1.

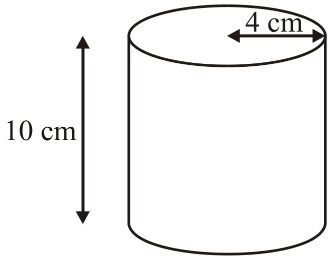


Diagram **NOT** accurately drawn

The diagram shows a cylinder with a height of 10 cm and a radius of 4 cm.

(a) Calculate the volume of the cylinder.
Give your answer correct to 3 significant figures.

..........................cm^3

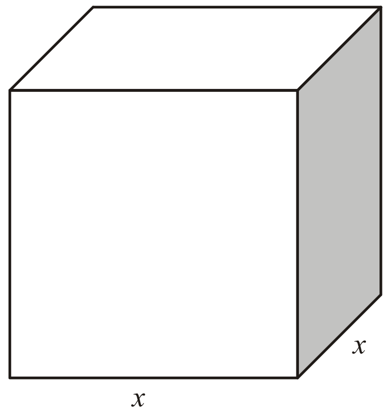
(2)

The length of a pencil is 13 cm.
The pencil cannot be broken.

(b) Show that this pencil cannot fit inside the cylinder.

(3)
(Total 5 marks)

2.



A cuboid has a square base of side x cm.
The height of the cuboid is 1 cm more than the length x cm.
The volume of the cuboid is 230 cm^3.

(a) Show that $x^3 + x^2 = 230$

(2)

The equation $x^3 + x^2 = 230$

has a solution between $x = 5$ and $x = 6$.

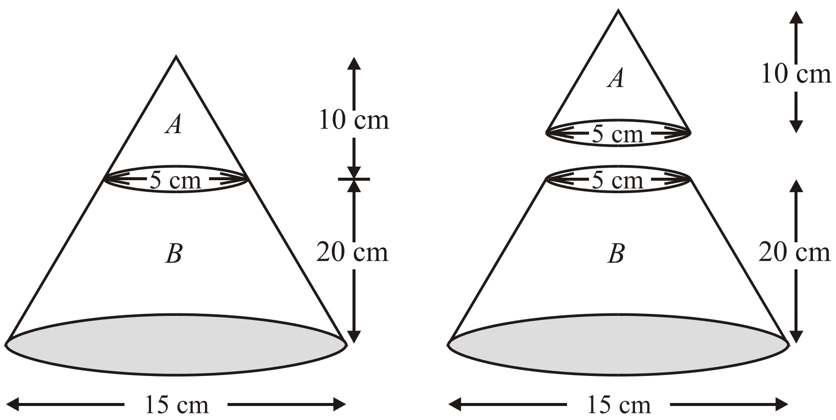
(b) Use a trial and improvement method to find this solution.
Give your answer correct to 1 decimal place.
You must show **all** your working.

$x =$ ....

(4)
(Total 6 marks)

3.

Diagram **NOT** accurately drawn



The diagram represents a large cone of height 30 cm and base diameter 15 cm.

The large cone is made by placing a small cone A of height 10 cm and base diameter 5 cm on top of a frustum B.

(a) Calculate the volume of the frustum B.
Give your answer correct to 3 significant figures.

.........................cm^3

(3)

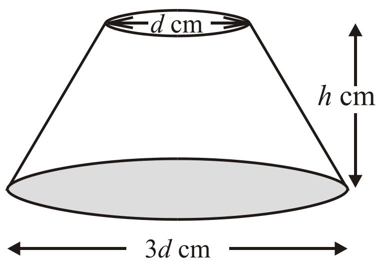


Diagram **NOT** accurately drawn

The diagram shows a frustum.
The diameter of the base is $3d$ cm and the diameter of the top is d cm.
The height of the frustum is h cm.

The formula for the curved surface area, S cm^2, of the frustum is

$$S = 2\pi d\sqrt{h^2 + d^2}$$

(b) Rearrange the formula to make h the subject.

h = ...

(3)

Two mathematically similar frustums have heights of 20 cm and 30 cm.

The surface area of the smaller frustum is 450 cm^2.

(c) Calculate the surface area of the larger frustum.

.........................cm^2

(2)

(Total 8 marks)

4. The mass of 5 m^3 of copper is 44 800 kg.

(a) Work out the density of copper.

…………………………… kg/m^3

(2)

The density of zinc is 7130 kg/m^3.

(b) Work out the mass of 5 m^3 of zinc.

………………………… kg

(2)

(Total 4 marks)

5.

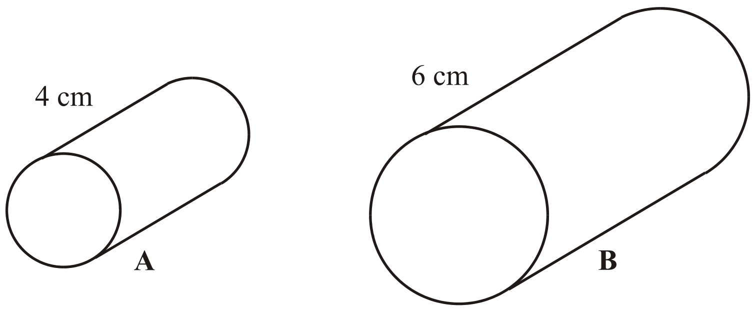


Diagram **NOT** accurately drawn

Cylinder **A** and cylinder **B** are mathematically similar.
The length of cylinder **A** is 4 cm and the length of cylinder **B** is 6 cm.
The volume of cylinder **A** is 80 cm^3.

Calculate the volume of cylinder **B**.

………………………… cm^3
(Total 3 marks)

6.

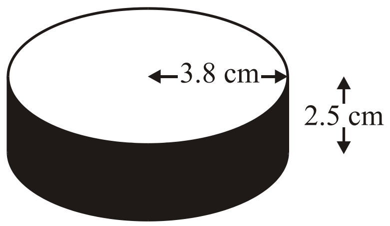


Diagram **NOT** accurately drawn

An ice hockey puck is in the shape of a cylinder with a radius of 3.8 cm, and a thickness of 2.5 cm.

It is made out of rubber with a density of 1.5 grams per cm^3.

Work out the mass of the ice hockey puck.
Give your answer correct to 3 significant figures.

.... grams
(Total 4 marks)

7. The diagram shows a sector of a circle with a radius of x cm and centre O.
PQ is an arc of the circle.
Angle $POQ = 120°$.

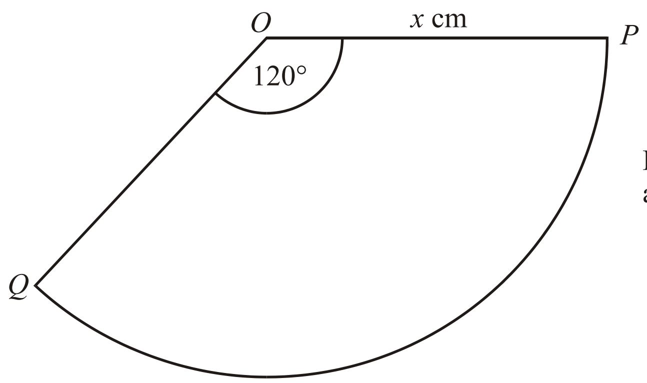


Diagram **NOT** accurately drawn

(a) Write down an expression in terms of π and x for

(i) the area of this sector,

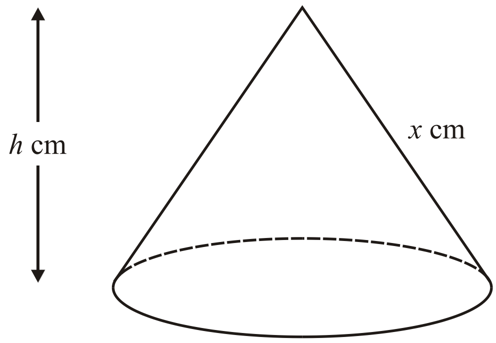
....

(ii) the arc length of this sector.

....

(2)

The sector is the net of the curved surface of this cone.
Arc PQ forms the circumference of the circle that makes the base of the cone.



The curved surface area of the cone is A cm^2.
The volume of the cone is V cm^3.
The height of the cone is h cm.

Given that $V = 3A$,

(b) find the value of h.

....

(3)
(Total 5 marks)

8. X and Y are two geometrically similar solid shapes.

The total surface area of shape X is 450 cm^2.
The total surface area of shape Y is 800 cm^2.

The volume of shape X is 1350 cm^3.

Calculate the volume of shape Y.

