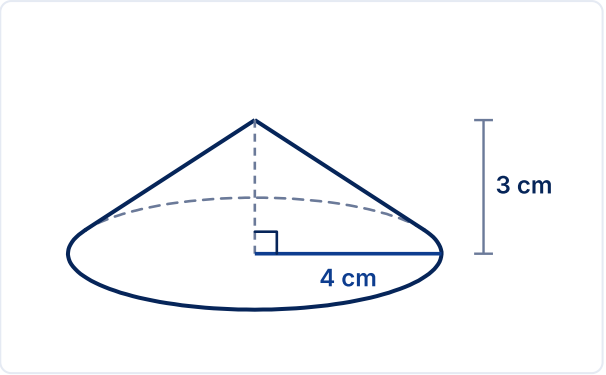
1. Calculate the exact surface area of the sphere, in terms of π.
2. Calculate the volume of the sphere. Give your answer correct to 3 significant figures.



8. **5 marks · Paper 1 style · calculator allowed**

A solid right circular cone has a base radius of $4\ \text{cm}$ and a vertical height of $3\ \text{cm}$.

1. Calculate the slant height of the cone.
2. Calculate the curved surface area of the cone.



9. **4 marks · Paper 1 style · calculator allowed**

Consider the points $P(1, 2, 3)$ and $Q(4, -2, 5)$ in 3D space.

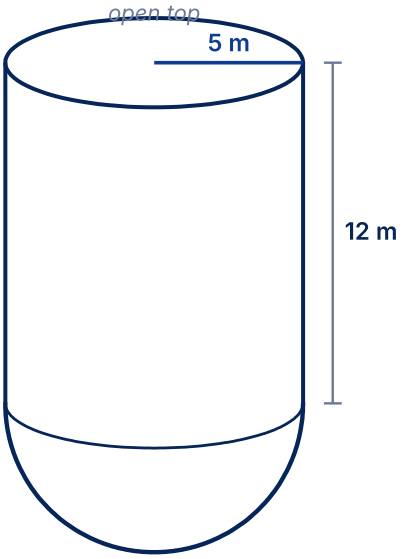
(a) Find the coordinates of the midpoint of $[PQ]$.

(b) Calculate the exact distance between P and Q.

10. **7 marks · Paper 2 style · calculator allowed**

A water storage tank is designed in the shape of a cylinder with a solid hemisphere perfectly attached to its bottom base. The tank has no top (it is open). The internal radius of the tank is $5\ \text{m}$ and the internal height of the cylindrical section is $12\ \text{m}$.

1. Calculate the total internal capacity (volume) of the tank.
2. The inner surfaces of the tank are to be coated with a protective resin. Calculate the total internal surface area that needs to be coated.



Answers and worked solutions

Question 1

3 marks

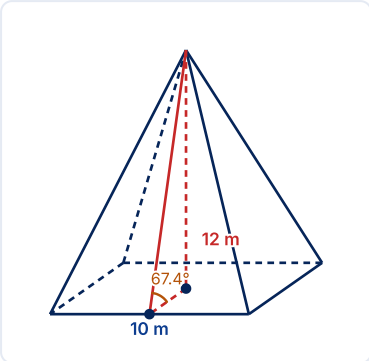
Answer: $67.4°$

Form the right-angled triangle from the centre of the base to the midpoint of a base edge ($10 \div 2 = 5$ m) and up to the apex (height 12 m) (M1)

Use the tangent ratio:

$\tan\theta = \frac{12}{5} = 2.4$ M1

$\theta = \arctan(2.4) \approx 67.4°$ A1



Use the triangle EOM: tan = $\frac{12}{5}$

Question 2

3 marks

Answer: 6

Set the sphere volume formula equal to the given volume: $\frac{4}{3}\pi r^3 = 288\pi$ M1

Rearrange for r^3:

$r^3 = 288 \times \frac{3}{4} = 216$ M1

Take the cube root: $r = \sqrt[3]{216} = 6$ cm A1

Question 3

3 marks

Answer: $151\ \text{cm}^3$

cone $\frac{1}{3}\pi(3)^2(10) = 30\pi$ (A1)

hemisphere $\frac{2}{3}\pi(3)^3 = 18\pi$ (A1)

