DENSITY

[ESTIMATED TIME: 75 minutes]

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1. **[2 marks]**

The mass of 4 m^3 of copper is 35 800 kg.

Calculate the density of the copper.

$$D = \frac{M}{V} = \frac{35800}{4} = 8950$$

.... 8950 .... kg/m^3

(2)

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2. **[2 marks]**

The density of steel is 8050 kg/m^3.

Work out the mass of 5 m^3 of steel.

$$M = Vol \times Den$$
$$= 5 \times 8050$$
$$= 40250$$

.... 40250 .... kg

(2)

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3. **[2 marks]**

A gold chain has a volume of 4 cm^3.

The density of gold is 19.3 grams per cm^3.

Calculate the mass of the gold chain.

$$Mass = Vol \times Density$$
$$= 4 \times 19.3$$
$$= 77.2$$

.... 77.2 .... g

(2)

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4.   **[2 marks]**

The mass of a standard gold bar is 1000 grams.
The density of gold is 19.3 grams per cm^3.
Work out the volume of a standard gold bar.

$$Vol = \frac{M}{D} = \frac{1000}{19.3} = 51.8$$

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

(2)

5.   **[3 marks]**
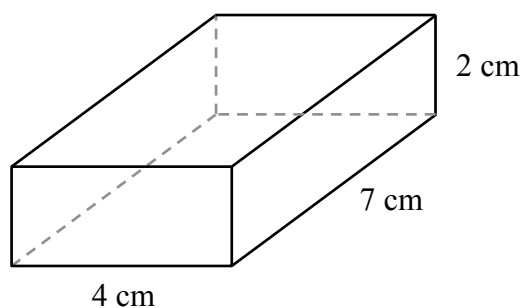

2 cm

Diagram **NOT**
accurately drawn

7 cm

4 cm

The diagram shows a solid wooden block in the shape of a cuboid.
The block is made from wood with density 0.58 g/cm^3
Work out the mass of the block.

$$Mass = Vol \times Density$$

$$= 7 \times 4 \times 2 \times 0.58$$

$$= 32.48$$

$$= 32.5 \text{ to } 3 \text{ s.f.}$$

........32.5........ g

(3)

6. **[2 marks]**

The density of concrete is 2.4 g/cm³.

Work out the mass of a concrete slab which has a volume of 12 m³.

Give your answer in kilograms.

$$\text{Density} = 2.4 \text{ g/cm}^3$$
$$= 2.4 \times 10^6 \text{ g/m}^3$$
$$= 2.4 \times 10^3 \text{ kg/m}^3$$

$$\text{Mass} = \text{Vol} \times \text{Density}$$
$$= 12 \times 2.4 \times 10^3 = 28,800 \text{ kg}$$

................28,800................ kg

(2)

7. **[3 marks]**

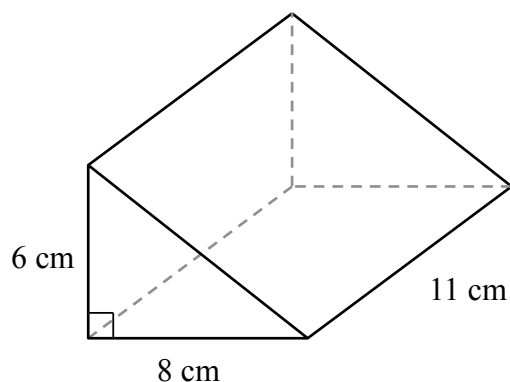The diagram shows a solid triangular prism.

Diagram **NOT** accurately drawn

$$\text{Vol} = \frac{1}{2} \times 8 \times 6 \times 11 = 264 \text{ cm}^3$$

The prism is made from steel.

The density of the steel is 7.9 grams per cm³.

Calculate the mass of the prism.

Give your answer in kilograms, correct to 3 significant figures.

$$\text{Mass} = \text{Vol} \times \text{Density}$$
$$264 \times 7.9 = 2085.6 \text{ g}$$
$$= 2.0856 \text{ kg}$$
$$= 2.09 \text{ kg} \quad \text{to 3 s.f.}$$

................2.09 kg................

(3)

8. [4 marks]

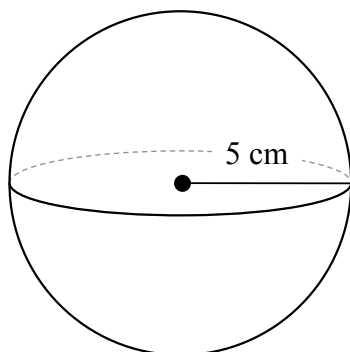The diagram shows a solid rubber ball in the shape of a sphere.