.... cm^3
(Total 3 marks)

9.

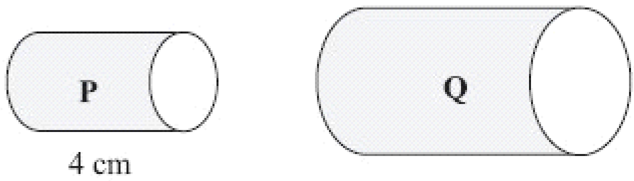


Diagram **NOT** accurately drawn

Two cylinders, **P** and **Q**, are mathematically similar.

The total surface area of cylinder **P** is 90π cm^2.

The total surface area of cylinder **Q** is 810π cm^2.

The length of cylinder **P** is 4 cm.

(a) Work out the length of cylinder **Q**.

…………… cm

(3)

The volume of cylinder **P** is $100\pi\ \text{cm}^3$.

(b) Work out the volume of cylinder **Q**.
Give your answer as a multiple of π.

…………… cm^3
(2)
(Total 5 marks)

10.

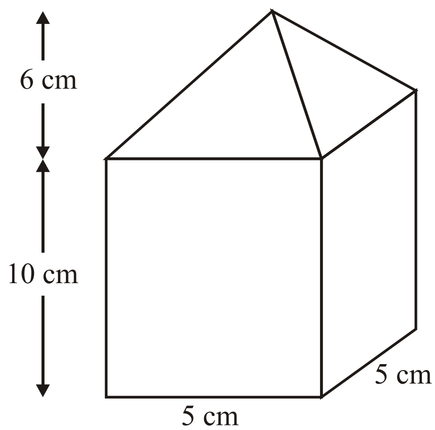


Diagram **NOT** accurately drawn

The diagram shows a model.
The model is a cuboid with a pyramid on top.
The base of the model is a square with sides of length 5 cm.
The height of the cuboid in the model is 10 cm.
The height of the pyramid in the model is 6 cm.

(a) Calculate the volume of the model.

.... cm^3

(3)

The model represents a concrete post.
The model is built to a scale of 1:30
The surface area of the model is 290 cm^2.

(b) Calculate the surface area of the post.
Give your answer in square metres.

.... m^2

(3)

(Total 6 marks)

11.

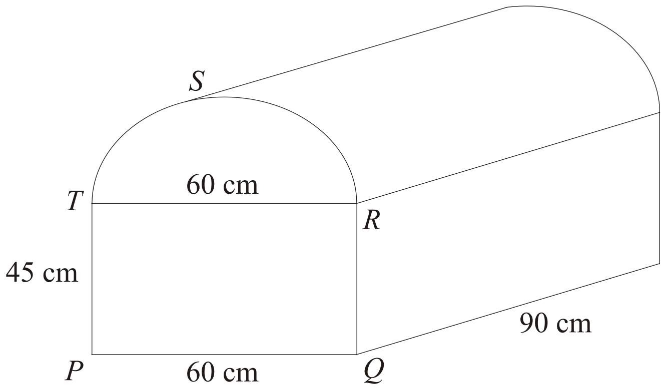


Diagram **NOT** accurately drawn

The diagram shows a prism of length 90 cm.
The cross section, *PQRST*, of the prism is a semi-circle above a rectangle.
PQRT is a rectangle.
RST is a semi-circle with diameter *RT*.
$PQ = RT = 60$ cm.
$PT = QR = 45$ cm.

Calculate the volume of the prism.
Give your answer correct to 3 significant figures.

.... cm^3
(Total 4 marks)

12.

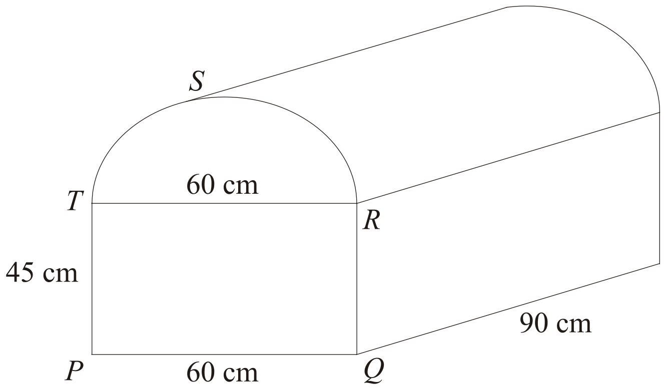


Diagram **NOT** accurately drawn

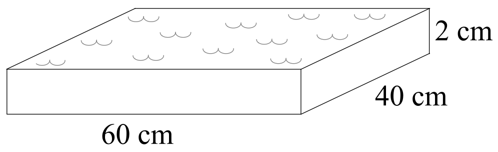
The diagram shows a prism of length 90 cm.
The cross section, *PQRST*, of the prism is a semi-circle above a rectangle.
PQRT is a rectangle.
RST is a semi-circle with diameter *RT*.
PQ = *RT* = 60 cm.
PT = *QR* = 45 cm.

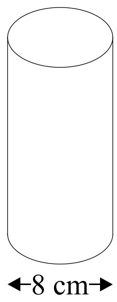
Calculate the volume of the prism.
Give your answer correct to 3 significant figures.
State the units of your answer.

....

(Total 5 marks)

13.





Diagrams **NOT** accurately drawn

A rectangular tray has length 60 cm, width 40 cm and depth 2 cm.
It is full of water.
The water is poured into an empty cylinder of diameter 8 cm.

Calculate the depth, in cm, of water in the cylinder.
Give your answer correct to 3 significant figures.

.... cm
(Total 5 marks)

14.

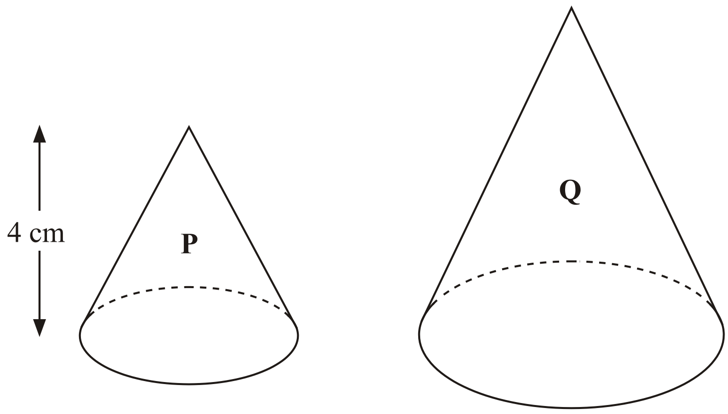


Diagram **NOT** accurately drawn

Two cones, **P** and **Q**, are mathematically similar.
The total surface area of cone **P** is 24 cm^2.
The total surface area of cone **Q** is 96 cm^2.
The height of cone **P** is 4 cm.

(a) Work out the height of cone **Q**.

.... cm
(3)

The volume of cone **P** is 12 cm^3.

(b) Work out the volume of cone **Q**.

.... cm^3

(2)
(Total 5 marks)

15. The diagram shows a cylinder and a sphere.

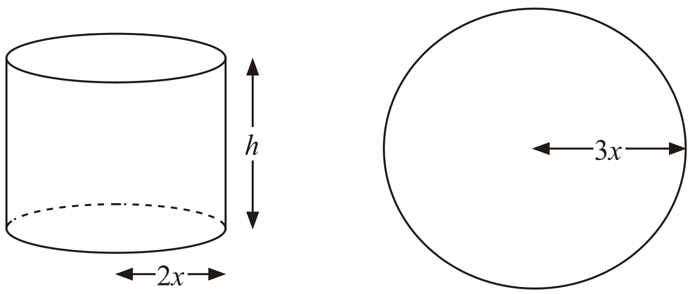


Diagram **NOT** accurately drawn

The radius of the base of the cylinder is $2x$ cm and the height of the cylinder is h cm.
The radius of the sphere is $3x$ cm.
The volume of the cylinder is equal to the volume of the sphere.

Express h in terms of x.
Give your answer in its simplest form.

h = ...
(Total 3 marks)

16.

