

DENSITY

SOLUTIONS

GCSE (+ IGCSE) EXAM QUESTION PRACTICE

1. [New, 2018]

Density [2 Marks]

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

Calculate the density of the copper.

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\text{DENSITY} = \frac{35800}{4} \text{ (m)}$$

$$\frac{8950}{\text{kg/m}^3} \text{ (A1)}$$

(2)

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

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

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\text{MASS} = \text{VOLUME} \times \text{DENSITY}$$

$$= 5 \times 8050 \text{ (m)}$$

$$\text{40 250 (A1)} \\ \text{..... kg}$$

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

The density of gold is $19.3 \text{ grams per cm}^3$.

Calculate the mass of the gold chain.

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\text{MASS} = \text{VOLUME} \times \text{DENSITY}$$

$$= 4 \times 19.3 \quad (\text{m1})$$

$$\underline{\quad 77.2 \quad} \text{ g} \quad (\text{A1})$$

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.

$$\text{VOLUME} = \frac{\text{MASS}}{\text{DENSITY}}$$

$$= \frac{1000}{19.3} \text{ (ml)}$$

$$= 51.813 \dots$$

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\dots\dots\dots 51.8 \text{ (A1)} \text{ cm}^3$$

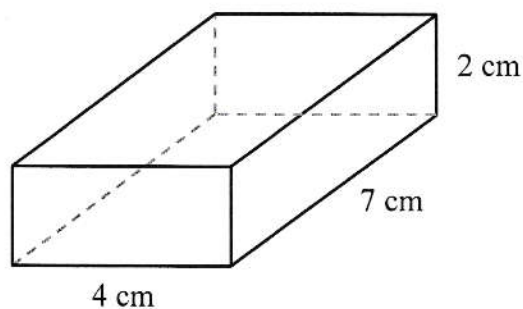


Diagram **NOT**
accurately drawn

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

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.

$$\text{MASS} = \text{VOLUME} \times \text{DENSITY}$$

$$= (4 \times 2 \times 7) \times 0.58 \quad (\text{mi}) \quad [\text{FOR VOLUME} \times \text{DENSITY}]$$

$$(\text{mi}) [\text{FOR EITHER}] = 56 \times 0.58$$

$$= 32.48 \quad (\text{mi})$$

32.5

..... g

The density of concrete is 2.4 g/cm^3 .

Work out the mass of a concrete slab which has a volume of 12 m^3 .

Give your answer in kilograms.

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\text{MASS} = \text{VOLUME} \times \text{DENSITY}$$

$$= 12 \times 2400 \text{ (m)}$$

I HAVE CHANGED g/cm^3
INTO kg/m^3

$$\begin{array}{r} 28800 \text{ (A1)} \\ \hline \text{kg} \\ (2) \end{array}$$

The diagram shows a solid triangular prism.

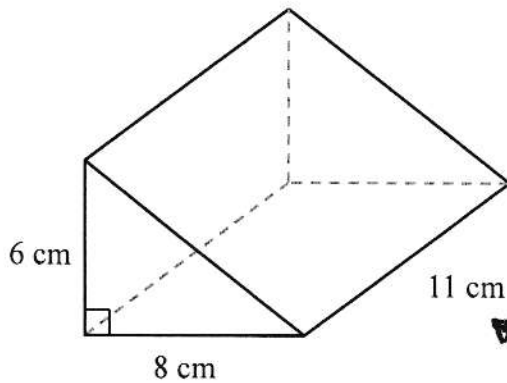


Diagram NOT
accurately drawn

1ST

$$V = \left[\frac{1}{2} \times 6 \times 8 \right] \times 11 = \underline{\underline{264}} \text{ cm}^3$$

(m)

The prism is made from steel.

The density of the steel is 7.9 grams per cm^3 .

Calculate the mass of the prism.

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

2ND

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\Rightarrow \text{MASS} = \text{VOLUME} \times \text{DENSITY}$$

$$= 264 \times 7.9 \quad (m)$$

$$= 2085.6 \text{ GRAMS}$$

$$\rightarrow \underline{\underline{2.09 \text{ kg}}} \quad (A1)$$

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

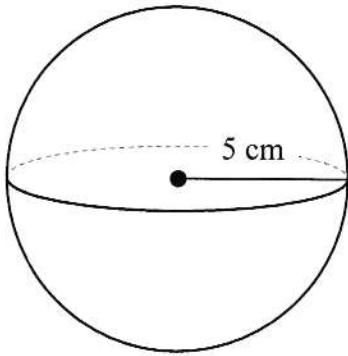


Diagram NOT
accurately drawn

[1ST]

$$V = \frac{4}{3}\pi r^3 = \underline{\underline{523.598\dots}}$$

(m)

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.