5 cm

Diagram **NOT**
accurately drawn

The radius of the ball is 5 cm.
The mass of the ball is 550 grams.
An object will only float in water if its density is less than 1.0 g/cm^3.
Will this rubber ball float in water?
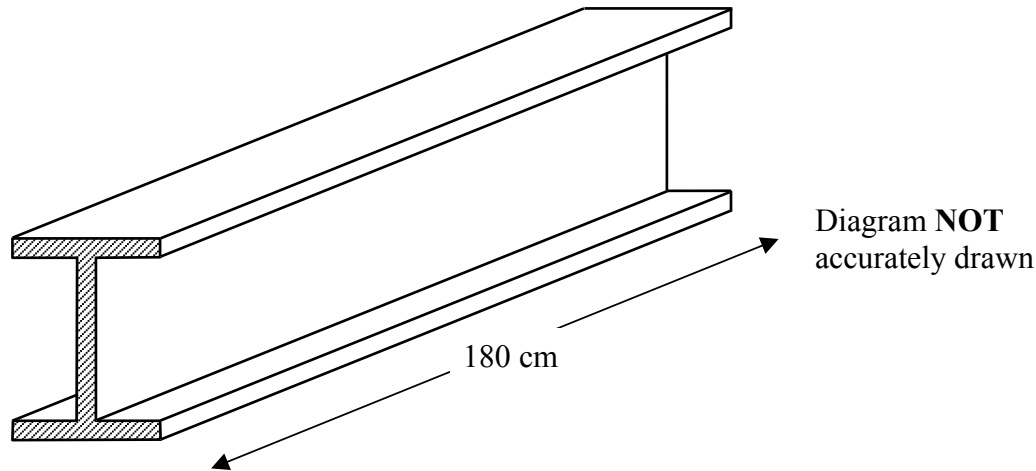You must show clear calculations to justify your answer.

$$Vol = \frac{4}{3}\pi r^3$$

$$Density = \frac{Mass}{Vol} = \frac{550}{\left(\frac{4}{3}\pi \times 5^3\right)} = 1.0504 \ g/cm^3$$

Ball sinks in water ~ i.e. does not float

Since $1.05 > 1.00 \ g/cm^3$

(4)

9. [5 marks]

The diagram shows a steel girder in the shape of a prism.

Diagram **NOT** accurately drawn

180 cm

The length of the girder is 180 cm.
The cross sectional area of the girder is 18 cm².
The steel has a density 7.8 g/cm³.
Justin has a pickup truck.
The maximum load that Justin's truck can carry is 500 kg.

Find the maximum number of these steel girders that Justin can carry in his truck, without exceeding the maximum load.

Mass of one girder

$=$ Vol × Den

$=$ 18 × 180 × 7.8 g

$= 25272$ g

$= 25.272$ Kg

$\dfrac{500}{25.272} = 19.78$

Can carry 19 girders

....
(5)

| **10.** | **[4 marks]** |

200g of aluminium and 200g of copper are mixed to make 400g of an alloy.

Aluminium has a density of 2.7 g/cm^3.

Copper has a density of 8.9 g/cm^3.

Work out the density of the alloy.

$$\begin{array}{cccc} & M & V & D \\ \text{Aluminium} & 200g & 74.07\,cm^3 & 2.7\,g/cm^3 \\ \text{Copper} & 200g & 22.47\,cm^3 & 8.9\,g/cm^3 \\ \hline & 400g & 96.54 & \end{array}$$

$$D = \frac{M}{V} = \frac{400}{96.54} = 4.14\,g/cm^3$$

........................4.14........................ g/cm^3

(4)

| **11.** | **[4 marks]** |

Liquid A has a density of 0.7 g/cm^3.

Liquid B has a density of 1.6 g/cm^3.

140 g of liquid A and 128 g of liquid B are mixed to make liquid C.