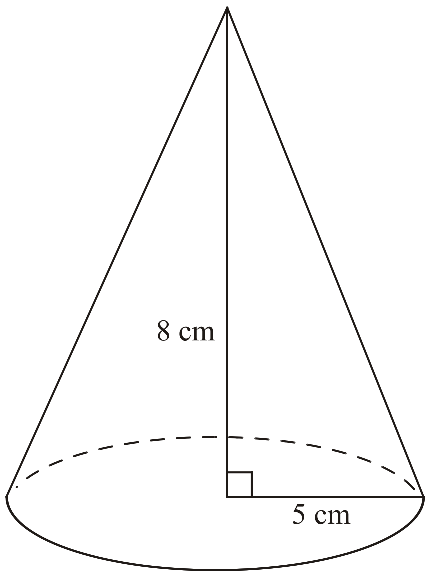


Diagram **NOT** accurately drawn

A cone has a base radius of 5 cm and a vertical height of 8 cm.

(a) Calculate the volume of the cone.
Give your answer correct to 3 significant figures.

.... cm^3

(2)

Here is the net of a different cone.

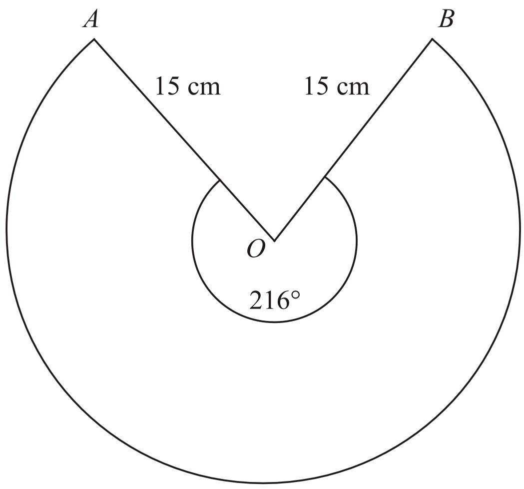


Diagram **NOT** accurately drawn

The net is a sector of a circle, centre O, and radius 15 cm.
Reflex angle $AOB = 216°$
The net makes a cone of slant height 15 cm.

(b) Work out the vertical height of the cone.

.... cm
(4)
(Total 6 marks)

17.

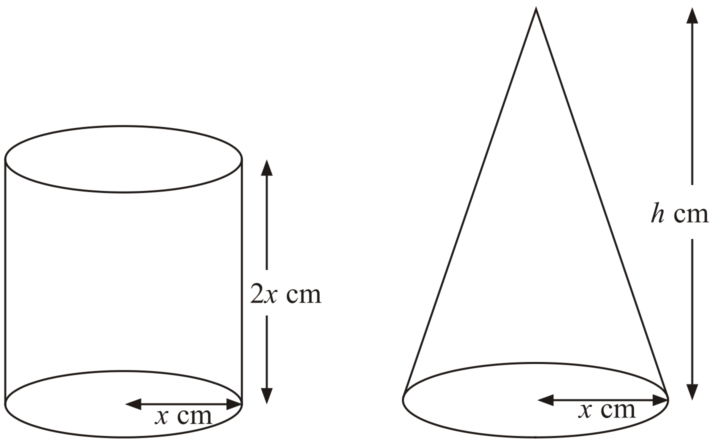


Diagram **NOT** accurately drawn

A cylinder has base radius x cm and height $2x$ cm.

A cone has base radius x cm and height h cm.

The volume of the cylinder and the volume of the cone are equal.

Find h in terms of x.
Give your answer in its simplest form.

h = ...
(Total 3 marks)

18. The diagram shows a storage tank.

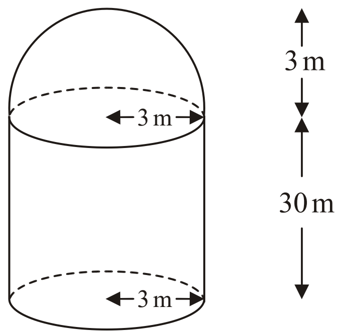


Diagram **NOT** accurately drawn

The storage tank consists of a hemisphere on top of a cylinder.

The height of the cylinder is 30 metres.
The radius of the cylinder is 3 metres.
The radius of the hemisphere is 3 metres.

(a) Calculate the total volume of the storage tank.
Give your answer correct to 3 significant figures.

.... m^3
(3)

A sphere has a volume of 500 m^3.

(b) Calculate the radius of the sphere.
Give your answer correct to 3 significant figures.

.... m
(3)
(Total 6 marks)

19.

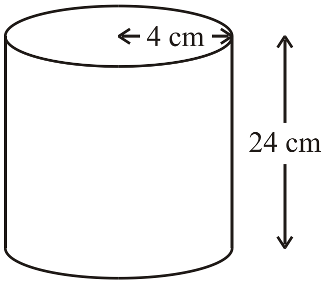


Diagram **NOT** accurately drawn

A cylinder has a height of 24 cm and a radius of 4 cm.
Work out the volume of the cylinder.
Give your answer correct to 3 significant figures.

…………………………… cm^3
(Total 2 marks)

20. A clay bowl is in the shape of a hollow hemisphere.

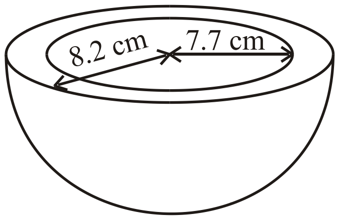


Diagram **NOT** accurately drawn

The external radius of the bowl is 8.2 cm.
The internal radius of the bowl is 7.7 cm.
Both measurements are correct to the nearest 0.1 cm.

The upper bound for the volume of clay is $k\pi$ cm^3.
Find the exact value of k.

k = ………………………..

(Total 4 marks)

21.

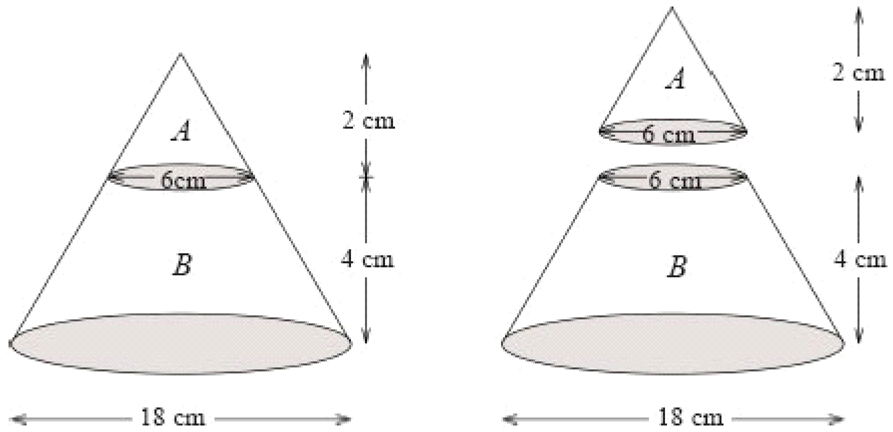


Diagram **NOT** accurately drawn

The diagram represents a large cone of height 6 cm and base diameter 18 cm.

The large cone is made by placing a small cone *A* of height 2 cm and base diameter 6 cm on top of a frustum *B*.

Calculate the volume of the frustum *B*.
Give your answer in terms of π.

....
(Total 4 marks)

22.

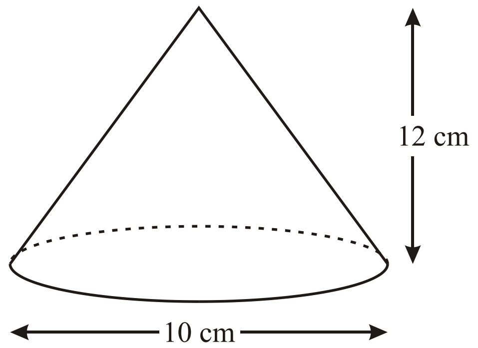


Diagram **NOT** accurately drawn

The diagram represents a cone.
The height of the cone is 12 cm.
The diameter of the base of the cone is 10 cm.

Calculate the curved surface area of the cone.
Give your answer as a multiple of π.

…………….. cm^2

(Total 3 marks)

23.

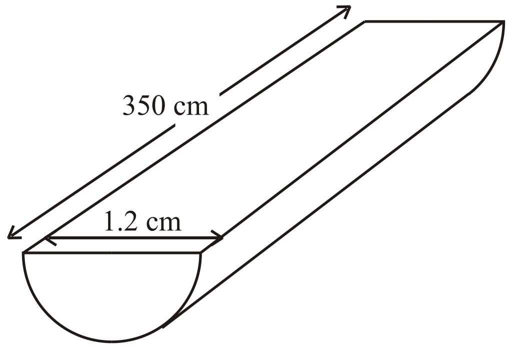


Diagram **NOT** accurately drawn

The diagram shows a piece of wood.
The piece of wood is a prism of length 350 cm.
The cross-section of the prism is a semi-circle with diameter 1.2 cm.