[2ND]

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$= \frac{550}{523.598\dots}$$

(m)

$$= \underline{\underline{1.0504 \text{ g/cm}^3}}$$

(A)

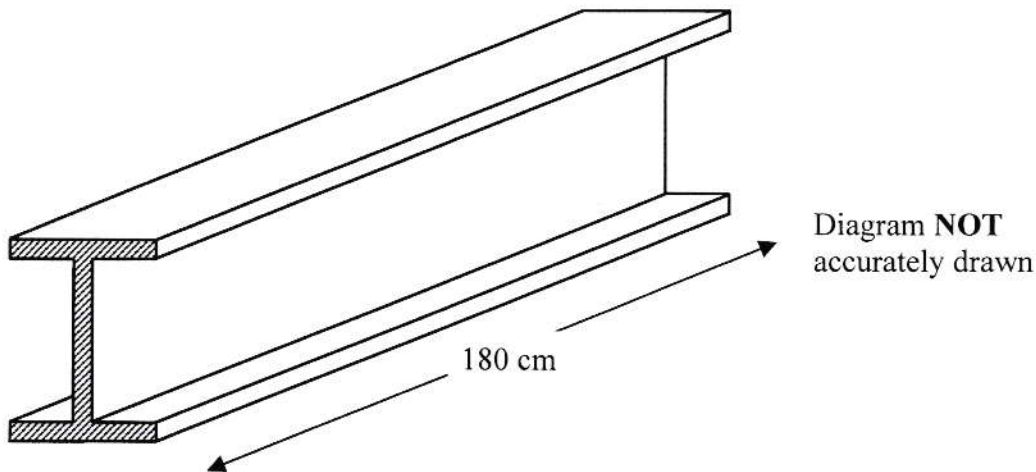
THIS IS GREATER THAN 1.0 g/cm^3

SO IT WILL NOT FLOAT!

(A)

[MUST HAVE FULL CALCULATIONS!]

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



The length of the girder is 180 cm.

The cross sectional area of the girder is 18 cm^2 .

The steel has a density 7.8 g/cm^3 .

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.

1ST $V = 180 \times 18$
 $= \underline{\underline{3240 \text{ cm}^3}}$ (m)

2ND

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$\Rightarrow \text{MASS} = \text{VOLUME} \times \text{DENSITY}$$

$$\downarrow$$

$$= 3240 \times 7.8 \quad \text{(m)}$$

OF ONE GIRDER

$$= 25272 \text{ g}$$

$$= \underline{\underline{25.272 \text{ kg}}} \quad \text{(A)}$$

3RD

$$\text{MAXIMUM GIRDERS} = \frac{500}{25.272} \quad \text{(m)}$$

$$= 19.78... \Rightarrow \underline{\underline{19}} \quad \text{(A)}$$

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.

$$\begin{aligned}
 \text{1ST } \text{TOTAL VOLUME} &= V_{\text{AL}} + V_{\text{CU}} \\
 &= \frac{M_{\text{AL}}}{D_{\text{AL}}} + \frac{M_{\text{CU}}}{D_{\text{CU}}} \\
 &= \frac{200}{2.7} + \frac{200}{8.9} = \underline{\underline{96.5459\dots}} \quad (\text{A1})
 \end{aligned}$$

$$\begin{aligned}
 \text{2ND } \text{NEW DENSITY} &= \frac{\text{MASS}}{\text{VOLUME}} \quad (\text{m}) \\
 &= \frac{400}{96.54\dots} \quad (\text{m}) \\
 &\quad \quad \quad 4.14 \quad (\text{A1}) \text{ g/cm}^3
 \end{aligned}$$

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.

[1ST]

$$V_c = V_A + V_B$$

$$\left[V = \frac{M}{D} \right]$$

$$= \frac{140}{0.7} + \frac{128}{1.6}$$

$$= \underline{\underline{280}} \text{ cm}^3 \text{ (A5)}$$

(ml)

[2ND]

$$D_c = \frac{M_c}{V_c}$$

$$= \frac{140 + 128}{280} \text{ (ml)}$$

$$0.957 \text{ (A1)} \text{ g/cm}^3$$

Brass is an alloy which is made by mixing copper and zinc.

