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GCSE MATHEMATICS • GEOMETRY

Volume and Surface Area

Worked Solutions

Pearson Edexcel GCSE (1MA1) & International GCSE (4MA1) • Calculator allowed

Full worked solutions for the free Volume and Surface Area worksheet, GCSE and iGCSE Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Volume and Surface Area worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. In the exam, method marks are given for correct working even when the final answer is wrong. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **P** = process mark, **A** = accuracy mark, **B** = independent mark, **C** = communication mark.

Question sheet

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A**Your turn answers**

Compare each line of your working with the solution. Answers are to 1 decimal place unless they are exact.

FOUNDATION

A1 $\frac{1}{2} \times 7 \times 6 \times 9 = \boxed{189} \text{ cm}^3$

A2 $\pi \times 5^2 \times 4 = 100\pi = 314.15\dots \quad \boxed{314.2} \text{ cm}^3$

A3 $2(8 \times 3 + 8 \times 4 + 3 \times 4) = 2(24 + 32 + 12) = \boxed{136} \text{ cm}^2$

HIGHER

A4 $l = \sqrt{5^2 + 12^2} = 13 \quad \pi \times 5 \times 13 = 65\pi = 204.20\dots \quad \boxed{204.2} \text{ cm}^2$

A5 $\frac{4}{3}\pi \times 6^3 = 288\pi = 904.77\dots \quad \boxed{904.8} \text{ cm}^3$

A6 The small cone has radius 4 cm and height 7.5 cm $\frac{1}{3}\pi(8^2 \times 15 - 4^2 \times 7.5) = 280\pi = 879.64\dots$
 $\boxed{879.6} \text{ cm}^3$

A7 $\frac{4}{3}\pi r^3 = 1000$, so $r^3 = \frac{750}{\pi} = 238.7\dots \quad r = 6.20\dots \quad \boxed{6.2} \text{ cm}$

B**Fluency solutions**

One mark for each correct part. The notes in *italics* explain why each sequence was chosen.

FOUNDATION

B1 (a) $12 \times 5 = \boxed{60}$ (b) $\frac{1}{2} \times 8 \times 3 \times 7 = \boxed{84}$ (c) $\frac{1}{2}(4+6) \times 3 \times 10 = \boxed{150}$ (d) area $6 \times 2 + 2 \times 3 = 18$,
 $18 \times 4 = \boxed{72} \text{ cm}^3$

Every prism: area of the cross-section $\times$ length.

B2 (a) $\pi \times 4^2 \times 10 = 160\pi = 502.65\dots \quad \boxed{502.7} \text{ cm}^3$ (b) $2\pi \times 4 \times 10 = 80\pi \quad \boxed{251.3} \text{ cm}^2$
 (c) $80\pi + 2 \times \pi \times 4^2 = 112\pi \quad \boxed{351.9} \text{ cm}^2$ (d) $502.65\dots \div 1000 \quad \boxed{0.50} \text{ litres}$



B3 (a) $6 \times 25 = 150$ (b) $2(24 + 15 + 10) = 98$ (c) two triangles $2 \times 6 = 12$, three rectangles $(3 + 4 + 5) \times 10 = 120$: 132 (d) no lid: $60 + 2(40 + 24) = 188 \text{ cm}^2$

B4 (a) $3 \times 100^3 = 3\,000\,000 \text{ cm}^3$ (b) 4.5 litres (c) 2500 cm^3 (d) $80\,000 \div 100^3 = 0.08 \text{ m}^3$
 $1 \text{ m} = 100 \text{ cm}$, so $1 \text{ m}^3 = 100^3 \text{ cm}^3$. $1 \text{ litre} = 1000 \text{ cm}^3$

B5 (a) $36\pi = 113.09 \dots$: 113.1 cm^3 (b) $12\pi = 37.69 \dots$: 37.7 cm^3 (c) $64\pi = 201.06 \dots$: 201.1 cm^2

B6 (a) $120 \div 20 = 6 \text{ cm}$ (b) $300 \div 25 = 12 \text{ cm}$ (c) $250\pi \div 25\pi = 10 \text{ cm}$ (d) $\sqrt[3]{343} = 7 \text{ cm}$