Calculate the volume of the piece of wood.
Give your answer correct to 3 significant figures.

………………………… cm^3
(Total 4 marks)

24.

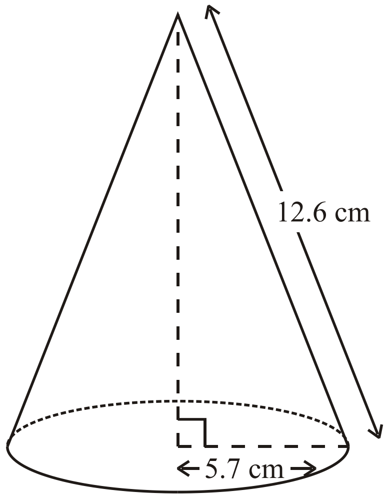


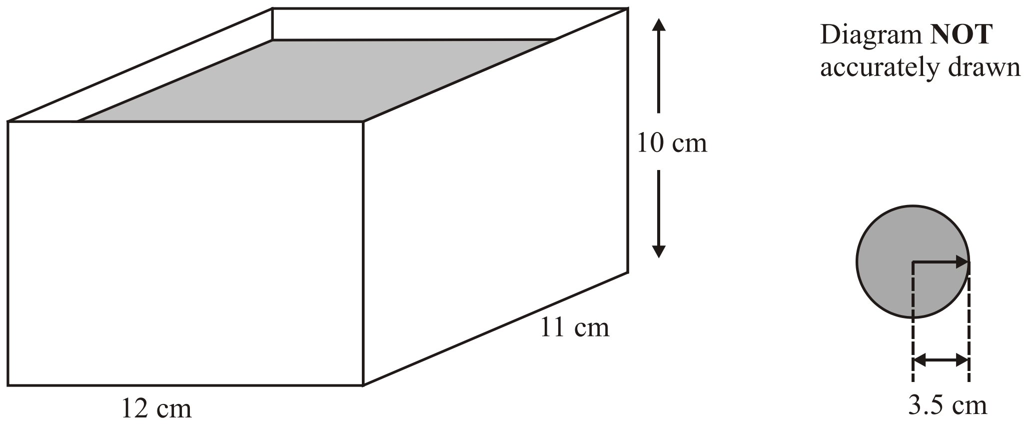
Diagram **NOT** accurately drawn

The radius of the base of a cone is 5.7 cm.
Its slant height is 12.6 cm.

Calculate the volume of the cone.
Give your answer correct to 3 significant figures.

…………………….. cm^3
(Total 4 marks)

25.



A rectangular container is 12 cm long, 11 cm wide and 10 cm high.
The container is filled with water to a depth of 8 cm.

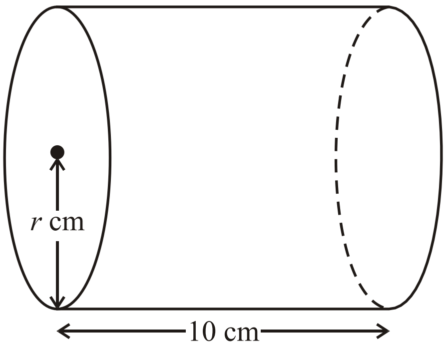
A metal sphere of radius 3.5 cm is placed in the water.
It sinks to the bottom.

Calculate the rise in the water level.
Give your answer correct to 3 significant figures.

..............................cm
(Total 4 marks)

26.

Diagram **NOT** accurately drawn



The diagram shows a cylinder.
The radius of the cylinder is *r* cm.
The length of the cylinder is 10 cm.

The volume of the cylinder is 140 cm^3.

Work out the value of *r*.
Give your answer correct to 3 significant figures.

r =.....................................
(Total 3 marks)

27.

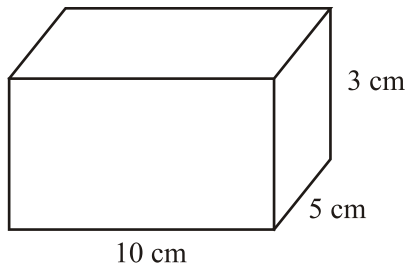


Diagram **NOT** accurately drawn

The diagram shows a solid cuboid.
The cuboid has length 10 cm, width 8 cm and height 5 cm.

The cuboid is made of wood.
The wood has a density of 0.6 grams per cm^3.

Work out the mass of the cuboid.

.... grams
(Total 4 marks)

28. Here is a triangular prism.

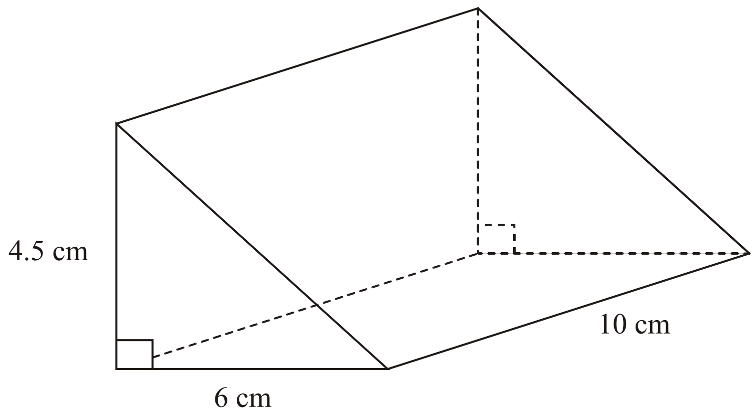


Diagram **NOT** accurately drawn

Calculate the volume of the prism.

.... cm^3

(Total 3 marks)

29.

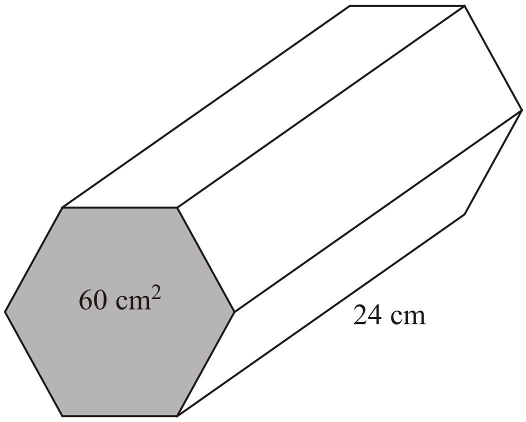


Diagram **NOT** accurately drawn

The diagram shows a solid hexagonal prism.

The area of the cross-section of the prism is 60 cm^2.
The length of the prism is 24 cm.

(a) Work out the volume of the prism.

.... cm^3
(2)

The prism is made from wood.
The prism has a mass of 648 g.

(b) Work out the density of the wood.

.... g/cm^3
(2)
(Total 4 marks)

30.

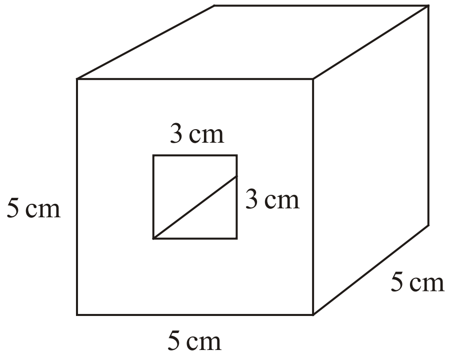


Diagram **NOT** accurately drawn

The solid shape, shown in the diagram, is made by cutting a hole all the way through a wooden cube.
The cube has edges of length 5 cm.
The hole has a square cross section of side 3 cm.

(a) Work out the volume of wood in the solid shape.

.... cm^3

(2)

The mass of the solid shape is 64 grams.

(b) Work out the density of the wood.