Work out the density of liquid C.

$$\begin{array}{cccc} & M & V & D \\ A & 140g & 200\,cm^3 & 0.7\,g/cm^3 \\ B & 128g & 80\,cm^3 & 1.6\,g/cm^3 \\ \hline & 268g & 280\,cm^3 & \end{array}$$

$$D = \frac{M}{V} = \frac{268}{280} = 0.957\,g/cm^3$$

........................0.957........................ g/cm^3

(4)

12. [4 marks]

Br
Co
Zir
1 k
W
Gi

6 cm

8 cm

11 cm

12 cm

5 cm

11 cm

13 cm
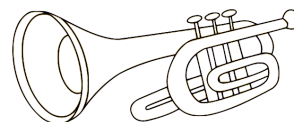
Handwritten: M

V   D

Copper   630g   70.79 cm³   8.9 g/cm³

Zinc   370g   52.11 cm³   7.1 g/cm³

5 cm

9 cm

122.90 cm³

Brass   1000g

D = M/V = 1000/122.9

4 cm

9 cm   1000

6 cm   122.9

12 cm   = 8.14

14 cm

13 cm

8.14

8.14

(4)

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13. [4 marks]

One sheet of A4 paper has dimensions 21.0 cm by 29.7 cm.
The paper has a mass of 80 g per m^2.
Work out the total mass of 500 sheets of A4 paper.
Give your answer in kilograms, correct to 3 significant figures.

One sheet 0.21×0.297 m^2
$= 0.06237$ m^2

Mass = $80 \times 0.06237 \times 500$ g
500 sheets

$= 2494.8$ g

$= 2.49$ Kg

2.49 kg

(4)

14. **[4 marks]**

. Mia makes an orange drink by mixing orange concentrate with water.
She mixes 15 ml of orange concentrate with 200 ml of water.
The density of the orange concentrate is 1.24 g/cm^3.
The density of water is 1.00 g/cm^3.
Work out the density of Mia's drink.
Give your answer correct to 2 decimal places.

$$M \qquad V \qquad D$$

Orange   18.6g   15 cm^3 1.24 g/cm^3

Water   200 g   200 cm^3 1.00 g/cm^3

$$\overline{218.6g} \qquad \overline{215 cm^3}$$

$$D = \frac{M}{V} = \frac{218.6}{215}$$

$$= 1.0167$$

...........1.02........... g/cm^3

(3)

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15. **[4 marks]**

The density of apple juice is 1.05 grams per cm^3.
The density of fruit syrup is 1.4 grams per cm^3.
The density of carbonated water is 0.99 grams per cm^3.
25 cm^3 of apple juice are mixed with 15 cm^3 of fruit syrup and 280 cm^3 of carbonated water to make a drink with a volume of 320 cm^3.
Work out the density of the drink.
Give your answer correct to 2 decimal places.

$$M \qquad V \qquad D$$

apple   26.25g   25 cm^3 1.05 g/cm^3

Syrup   21 g   15 cm^3 1.4 g/cm^3

water   277.2 g   280 cm^3 0.99 g/cm^3

$$\overline{324.45 g} \qquad \overline{320 cm^3}$$

$$D = \frac{M}{V} = \frac{324.45}{320}$$

$$= 1.0139$$

...........1.01........... g/cm^3

(4)

16. **[5 marks]**

The densities of two different liquids A and B are in the ratio $11 : 9$
The mass of 1 ml of liquid B is 1.2 g.
10 ml of liquid A is mixed with 20 ml of liquid B to make 30 ml of liquid C.
Work out the density of liquid C.

Density $B = \frac{M}{V} = \frac{1.2}{1} = 1.2 \, g/cm^3$

Density $A = 1.2 \times \frac{11}{9} = 1.467 \, g/cm^3$

	M	V	D
A	14.67 g	10 cm³	1.467 g/cm³
B	24 g	20 cm³	1.2 g/cm³
	38.67 g	30 cm³	

$D = \frac{M}{V} = \frac{38.67}{30}$

.... 1.289 .... g/cm³
1.29   to 3 s.f. **(4)**

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17. **[5 marks]**

. A solid snooker ball is made in the shape of a sphere.
The ball has a mass of 156 g measured to the nearest gram.
Its diameter is 57 mm measured to the nearest millimetre.
Find the lower bound for the density of the ball.
Give your answer correct to 3 significant figures.