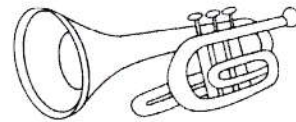
Copper has a density of 8.9 g/cm^3 .

Zinc has a density of 7.1 g/cm^3 .

1 kilogram of brass is made by mixing 630 g of copper with 370 g of zinc.

Work out the density of the brass.

Give your answer correct to 1 decimal place.



1ST

$$V_{\text{BRASS}} = V_{\text{Cu}} + V_{\text{Zn}} = \frac{M_{\text{Cu}}}{D_{\text{Cu}}} + \frac{M_{\text{Zn}}}{D_{\text{Zn}}}$$

$$= \frac{630}{8.9} + \frac{370}{7.1} = \underline{\underline{122.899...}} \quad (\text{A1})$$

(m1)

2ND

$$D_{\text{BRASS}} = \frac{M}{V}$$

$$= \frac{630 + 370}{122.899...} \quad (\text{m1})$$

$$\dots\dots\dots 8.14 \quad (\text{A1}) \dots\dots\dots \text{g/cm}^3$$

One sheet of A4 paper has dimensions 21.0 cm by 29.7 cm.

The paper has a mass of 80 g per m².

Work out the total mass of 500 sheets of A4 paper.

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

DENSITY OF PAPER IS
ACTUALLY MEASURED IN
g/m² RATHER THAN
g/m³!

FOR ONE SHEET,

CHANGE TO m

$$\text{MASS} = (0.21 \times 0.297) \times 80 \quad (\text{m})$$

$$= \underline{\underline{4.9896}} \text{ g} \quad (\text{AI})$$

∴ FOR 500 SHEETS,

$$\text{MASS} = 500 \times 4.9896 \quad (\text{m})$$

$$= 2494.8 \text{ g}$$

$$= \underline{\underline{2.49}} \text{ kg} \quad (\text{AI})$$

(4)

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.

$$\begin{aligned} \text{TOTAL MASS} &= \text{MASS}_c + \text{MASS}_w \\ &= 1.24 \times 15 + 1 \times 200 \quad (\text{mii}) \\ &= \underline{\underline{218.6 \text{ g}}} \quad (\text{AI}) \end{aligned}$$

IST

$$\text{TOTAL VOLUME} = \underline{\underline{215 \text{ cm}^3}}$$

ml $\equiv$ cm³

$$\begin{aligned} \text{FINAL DENSITY} &= \frac{\text{MASS}}{\text{VOLUME}} \\ &= \frac{218.6}{215} \quad (\text{mii}) \end{aligned}$$

$$\underline{\underline{1.02}} \quad (\text{AI}) \text{ g/cm}^3$$

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.

$$\begin{aligned}\text{TOTAL MASS} &= 1.05 \times 25 + 1.4 \times 15 + 0.99 \times 280 \\ &= \underline{\underline{324.45}} \text{ g}\end{aligned}$$

$$\begin{aligned}\text{DENSITY} &= \frac{324.45}{320} \\ &= 1.0139\dots\end{aligned}$$

$$\dots\dots\dots 1.01 \dots\dots\dots \text{g/cm}^3$$

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 .

$$D_B = \frac{1.2}{1} = \underline{1.2} \Rightarrow D_A = \frac{1.2 \times 11}{9} = \underline{1.46} \quad (B1)$$

$$\begin{aligned} \text{TOTAL MASS} &= 10 \times 1.46 + 20 \times 1.2 \quad (M1) \\ &= \underline{38.6} \quad (A1) \end{aligned}$$

$$D_C = \frac{\text{MASS}}{\text{VOLUME}} = \frac{38.6}{30} \quad (M1) = \underline{1.28} \text{ g/cm}^3 \quad (A1)$$

. 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.

1st

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

$$= \frac{4}{3} \times \pi \times 2.875^3 \quad (\text{M1})$$

$$= 99.541 \text{ cm}^3 \quad (\text{A1}) \quad (\text{B1})$$

$$\text{Density} = \frac{155.5}{99.541} \quad (\text{B1})$$

$$1.56 \quad (\text{A1}) \text{ g/cm}^3$$

$$\text{DENSITY}_{[\text{Lower}]} = \frac{\text{MASS}_{[\text{Lower}]}}{\text{VOLUME}_{[\text{High}]}}$$

[UPPER BOUND FOR DIAMETER = 57.5 mm

⇒ UPPER BOUND FOR RADIUS = 28.75 mm

= 2.875 cm]