.... grams per cm^3

(2)
(Total 4 marks)

1. (a) 502 – 503 cm^3 2

$V = \pi \times 4^2 \times 10$

M1 for $\pi \times 4^2 \times 10$
A1 502 − 503

(b) $\sqrt{164} < 13$ 3

$P^2 = 10^2 + 8^2$
$P = \sqrt{164}$

M1 for sight of a correct right-angled triangle
M1 for $10^2 + 8^2$
A1 for conclusion based on a correct calculation or 12.8 seen

[5]

2. (a) AG 2

$x^2(x + 1) = 230$

M1 for $x \times x \times (x + 1)$ or $x \times x \times x + 1$ oe, $x^2 (x + 1)$, $x^2 \times x + 1$
A1 cao from $x \times x \times (x + 1)$, no need to see 230

(b) 5.8 4

5 – 150 6 – 252
5.1 – 158.7
5.2 – 167.6
5.3 – 177.0
5.4 – 186.6
5.5 – 196.6
5.6 – 207.0
5.7 – 217.7
5.8 – 228.8
5.9 –240.2
5.85 – 234.4

B 2 for trial between 5.8 and 5.9 inclusive evaluated
(B1 for different trial between 5 and 6 inclusive evaluated)
B1 for different trial between 5.8 and 5.85 (not including 5.8)
B1 (dep on at least one previous B1) cao for 5.8, 5.81, 5.811

[6]

3. (a) 1700 3

$$\pi \times 30 \times \frac{7.5^2}{3} - \pi \times 10 \times \frac{2.5^2}{3} = 1767 - 65$$

M1 for either $\pi \times 30 \times \frac{7.5^2}{3}$ *or* $\pi \times 10 \times \frac{2.5^2}{3}$
M1 (dep) for difference
A1 1700 – 170
SC *B1 Using d instead of r, 6800 – 6808*

(b) $h = \sqrt{\dfrac{S^2 - 4\pi^2 d^4}{4\pi^2 d^2}}$ 3

$\dfrac{S}{2\pi d} = \sqrt{h^2 + d^2}$

$\left(\dfrac{S}{2\pi d}\right)^2 = h^2 + d^2$

M1 for correctly isolating $\sqrt{h^2 + d^2}$ *or* $h^2 + d^2$ *or h + d or* kh^2 *or kh*
M1(indep) squaring both sides
A1

$h = \sqrt{\dfrac{S^2 - 4\pi^2 d^4}{4\pi^2 d^2}}$, $h = \dfrac{\sqrt{S^2 - 4\pi^2 d^4}}{2\pi\pi}$

$h = \sqrt{\left(\dfrac{S}{2\pi\pi}\right)^2 - d^2}$

(c) 1012.5 2

$\left(\dfrac{30}{20}\right)^2 \times 450$ or $450 \div \left(\dfrac{20}{30}\right)^2$

M1 for sight of correct SF^2 *including 4:9*
A1 1010 to 1013

[8]

4. (a) 8960 2

44800 ÷ 5

M1 for 44800 ÷ 5
A1 cao

(b) 35650 2

7130 × 5

M1 for 7130 × 5
A1 cao

[4]

5. 270 3

Sf = $\frac{3}{2}$

Vol = $\left(\frac{3}{2}\right)^3 \times 80$

M1 for $\frac{3}{2}$ oe (or $\frac{2}{3}$ oe or ratio with evidence)

M1 for $\left(\frac{3}{2}\right)^3 \times 80$ oe

A1 cao

[3]

6. 170 4

Vol = $\pi \times 3.8^2 \times 2.5 = \pi \times 14.44 \times 2.5$
= 45.36… × 2.5 = 113.411
Mass = “113” × 1.5 = 170.1165

M1 for $\pi \times r^2 \times 2.5$ where r = is 3.8 or 7.6
A1 if r = 3.8
M1 for “113” × 1.5
A1 for 169.5 – 170.3 cao

[4]

7. (a) (i) $\frac{1}{3}\pi x^2$ 1

B1 for $\frac{1}{3}\pi x^2$ *oe*

(ii) $\frac{2}{3}\pi x$ 1

B1 for $\frac{2}{3}\pi x$ *oe*

(b) $h = 27$ 3

$1/3\pi \times (1/3x)^2 \times h = 3 \times 1/3\ \pi x^2$

$\frac{\pi h x^2}{27} = \pi x^2$

M1 for $\frac{1}{3}\pi r^2 h = 3\pi rx$

M1 for $2\pi\pi = \frac{2}{3}\pi x$ *or* $\pi rx = \frac{\pi x^2}{3}$ *or* $r = \frac{1}{3}x$

A1 for 27 cao

[5]

8. 3200 cm^3 3

SF (length) = $\sqrt{\frac{800}{450}} = \frac{4}{3}$

vol = '$\left(\frac{4}{3}\right)^3$' × 1350

B1 for Sf(length) = $\sqrt{\frac{800}{450}}$ *oe*

M1 for '$\left(\frac{4}{3}\right)^3$' × *1350 or* '$\left(\frac{4}{3}\right)^3$' = $\frac{vol}{1350}$ *oe*

A1 cao

SC for vol = 2400 give B0 M1 A0

[3]

9. (a) 12 3

$\frac{810\pi}{90\pi}$ or 9

$\sqrt{9}$ or 3

M1 for $\frac{810\pi}{90\pi}$ or 9 or $\frac{1}{9}$ or 1:9 oe

M1 for $\sqrt{\frac{810\pi}{90\pi}}$ or $\sqrt{9}$ or 3 or $\frac{1}{3}$ or $\sqrt{9}$: $\sqrt{1}$ oe

A1 cao

SC:B1 for answer of 36

(b) 2700π 2

3^3 or 27 or 2700

M1 for "3"^{3} or 27 or $\left(\sqrt{9}\right)^3$: $\left(\sqrt{81}\right)^3$ oe or 9^3 or 2700–

A1 cao

[5]

10. (a) $5 \times 5 \times 10 = 250$

$5 \times 5 \times 6 \div 3 = 50$

300 3

M1 for either $5 \times 5 \times 10$ or $5 \times 5 \times 6 \div 3$

M1 (dep) for '$5 \times 5 \times 6 \div 3$' + '$5 \times 5 \times 10$'

A1 cao

(b) Area scale factor is 30^2

$290 \times 30^2 = 261000$ cm^2

$261000 \div 10000$

26.1 3

B1 for 30^2 or 900

M1 for 290×30^2 or digits 261 seen

A1 cao

[6]

11. $(\frac{1}{2} \times \pi \times 30^2 + 60 \times 45) \times 90$ 4

$(1/2 \times 2827.43 + 2700) \times 90$
$(1413.7.. + 2700) \times 90$
$4113.7.. \times 90 = 370234.5...$
$= 370\ 000$

Cross-section approach:

M1 for $(\frac{1}{2} \times)\pi \times 30^2$" (= 2827.4 or 1413.7) or 60 × 45 (= 2700)

M1 for "$(\frac{1}{2} \times)\ \pi \times 30^2$" + 60 × 45 (complete method)

M1 for "any area" × 90 or 4110 – 4115

A1 for 370 000 to 370300

Volume approach:

M1 for $(\frac{1}{2} \times)\pi \times 30^2$ or 60 × 45

M1 for "$(\frac{1}{2} \times)\pi \times 30^2$" × 90 (= 127234 or 254468) or 60 × 45 × 90 (= 243000)

M1 for addition of two volumes

A1 for 370 000 to 370300 (370 235)

[4]

12. $(\frac{1}{2} \times \pi \times 30^2 + 60 \times 45) \times 90$ 5

$(1/2 \times 2827.43 + 2700) \times 90$
$(1413.7.. + 2700) \times 90$
$4113.7.. \times 90 = 370234.5...$
$= 370\,000$

Cross-section approach:

M1 for $(\frac{1}{2}\times)\pi \times 30^2$ (= 2827.4 or 1413.7) or 60×45 (= 2700)
M1 for "$(\frac{1}{2}\times)\ \pi \times 30^2$" + 60×45 (complete method)
M1 for "any area" × 90 or 4110 – 4115
A1 for 370 000 to 370300
B1 correct units

Volume approach:

M1 for $(\frac{1}{2}\times)\pi \times 30^2$ or 60×45
M1 for "$(\frac{1}{2}\times)\pi \times 30^2$" × 90 (= 127234 or 254468) or $60 \times 45 \times 90$ (= 243000)
M1 for addition of two volumes
A1 for 370 000 to 370300 (370 235)
B1 correct units

[5]

13. $60 \times 40 \times 2$ 5

4800
"4800"$= \pi \times 4^2 \times h$
$\frac{\text{"4800"}}{\text{"50.265..."}}$
$= 95.5$

M1 $60 \times 40 \times 2$
A1 for 4800
M1 for $\pi \times 4^2$ or 50.265...
M1 for "4800" ÷ "$\pi \times 4^2$"
A1 95.49 – 95.5

[5]

14. (a) $\frac{96}{24}$ or 4

$\sqrt{4}$ or 2 = 8 — 3

M1 for $\frac{96}{24}$ *or* $\frac{24}{96}$ *or 4 or* $\frac{1}{4}$ *oe*

M1 for $\sqrt{\frac{96}{24}}$ *or* $\sqrt{\frac{24}{96}}$ *or* $\sqrt{'4'}$ *or* $\frac{1}{\sqrt{'4'}}$ *or 2 or* $\frac{1}{2}$ *oe*