$D = \frac{M}{V}$

lower bound $\frac{low \, M}{high \, V}$

$155.5 \, g \leq Mass < 156.5 \, g$

$56.5 \, mm < diam < 57.5 \, mm$

$28.25 \, mm < radius < 28.75 \, mm$

lower bound $D = \frac{155.5}{\left(\frac{4}{3}\pi \times 28.75^3\right)}$ $= 1.562 \times 10^{-3} \, g/mm^3$

$= 1.562 \times 10^{-3} \times 1000 \, g/cm^3$

.... 1.56 .... g/cm³
(4)

18. **[5 marks]**

. A solid metal bar is made in the shape of a cuboid.
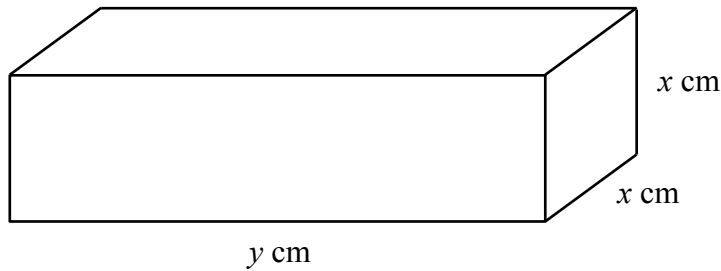
x cm

x cm

y cm

Diagram **NOT**
accurately drawn

The cross-section of the bar is a square of side x cm.
The length of the bar is y cm.
The mass of the bar is M kg.
$x = 5.0$ correct to 1 decimal place.
$y = 25$ correct to the nearest whole number.
$M = 4.24$ correct to 2 decimal places.
Calculate the density of the metal, in g/cm^3, that was used to make the bar.
Give your answer to an appropriate degree of accuracy.

$4.95 \leq x < 5.05$

$24.5 \leq y < 25.5$

$4.235 < M < 4.245$

Max Vol $= 5.05^2 \times 25.5$ Min Vol $4.95^2 \times 24.5$

Max Density $= \dfrac{\text{Max Mass}}{\text{Min Vol}} = \dfrac{4.245 \times 1000}{(4.95^2 \times 24.5)}$

$= 7.071$ g/cm^3

Min Density $= \dfrac{\text{Min Mass}}{\text{Max Vol}} = \dfrac{4.235 \times 1000}{(5.05^2 \times 25.5)}$

$= 6.512$ g/cm^3

Density $= 7$ g/cm^3 to nearest whole number
                              or to 1 sig fig

.... g/cm^3

(5)

A solid cone is made of wood.

18 cm

r cm

Diagram **NOT** accurately drawn

The height of the cone is 18 cm.
The mass of the cone is 0.98 kg
The wood has a density of 0.43 g/cm³
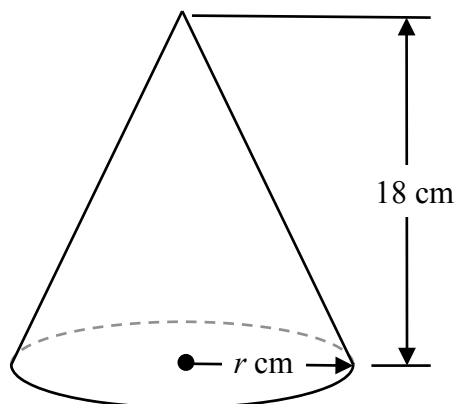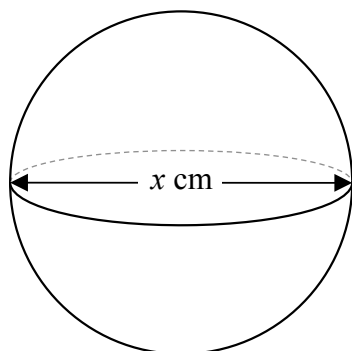Find the radius of the cone.
Give your answer correct to 2 significant figures.

$$Vol = \frac{1}{3}\pi r^2 h$$

$$Vol = \frac{Mass}{Density} = \frac{980}{0.43}$$

$$Vol = 2279 \ cm^3$$

$$2279 = \frac{1}{3}\pi r^2 \times 18$$

$$\frac{2279}{6\pi} = r^2$$

$$r = \sqrt{\frac{2279}{6\pi}}$$

$$r = 10.99 \ cm$$

$$r = 11 \ cm$$

.... cm

(5)

20. [5 marks]

. A solid sphere is made of glass.

Diagram **NOT** accurately drawn

x cm

The mass of the sphere is 58.4 g
The density of the glass is 2.6 g/cm^3
Find the diameter of the sphere.
Give your answer correct to 3 significant figures.

$$Vol = \frac{4}{3}\pi r^3$$

$$Vol = \frac{M}{D} = \frac{58.4}{2.6} = \frac{292}{13}$$

$$\frac{292}{13} = \frac{4}{3}\pi r^3$$

$$\frac{292}{13} \times \frac{3}{4\pi} = r^3$$

$$r = \sqrt[3]{\frac{292 \times 3}{13 \times 4\pi}}$$

$$r = 1.75 \text{ cm}$$

.... cm

(5)

A solid cube has a mass of 9.8 g.