HIGHER

B7 (a) $\sqrt{9^2 + 12^2} = 15 \text{ cm}$ (b) $\frac{1}{3}\pi \times 81 \times 12 = 324\pi$: 1017.9 cm^3
 (c) $\pi \times 9 \times 15 = 135\pi$: 424.1 cm^2 (d) $135\pi + 81\pi = 216\pi$: 678.6 cm^2

B8 (a) $r = 5$: $\frac{500}{3}\pi$: 523.6 cm^3 (b) $\frac{2}{3}\pi \times 216 = 144\pi$: 452.4 cm^3
 (c) curved $2\pi r^2$ plus flat πr^2 : $3\pi \times 36 = 108\pi$: 339.3 cm^2 (d) $4\pi r^2 = 400\pi$: $r = 10 \text{ cm}$

B9 (a) $90\pi + 18\pi = 108\pi$: 339.3 cm^3 (b) base 9π , side 60π , dome 18π : 87π : 273.3 cm^2
 (c) $12\pi + 18\pi = 30\pi$: 94.2 cm^3 (d) $l = 5$: cone 15π , dome 18π : 33π : 103.7 cm^2
Surfaces that are joined together are inside the solid, so they are not counted.

B10 (a) side 4: $6 \times 16 = 96 \text{ cm}^2$ (b) $r^3 = 27$, $r = 3$: $36\pi \text{ cm}^2$ (c) $\frac{1}{3}\pi \times 25 \times h = 100\pi$: $h = 12 \text{ cm}$
 (d) $2\pi r^3 = 54\pi$, $r^3 = 27$: $r = 3$

C

Reasoning solutions

Your wording can be different. Check that your reason makes the same point.

FOUNDATION

C1 The radius must be squared: $\pi r^2 h$. $\pi \times 9 \times 5 = 45\pi \text{ cm}^3$

C2 $1 \text{ m} = 100 \text{ cm}$, so $1 \text{ m}^3 = 100 \times 100 \times 100 = 1\,000\,000 \text{ cm}^3$. So $2 \text{ m}^3 = 2\,000\,000 \text{ cm}^3$



C3 Volume = length $\times$ width $\times$ height. Each is doubled, so the volume is multiplied by $2 \times 2 \times 2 = 8$

C4 A: $20 \times 10 \times 10 = 2000 \text{ cm}^3$. B: $\pi \times 36 \times 15 = 540\pi = 1696.5 \text{ cm}^3$ **A** holds more

HIGHER

C5 The curved surface uses the slant height, not the height. $l = \sqrt{36 + 64} = 10$ $\pi \times 6 \times 10 = 60\pi \text{ cm}^2$

C6 Hemisphere: $\frac{1}{2} \times \frac{4}{3}\pi r^3 = \frac{2}{3}\pi r^3$. Cone: $\frac{1}{3}\pi r^2 \times 2r = \frac{2}{3}\pi r^3$. They are equal.

C7 The curved part is half a sphere: $\frac{1}{2} \times 4\pi r^2 = 2\pi r^2$. The flat face is a circle, πr^2 . Total $3\pi r^2$

C8 (a) $\pi r^2 h = \frac{4}{3}\pi r^3$, so **$h = \frac{4}{3}r$**

(b) Cylinder: $2\pi r^2 + 2\pi r \times \frac{4}{3}r = \frac{14}{3}\pi r^2$. Sphere: $4\pi r^2 = \frac{12}{3}\pi r^2$

The **cylinder** is bigger, by **$\frac{2}{3}\pi r^2$**

D

Problem solving solutions

There is often more than one correct method. Any complete, correct method scores full marks.