A1 cao

(b) $12 \times 2^3 = 96$ — 2

M1 for '2' ^{3} *or 8*

A1 cao

[5]

15. $\pi(2x)^2 h = \frac{4}{3}\pi(3x)^3$

$$h = \frac{\frac{4}{3}\pi(3x)^3}{\pi(2x)^2} = 9x$$ — 3

M1 for $\pi(2x)^2 h = \frac{4}{3}\pi(3x)^3$ *(condone absence of brackets)*

M1 (dep) for valid algebra that gets to h = ax (condone one error in powers of numerical constants)

A1 cao

[3]

16. (a) $\frac{1}{3} \times \pi \times 5^2 \times 8 = \pi \times 25 \times 8 \div 3 = 209.4395$

209 – 210 — 2

M1 for $\frac{1}{3} \times \pi \times 5^2 \times 8$

A1 for 209 – 210

(b) Base radius = $\frac{216}{360} \times 15 = 9$

Height = $\sqrt{(15^2 - 9^2)} = 12$ 4

M1 for 216 ÷ 360
A1 for 9
M1 for $\sqrt{(15^2 - \text{“}9\text{”}^2)}$ *, where “9” < 15*
A1 cao

[6]

17. $\pi x^2(2x) = \frac{1}{3}\pi(x)^2 h$

$6x$ 3

M1 for a correct volume formula in terms of x, e.g. $\pi x^2(2x)$ *or* $\frac{1}{3}\pi x^2 h$

A1 for $\pi(2x) = \frac{1}{3}\pi h$ *or* $3\pi x^2(2x) = \pi x^2 h$ *or* $x^2(2x) = \frac{1}{3}x^2 h$ *(or better)*

A1 for 6x cao

[3]

18. (a) $V_c = \pi \times 3^2 \times 30$

$V_h = \frac{2}{3} \times \pi \times 3^3$

$V_c + V_h = 288\pi$

905 3

M1 $V_c = \pi \times 3^2 \times 30$ *(= 848.2…)* ***or*** $V_h = \frac{2}{3} \times \pi \times 3^3$ *(= 56.54...)*

M1 (dep) $V_c + V_h$ *(may be implied)*

A1 904 – 905 inclusive

(b) $\frac{4}{3} \times \pi \times R^3 = 500$

$R^3 = \frac{500 \times 3}{4 \times \pi}$

4.92 3

M1 for $\frac{4}{3} \times \pi R^3 = 500$

M1 for correct process to reach

$R^3 = \frac{500 \times 3}{4 \times \pi}$ *oe (= 119.3...) or* $\sqrt[3]{\frac{500 \times 3}{4 \times \pi}}$ *(implies 1st M1)*

A1 4.915 – 4.925

[6]

19. 1210 cm^3 2

$\pi \times 4^2 \times 24$

M1 for $\pi \times 4^2 \times 24$

A1 for 1210 or $1205 \leq$ *answer* < 1208

[2]

20. 75.879

$\frac{1}{2} \times \frac{4}{3}\pi \times 8.25^3 - \frac{1}{2} \times \frac{4}{3}\pi \times 7.65^3$

$= (374.34375 - 98.46475)\pi$

$= 75.879\pi$ 4

B1 for 8.25 or 7.65 seen

M1 for expression using r = 8.25 minus same expression using r = 7.65

M1 for $\frac{1}{2} \times \frac{4}{3}\pi \times R^3 - \frac{1}{2} \times \frac{4}{3}\pi \times r^3$ *used*

A1 cao

[4]

21. 156π 4

$\frac{1}{3} \times \pi \times 9^2 \times 6 - \frac{1}{3} \times \pi \times 3^2 \times 2$

$162\pi - 6\pi$

M1 for $\frac{1}{3} \times \pi \times 9^2 \times 6$ *OR* $\frac{1}{3} \times \pi \times 3^2 \times 2$

M1 for $\frac{1}{3}\pi^2 R^2 H - \frac{1}{3}\pi r^2 h$

A1 for 156π oe [must be a single expression]

B1 (indep) for cm^3

[4]

22. 65π 3

$l^2 = 5^2 + 12^2$

$l = 13$

$\pi \times 5 \times$ "13"

M1 for $5^2 + 12^2$

M1 dep for $\pi \times 5 \times \sqrt{5^2 + 12^2}$

A1 cao

[3]

23. 198 4

$\pi \times 0.6^2$ (1.13…)

$\frac{\text{"1.13..."}}{2}$

"0.565…" × 350

M1 for $\frac{\pi \times \left(\frac{1.2}{2}\right)^2 \times 350}{2} = \frac{1.13.... \times 350}{2} = \frac{395.8...}{2}$ *or*

0.565… × 350

(M2 for either $\frac{\pi \times \left(\frac{1.2}{2}\right)^2}{2}$ *OR* $\pi \times \left(\frac{1.2}{2}\right)^2$ *x 350, x ≤ 1.2cm)*

(M1 for either $\pi \times \left(\frac{1.2}{2}\right)^2$ *OR* $\frac{\pi \times x^2}{2}$ *OR* $\pi \times x^2 \times 350$*,*

x ≤ 1.2cm

A1 cao (accept 197.75 to 198 inclusive)

[4]

24. 382 4

$12.6^2 - 5.7^2 = 126.27$
height = 11.2 (369…)
V = $\pi(5.7)^2$ (“$\sqrt{126.27}$”) ÷ 3

M1 $12.6^2 = h^2 + 5.7^2$
M1 $\sqrt{12.6^2 - 5.7^2}$ $(= \sqrt{126.27})$
M1 (dep on 1st M1) for $\pi\,(5.7)^2$ (“$\sqrt{126.27}$”) $\div 3$
A1 for $380.8 \le ans < 382.5$

[4]

25. Vol sphere = $\frac{4}{3} \times \pi \times 3.5^3$
= 179.59...
Height = $\frac{"179.59"}{12 \times 11}$
1.36 4

M1 for $\frac{4}{3} \times \pi \times 3.5^3 = (179.59...)$
M1 for $12 \times 11 \times x$ = “179.59...” *or 1 cm rise is* $132cm^3$ *of water.~*
M1 for $x = \frac{"179.59"}{12 \times 11}$
A1 for 1.36 – 1.364
Alternative method
M1 for $\frac{4}{3} \times \pi \times 3.5^3 (= 179.59...)$
M1 for $12 \times 11 \times 8$ + “179.59”(= 1235.59...)
M1 for $\frac{"1235.59.."}{12 \times 11}$ *OR* $\frac{12 \times 11 \times 10 - "1235.59"}{12 \times 11}$
A1 for 1.36 – 1.364

[4]

26. $140 = \pi \times r^2 \times 10$
$r^2 = 140/10\pi$
$(= 4.4563……)$
2.11 — 3

M1 for $\pi r^2 \times 10 = 140$ or $A \times 10 = 140$
M1 for $(r^2 =) \dfrac{140}{10\pi} (= 4.456...)$
A1 for 2.11 – 2.112
(SC: Answer of scores M2 with or without working)

[3]

27. $10 \times 5 \times 8$ (= 400) — 4
"400" × 0.6 = 240

M2 for 10 × 5 × 8 (= 400)
(M1 for two of 10, 5, 8 seen as part of a volume calculation)
M1 for "400" × 0.6
A1 cao

[4]

28. ½ × 6 × 4.5 = 13.5 — 3
13.5 × 10
= 135

M1 for ½ × 6 × 4.5 oe (or 13.5 seen)
M1 for "½ × 6 × 4.5" × 10
A1 cao
SC: Award B1 for an answer of 270

[3]

29. (a) 60 × 24 (= 1440) — 2
= 1440

M1 for 60 × 24 (= 1440)
A1 cao

(b) 648 ÷ "1440" — 2
= 0.45

M1 ft for 648 ÷ "1440"
A1 ft for "0.45"

(a) $60^2 \times 24 = 86400$ gets M0A0
$60 \times 24 = 1440$ then 1440×60 (or $\times \frac{1}{2}$) $= 86400$ (720) gets M0A0
***BUT** 60 cm^2 $\times$ 24 gets M1*
*(b) Candidates will gain the full follow through credit, if their answer to part (b) is 648 divided by their answer to part (a), with or **without** working.*
Sorry, we will have to check these answers.
Most do seem to be getting the volume correct.