It has a density of 0.92 g/cm^3.

Find the surface area of the cube.

Give your answer correct to 2 significant figures.

$$Vol = \frac{M}{D} = \frac{9.8}{0.92} = 10.65217 \ cm^3$$

$$Edge \ x \qquad x = \sqrt{10.65217}$$

$$x = 2.2 \ cm$$

$$Each \ face = x^2$$

$$Surface \ area \ 6x^2 = 6 \times 2.2^2$$

$$= 29.04 \ cm^2$$

...................**29**.................cm^2

(5)

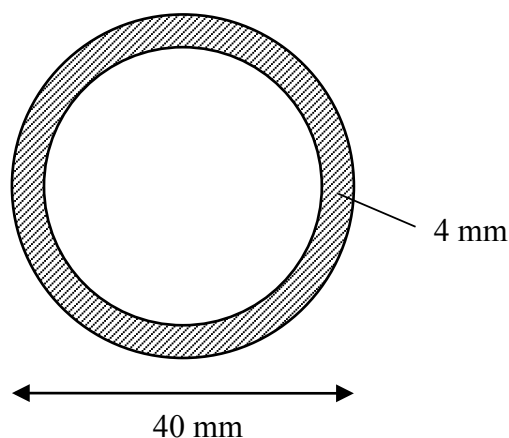A squash ball is made of rubber and is the shape of a sphere.

Diagram **NOT**
accurately drawn

4 mm

40 mm

The mass of the ball 24 g.
The external diameter of the ball is 40 mm.
The thickness of the rubber is 4 mm.
Assuming that the mass of air inside the ball is negligible, calculate the density of the rubber.

External radius r_1 = 20 mm
Internal radius r_2 = 16 mm

$$\text{Vol of rubber} = \frac{4}{3}\pi r_1^3 - \frac{4}{3}\pi r_2^3$$

$$= \frac{4}{3}\pi\left(20^3 - 16^3\right)$$

$$= 16353 \text{ mm}^3$$

$$= 16.353 \text{ cm}^3$$

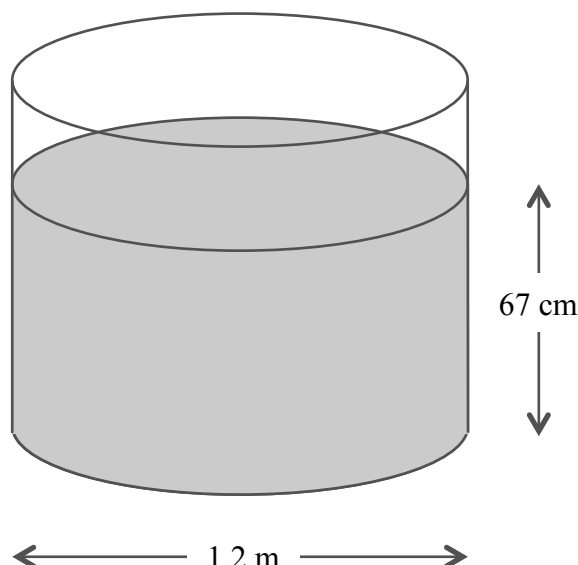$$\text{Density} = \frac{M}{V} = \frac{24}{16.353} = 1.47 \text{ g/cm}^3$$

........................g/cm^3

(5)

A 200 gallon steam kettle is used to make soup.
The kettle is in the shape of a cylinder.

Diagram **NOT**
accurately drawn

67 cm

1.2 m

The kettle has a diameter of 1.2 m.   *radius 60cm*
The depth of the soup in the kettle is 67 cm.
The density of the soup is 1.15 g/cm^3.
The soup is to be dispensed into tins that hold 400 g of soup each.
How many tins can be filled with the soup from the kettle?
You must show all your working.

$$Vol \quad \pi r^2 h \quad = \quad \pi \times 60^2 \times 67 = 757752 \, cm^3$$

$$M = Vol \times Density \qquad Mass = 757752 \times 1.15$$
$$= 871415 \, g$$

$$\frac{871415}{400} = 2178.5375$$

2178 tins can be filled.

....
(5)