$151\ \text{cm}^3$ (48π) A1

Question 4

4 marks

Answer: $2\sqrt{6}$

Volume of the sphere:

$V = \frac{4}{3}\pi(6^3) = 288\pi$ M1

Equate to the cylinder volume:

$\pi r^2(12) = 288\pi$ M1

Divide by 12π: $r^2 = 24$ A1

$r = \sqrt{24} = 2\sqrt{6}$ cm A1

Question 5

4 marks

Answer: 100π

Use Pythagoras for the perpendicular height: $h^2 = 13^2 - 5^2$ M1

$h = \sqrt{144} = 12$ cm A1

Substitute into $V = \frac{1}{3}\pi r^2 h$:

$V = \frac{1}{3}\pi(5^2)(12)$ M1

$V = 100\pi\ \text{cm}^3$ A1

Question 6

4 marks

Answer: 170π

Use the total surface area of a solid cylinder: $A = 2\pi r^2 + 2\pi rh$ M1

Area of the two circular ends:

$2 \times \pi(5)^2 = 50\pi$ A1

Curved surface area:

$2\pi(5)(12) = 120\pi$ A1

Total: $50\pi + 120\pi = 170\pi\ \text{cm}^2$ A1

Question 7

4 marks

Answer: (a) 169π; (b) 1150

1. Use surface area of a sphere formula: $SA = 4\pi r^2$. (M1)
   $SA = 4\pi(6.5)^2 = 4\pi(42.25)$.
   $SA = 169\pi\ \text{cm}^2$. A1
2. Use volume of a sphere formula: $V = \frac{4}{3}\pi r^3$. (M1)
   $V = \frac{4}{3}\pi(6.5)^3 = 1150.34\ldots$
   $V = 1150\ \text{cm}^3$ (to 3 s.f.). A1

Question 8

5 marks

Answer: (a) 5; (b) 62.8

1. Use Pythagoras' theorem to find slant height l. (M1)
   $l^2 = 4^2 + 3^2 = 16 + 9 = 25$.
   $l = 5$ cm. A1
2. Use curved surface area of a cone formula: $CSA = \pi rl$. (M1)
   $CSA = \pi(4)(5) = 20\pi$. (A1)
   $CSA \approx 62.8\ \text{cm}^2$ ($62.831\ldots$). A1

Question 9

4 marks

Answer: (a) $(2.5, 0, 4)$; (b) $\sqrt{29}$

1. Substitute into the 3D midpoint formula: $\left(\frac{1+4}{2}, \frac{2+(-2)}{2}, \frac{3+5}{2}\right)$ M1
   Midpoint $= (2.5, 0, 4)$ A1
2. Substitute into the 3D distance formula:
   $PQ = \sqrt{(4-1)^2 + (-2-2)^2 + (5-3)^2}$ M1
   $PQ = \sqrt{9 + 16 + 4} = \sqrt{29}$ A1

Question 10

7 marks

Answer: (a) 1200; (b) 534

1. $V_{cyl} = \pi(5)^2(12) = 300\pi$. (A1)
   $V_{hemi} = \frac{2}{3}\pi(5)^3 = \frac{250\pi}{3}$. (A1)
   Total Volume
   $= 300\pi + \frac{250\pi}{3} = \frac{1150\pi}{3} \approx 1200\ \text{m}^3$ ($1204.2\ldots$). A1
2. The tank is open, so no top circle. Internal SA
   $= CSA_{cyl} + CSA_{hemi}$. (M1)
   $CSA_{cyl} = 2\pi rh = 2\pi(5)(12) = 120\pi$. (A1)
   $CSA_{hemi} = 2\pi r^2 = 2\pi(5)^2 = 50\pi$. (A1)
   Total SA
   $= 120\pi + 50\pi = 170\pi \approx 534\ \text{m}^2$ ($534.07\ldots$). A1

Every solution is also on ibmathrevision.com/slai/volume-and-surface-area-exam-practice
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