[4]

30. (a) $5^3 - 5 \times 3 \times 3$
$125 - 45$

$(5 \times 5 - 3 \times 3) \times 5$
$(25 - 9) \times 5$
16×5

80 — 2

M1 for attempt to find volume of cube (e.g. $5 \times 5 \times n$ where $n \neq 6$) and subtract volume of the hole (e.g. $3 \times 3 \times n$ where $n \neq 6$) (needs to be dimensionally correct)
A1 cao

Alternative method
M1 for attempt to find area of the cross section and multiply by the depth of the prism (depth $\neq 6$)
A1 cao

(b) $64 \div 80$
0.8 — 2

M1 ft 64 ÷ "80"
A1 ft (to 2 sf or better)

[4]

1. **Mathematics A**

Paper 4

Less than half the candidates answered part (a) correctly. This was a straightforward question but a significant number failed to recall the correct formula. Many incorrect methods were seen. Often these started with $\pi \times 4$ or $2 \times \pi \times 4$ but some candidates did not use π at all. Part (b) was answered very poorly indeed. Few candidates thought of placing the pencil in the cylinder at an angle and even fewer recognised it to be a question in which they could use Pythagoras.

Paper 6

Part (a) was usually well done. There were some students who thought that the correct formula was $2\pi r^2$ presumably because of the two ends.
Part (b) caused no difficulty for candidates who realised that the crucial idea was to consider the pencil lying diagonally in the can, so making a right-angled triangle. Once that was realised most candidates scored full marks, although there was a significant number who used $10^2 + 4^2$.

Mathematics B Paper 19

The vast majority of candidates answered part (a) correctly. Part (b) was less well done. Many candidates did not recognise that they had to consider the diagonal length in the cylinder. Of those who did consider the diagonal and use Pythagoras's Theorem, a sizeable number used the radius instead of the diameter in their calculation.

2. **Paper 4**

Few candidates did any work in part (a) that related to the problem and many attempted to substitute numbers at this stage. Those who realised that the height of the cuboid was $x + 1$ usually gained at least one mark. Trial and improvement was generally popular and most candidates had some success in part (b). A surprising number did not evaluate a trial in the range $5.8 < x \le 5.85$, losing the final mark. Some did not fully evaluate their trials and gained no marks. A few candidates incorrectly evaluated expressions such as $5^3 + 6^2$, i. e. they used x and $x + 1$.

Paper 6

Part (a) was the first question on the paper where an equation was to be derived, which was then to be subsequently solved. Many candidates had the correct idea of multiplying length by width by height, but lost marks through poor algebra, such as $x \times x \times x + 1$. Some candidates tried to identify the cube term as a volume and the square term as an area and then argued that adding them together gave the total volume.
The second part was well done, with no evidence that candidates on this paper were put off by the squared term.

3. The first part was competently done with many candidates scoring full marks. Some thought they could take a short cut by using 20cm as the height.
Answers for part (b) varied considerably, but the general standard of algebra was poor. Common errors were as follows:

$$\sqrt{h^2 + d^2} = h + d$$

$$S - 2\pi d = \sqrt{h^2 + d^2}$$

$$S^2 = 2\pi d(h^2 + d^2)$$

Some candidates produced a correct formula for *h*, but went on to 'simplify' the square root, writing

$$\sqrt{\frac{S^2}{(2\pi d)^2} - d^2} = \frac{S}{2\pi d} - d$$

Part (c) was poorly answered except by candidates who knew that the scale factor for areas was the square of the scale factor for lengths, or used the corresponding result for the areas of similar shapes.

4. About one quarter of the candidates did not attempt this question but many of those that did used a correct method. Unfortunately the standard of arithmetic was poor. In part (a), for example, almost half of the candidates with a correct method could not divide 44800 by 5 correctly. Some candidates chose to multiply by 5 in part (a) and divide by 5 in part (b) and some were confused by 'm^3' and attempted to multiply or divide by 125.

5. Although many candidates were awarded credit for stating/using the correct linear scale factor, it was rare to find a full correct solution to this question on the ratio of volumes being proportional to the ratio of cubes of corresponding lengths. The two most common wrong answers were 120 and 180. A significant minority of those who used the correct method failed to obtain the correct answer because they made the calculation more difficult by cubing the decimal rather than the fraction.

6. Mathematics A

Paper 4

Only the more able candidate pursued this question through to a correct answer. The first stage involved recall of the method for calculating the volume of a cylinder. Weaker candidates merely multiplied the given numbers together without any reference to π. However, a greater proprotion of the candidature did include π in their answers than previosuly, which is encouraging, though the common error was to square the π. A majority of candidates therefore arrived at a correct volume for the cylinder, gaining half the marks. Of those who did, many then spoilt their solution by dividing by 1.5. Candidates who attempted to multiply an incorrect volume by 1.5 were given some credit at this stage.

Paper 6

This proved to be more of a challenge than expected. Most candidates could get 113 for the volume of the cylinder, but a substantial number went on to divide their volume by 1.5, instead of multiplying. A few candidates used πDh for the volume.

Mathematics B

Paper 17

The formulae for the area and circumference of a circle is clearly not as well known as one would like. Very few candidates scored full marks on this question.
A significant number of candidates ignored phi and calculated $3.8^2 \times 2.5$ in order to find the volume. Weaker candidates often calculated 3.8×2.5. Many used the density correctly in an attempt to find the mass and were awarded one mark for multiplying by 1.5.

Paper 19

The majority of candidates were able to gain some marks on this question either for evaluating the volume correctly or for knowing that the volume had to be multiplied by the density in order to find the mass of the ice hockey puck. Common errors including using $2\pi rh$ for the volume of a cylinder or dividing rather than multiplying by the density.

7. Candidates found this to be the most demanding question on the paper with only 3% able to give a fully correct solution to part (b). About 12% of candidates were able to write an expression in terms of x, r and h but then failed to write r in terms of x. (r being the radius of the base of the cone). It was gratifying to note however that about 50% of candidates were able to obtain both marks for part (a).

8. There was a great deal of misunderstanding over this question. Of course, it is a standard one of its sort. However, pupils do seem to find the ideas difficult and so it proved on this question. One method which did work successfully is to focus on the two areas and from the fraction $\frac{800}{450} = \frac{16}{9}$. This gives the scale factor for the areas. Square rooting this gives the scale factor of the lengths and cubing this scale factor gives the scale factor for the volumes. Most candidates simply used the ratio of the areas to form a multiplier which was then used directly on the smaller volume to get 2400 cm^3 for the larger one.

9. **Specification A**

Most candidates attempted this question but only the best were able to achieve full marks. By far the most common answer to part (a) was 36, and to part (b) was 900π.
In part (b), some candidates were able to score a mark for cubing the scale factor they derived in part (a). A small number of candidates calculated the radius of *P* to deduce the radius, and hence the volume, of *Q*. A significant proportion of those candidates getting as far as the volume 2700π did not understand the demand of the question and omitted to include the π in their final answer.

Specification B

The most commonly seen answer to this question was 36 in (a) and 900π in (b). These were both incorrect solutions and occurred when candidates mistakenly used the area scale factor as the length and then volume scale factor. A small minority of candidates were able to often fully correct solutions although the omission of π from the answer to (b) resulted in some candidates failing to gain the final accuracy mark. There was evidence of some poor arithmetic in this question with 810 divided by 90 being evaluated as 90.

10. Many candidates scored 2 out of the three marks available for part (a). The formula for the volume of a pyramid was not well known and the most common answer was 325 from $250 + 5 \times 5 \times 6 \div 2$. Part (b) tested both knowledge of area scale factors and of conversion of units. Candidates who saw the 30^2 generally went on to gain at least 2 out of the three marks.

11. Many candidate made a valiant attempt at this unstructured question, but there were too many considerations and decisions to be taken, and it was perhaps inevitable that at some stage candidates would fail to make a correct decision. These included using 60 as the radius, failing to halve for a semicircle, quoting the formula for circumference instead of area, and multiplying the wrong dimensions together. Handling circular formulae is a general weakness. Most candidates picked up two marks for showing methods which included finding the area of a cuboid volume, or showing an appreciation that the volume was up of an area multiplied by 90. At the final stage candidates again showed their inability to round to 3 significant figures.