FOUNDATION

D1 Water depth 30 cm: $60 \times 30 \times 30 = 54000 \text{ cm}^3$ **54** litres

D2 Surface area = $2(2 \times 1.5 + 2 \times 1 + 1.5 \times 1) = 13 \text{ m}^2$ $13 \div 5 = 2.6$ litres **3** tins

D3 Volume = $\pi \times 25 \times 20 = 1570.79 \dots \text{ cm}^3$ depth = $1570.79 \dots \div 300 = 5.23 \dots$ **5.2** cm

D4 $12 \times 1.5 \times 0.1 = 1.8 \text{ m}^3$ $1.8 \times 90 =$ **£162**

HIGHER

D5 Sphere: $\frac{4}{3}\pi \times 216 = 288\pi$ $\pi \times 16 \times h = 288\pi$ **$h = 18$** cm



D6 Extend to a cone of height H : $\frac{15}{10} = \frac{H}{H-20}$, so $H = 60$

$$\frac{1}{3}\pi(15^2 \times 60 - 10^2 \times 40) = \frac{9500}{3}\pi = 9948.37 \dots \text{cm}^3 \quad \boxed{9.9} \text{ litres}$$

D7 $\frac{1}{3}\pi r^2 \times 10 = 120\pi$, so $r^2 = 36$ and $r = 6$ $l = \sqrt{36 + 100} = \sqrt{136} = 2\sqrt{34}$

$$\pi \times 6 \times 2\sqrt{34} = \boxed{12\sqrt{34}\pi} \text{ cm}^2$$

D8 (a) The cylinder has radius r and height $2r$: volume $2\pi r^3$. Sphere $\frac{4}{3}\pi r^3$, which is $\frac{2}{3}$ of it. **33.3%** is outside

(b) Curved surface $= 2\pi r \times 2r = 4\pi r^2$, the same as the sphere's surface area.

E

Exam practice solutions

Marks are shown on the right of each line.

FOUNDATION

Foundation and Higher crossover

E1 $7 \times 3 \times 4$

$$\boxed{84} \text{ cm}^3$$

M1

A1

E2 Area of the L-shape $= 8 \times 3 + 3 \times 3$

$$= 33 \text{ cm}^2$$

$$33 \times 10 = \boxed{330} \text{ cm}^3$$

M1

A1

A1

E3 $\pi \times 7^2 \times 12 = 588\pi$

$$\boxed{1847.3} \text{ cm}^3$$

M1

A1

E4 Triangles: $2 \times \frac{1}{2} \times 8 \times 6 = 48$

Rectangles: $(6 + 8 + 10) \times 15 = 360$

$$\boxed{408} \text{ cm}^2$$

M1

M1

A1

E5 1.2×1000

$$\boxed{1200} \text{ litres}$$

M1

A1



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E6 2 litres = 2000 cm^3 B1
 $\pi \times 25 \times h = 2000$ M1
 $h = 25.46 \dots$ **25.5** cm A1

HIGHER

E7 $h = \sqrt{25^2 - 7^2} = 24$ M1
 $\frac{1}{3}\pi \times 49 \times 24 = 392\pi$ M1
1231.5 cm^3 A1

E8 Cylinder $\pi \times 16 \times 10 = 160\pi$ M1
Hemisphere $\frac{2}{3}\pi \times 64 = \frac{128}{3}\pi$ M1
 $\frac{608}{3}\pi = 636.6 \dots$ **636.7** cm^3 A1

E9 Big cone $\frac{1}{3}\pi \times 144 \times 16 = 768\pi$ M1
Small cone: radius 6, height 8: $\frac{1}{3}\pi \times 36 \times 8 = 96\pi$ M1
 $768\pi - 96\pi = 672\pi$ M1
2111.2 cm^3 A1

E10 (a) Cylinder $\pi \times 36 \times 10 = 360\pi$; each sphere $\frac{4}{3}\pi \times 1.5^3 = 4.5\pi$ M1
 $360\pi \div 4.5\pi =$ **80** A1
(b) Each sphere $\frac{4}{3}\pi \times 8 = \frac{32}{3}\pi$; $360\pi \div \frac{32}{3}\pi = 33.75$ M1
33 spheres A1
Left over: $360\pi - 33 \times \frac{32}{3}\pi = 8\pi$, and $\frac{8\pi}{360\pi} =$ **2.2%** A1