12. This proved to be a very accessible question for the candidates taking the paper. They were able to recognise the fact that there were 2 shapes to deal with and were generally successful in doing so. The more common of the two methods seen was to find the cross-sectional area from a rectangle plus a semi circle. A few candidates used the wrong formula for the area of a circle and a few did not realise that they had to find the area of half a circle. Successful candidates went on to complete the problem by adding the two areas together and then multiplying by 90 to get an answer in cubic cm. The other common method involved adding the volume of the cuboid to that of a semi-cylinder. This was also seen to be done successfully. However, it was quite common to see the volume of the cuboid added to the area of the semicircle rather than to half the volume of a cylinder. Candidates who tried to change from cubic cm to cubic m very often got the answer wrong. They were not penalised for this error so long as the displayed the correct answer initially.

13. Virtually all candidates were able to calculate the volume of water in the rectangular tray. Most then went on to divide this volume by something (either 8 or $\pi\times 8$ or $\pi\times 4^2$), with many then getting the full 5 marks. Once source of error was of those who correctly wrote 4800 divided by 16π but who incorrectly calculated this as $\frac{4800}{16} \times \pi$.

14. This question was not answered well. The vast majority of candidates that attempted this question were able to find the scale factor 4 of the enlargement, usually by dividing 96 by 24 or by ratios, but few of these knew how to proceed from this to the linear scale factor 2 in part (a) and the volume scale factor 8 in part (b). Most candidates simply multiplied the height by 4 to get 16cm in part (a), and multiplied the volume by 4 to get 48cm^3 in part (b).

Very few candidates attempted to use the area and volume formulae for a cone.

15. Few candidates were able to achieve full marks in this question. A surprising number of candidates used incorrect formulae, particularly for the sphere, indicating that many candidates were perhaps unfamiliar with the contents of the formula page.

By far the most common error was the omission of the implied brackets for the powers of $2x$ and $3x$, so that only the x's were squared and cubed. Of those who tried to deal with the numbers a very common error was $3^3 = 9$. The use of algebra to make h the subject of the formula was a problem for some candidates- subtraction often taking the place of division. It was encouraging to see that candidates are now much happier dealing with π by not replacing it with a decimal approximation.

16. Part (a) proved to be straightforward. However, part (b) proved to be challenging. In particular many candidates could not visualise how the sector could turn into the curved surface of the cone and consequently concentrated on the 144° instead of the 216°. Many candidates assumed that the base radius of the cone had to be 15cm and then worked out $15^2 + 15^2$, mistaking the position of the right angle. Of those that got the correct answer, most did it by finding the arc length of the sector and then realising that this would become the circumference of the base of the cone. They then found the radius of the base (9cm) from $\frac{\text{arc lenght}}{2\pi}$. A correct, but less common successful approach was to calculate the area of the sector and then use the formula for the curved surface area of the cone to find the radius from $\frac{\text{area of sector}}{\pi + 15}$.

17. Many candidates were able to score one mark for writing a correct formula for the volume of the cone or the volume of the cylinder in terms of x, and some were able to equate two correct formulae, but few could rearrange the equation accurately to find *h* in terms of *x*. A common error here was $\frac{2x}{\left(\frac{1}{3}\right)} = \frac{2}{3}x$. A small number of candidates were able to compare the two volume formulae and simply write down the answer without working.

18. In part (a), for the volume of the cylinder many used the diameter instead of the radius, others used the surface area. For the volume of the hemisphere – many did not divide by 2, others used 4 × pi × r^2 and then divided by 2 Most candidates realised they had to add two answers together. Other errors in accuracy were through premature rounding. Just under 60% of candidates failed to gain any marks, about 16% of candidates gained full marks. In part (b) working was not always clear in this question and premature (or incorrect) rounding of values in responses where the working was sparse often cost candidates method marks that they might otherwise have gained.

Of those who made a reasonable attempt, many used 4/3 pi r^2 as their initial formula. Others got as far as R^3 = 119.3 but then took the square root instead of cube root. Those candidates that started by quoting an equation were the most successful. The correct answer was seen from just over 14% of candidates.

19. Those who knew the formula for the volume of a cylinder (or area of a circle) generally gained both marks. Attempts at rounding to 3 significant figures were generally poor although were not penalised.

20. Only the most able candidates obtained the correct answer to this demanding question. Many average candidates gained a mark for either a correct bound or for use of a correct formula. Common method errors included using the given values rather than the values for bounds or using 0.5cm as the radius of a hemisphere. Candidates also failed to divide the volume of the sphere by 2. Candidates seldom left □ in their calculation, preferring to evaluate the volume fully and then divide by □ in the final step. Unfortunately, the majority of those who did this lost the final accuracy mark.

21. The majority of candidates were able to score at least one mark here for correctly using the volume of a cone although the diameter was sometimes incorrectly used instead of the radius. The majority of candidates recognised that they had to subtract the volumes of two cones but were let down by their arithmetical skills. The more able candidates understood how to leave their answers in terms of □ but often failed to carry out the final subtraction. As there were no units given on the answer line for this question, candidates were expected to include units with their answer. Only a minority of candidates did do this.

22. The vast majority of candidates were able to select the correct formula from the formula sheet but this, by itself, was not sufficient to gain any marks. Few candidates realised the need to first use Pythagoras's Theorem. Those who did appreciate the need to use Pythagoras's Theorem generally went on to score full marks although there was some evidence of poor arithmetic in answers to this question.

23. This question was generally well done with many candidates scoring full marks. Candidates should be encouraged to show their substitution into a formula. A number of candidates stated □r^2 without showing □ $\times 0.6^2$, instead giving a value corresponding to (□ $\times$ 0.6)^2. Others used $r = 1.2$ or forgot to divide the volume of the cylinder by 2.

24. Fully correct answers to this question were seen from over half the candidates. The majority of candidates did obtain the correct height using Pythagoras' Theorem and generally then went on to obtain an acceptable value for the volume. Weaker candidates just used $h = 12.6$ in the formula for the volume of a cone.

25. Too many candidates were unable to copy the formula for the volume of the sphere correctly from the formula page. $\frac{3}{4}\pi r^3$ and $\frac{4}{3}\pi r^2$ were two common incorrect formula frequently quoted. Some candidates also used the formula for the surface area of a sphere or the area of a circle. Fully correct solutions were seen from about 17% of candidates using a variety of methods.

26. The general level of success on this question was disappointing. The most successful candidates were those who were able to start by equating the volume of the cylinder to 140 using the correct formula for the volume of a cylinder. Various incorrect formulae were used for the volume of the cylinder, those for the volume of a cone or the curved surface area of a cone being the most popular. A significant number of candidates who did use the correct formula were then unable to find the value of r correctly as they frequently took the square root before dividing by π. There was also plenty of subtraction instead of division during rearrangement.

27. There were many interesting approaches to this question. Many tried to find the surface area rather than the volume and some tried to divide by the density rather than multiply by 0.6. Only about 35% of candidates obtained the fully correct answer of 240 grams though 40% of candidates achieved partial success.

28. Finding the volume of a triangular prism seemed to be a question that had been well experienced in the preparation for the examination. Attempts at calculating the area of the triangle by evaluating '4.5 × 6', with or without the '½', were very common. A method mark was given for the correct area of '13.5'. Multiplying the area by '10' produced the correct volume of '135'. The missing element in many solutions was the '½' that produced a volume of '270' rather than the '135'. This gained a mark but it could have achieved three marks if the '½' had been included in the calculations. There were also many attempts at finding the surface area of the prism.

Some of the more successful attempts had written down the correct formula for finding the area of the triangle and this approach certainly paid dividends with 1.7 being the mean mark for this question.

29. Although in part (a) the correct answer of 1440 was usually seen, a significant number of candidates failed to score by working out $60^2 \times 24$ instead of 60×24. Sometimes an answer of 1140 was seen after a correct method.

There were a number of attempts to find the surface area of the prism. This was usually achieved by assuming that 10 cm was the length of each edge of the cross section; $10 \times 6 \times 20 = 1440$ then followed, gaining no marks.

In part (b), dividing "1440" by 648 was seen as often as the correct method. Weaker candidates commonly found the product of volume and mass.

30. Fully correct answers to this question were only given by 23% of candidates. In part (a) it was common to see the volume of the 5cm cube being given correctly but then incorrect calculations for the hole were frequently seen. Some candidates thought the hole was a 3 cm cube and not a square prism with length 5cm. Where candidates tried to subtract two sensible volumes they were awarded a mark, however it was quite common to see candidates try to subtract 9cm^2 away from 125cm^3 and therefore achieve no marks.

In part (b) full marks were awarded for dividing the mass of 64 grams by the volume calculated in part (a) and 39% of candidates scored 2 marks usually for doing this. A large number of candidates divided volume by mass or multiplied mass and volume and so gained no credit. It was disappointing to see 39% of candidates gaining no marks at all in this question.