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

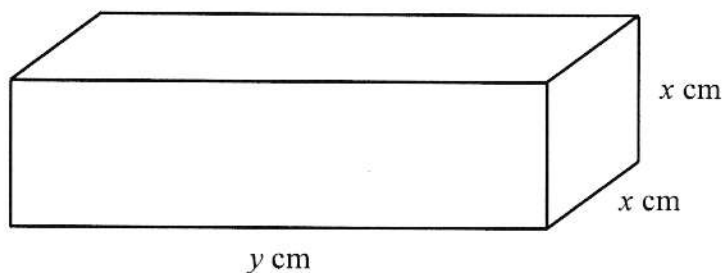


Diagram **NOT**
accurately drawn

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.

$$\begin{aligned} V_{\text{MAX}} &= 5.05^2 \times 25.5 \\ &= 650.313... \text{ (ml)} \end{aligned}$$

$$\begin{aligned} V_{\text{MIN}} &= 4.95^2 \times 24.5 \\ &= 600.311... \text{ (ml)} \end{aligned}$$

$$\text{DENSITY}_{\text{MAX}} = \frac{4245}{600.311}$$

$$= 7.07133... \text{ (ml)}$$

$$\text{DENSITY}_{\text{MIN}} = \frac{4235}{650.313...}$$

$$= 6.51224... \text{ (ml)}$$

ROUNDING IS ONLY
THE SAME WHEN
DONE TO NEAREST
WHOLE NUMBER,
SO THIS IS THE
APPROPRIATE DEGREE
OF ACCURACY!

$$\dots\dots\dots 7 \text{ (A1)} \text{ g/cm}^3$$

A solid cone is made of wood.

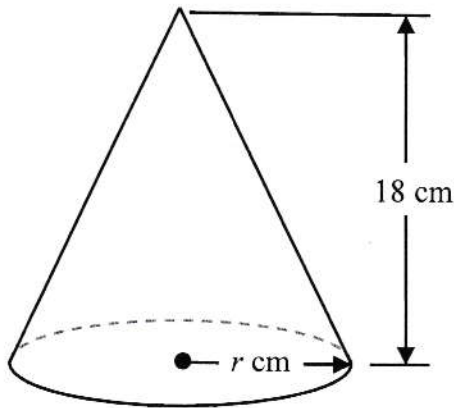


Diagram NOT
accurately drawn

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/cm^3

Find the radius of the cone.

Give your answer correct to 2 significant figures.

1ST

$$\text{VOLUME} = \frac{980}{0.43}$$

$$= 2279.06 \dots \text{ (m1)}$$

CHANGED TO
GRAMS!

2ND

$$\frac{1}{3} \pi r^2 \times 18 = 2279.06 \text{ (m1) [EQUATION]}$$

$$\Rightarrow r^2 = \frac{2279.06 \times 3}{18 \pi} \text{ (m1) ['r' ISOLATED]}$$

$$= 120.908 \dots \text{ (m1)}$$

$$\Rightarrow r = 10.995 \dots$$

$$= \underline{\underline{11 \text{ cm}}} \text{ (A1)}$$

A solid sphere is made of glass.

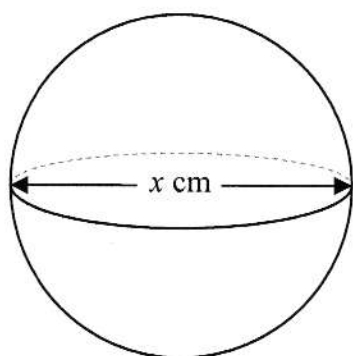


Diagram **NOT**
accurately drawn

The mass of the sphere is 58.4 g

The density of the glass is 2.6 g/cm³

Find the diameter of the sphere.

Give your answer correct to 3 significant figures.

[1ST]

$$VOLUME = \frac{58.4}{2.6}$$

$$= 22.461... \quad (M1)$$

[2ND]

$$\frac{4}{3}\pi r^3 = 22.461 \quad (M1) \text{ [EQUATION]}$$

$$\Rightarrow r^3 = \frac{22.461 \times 3}{4\pi} \quad (M1) \text{ ['r' ISOLATED]}$$

$$= 5.36229...$$

$$\Rightarrow r = 1.75031... \quad (M1)$$

$$\Rightarrow x = 3.5006...$$

$$= \underline{\underline{3.50}} \text{ cm} \quad (A1)$$

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.

$$\text{VOLUME} = \frac{9.8}{0.92}$$

$$= 10.652... \text{ (m)} \text{ cm}^3$$

$$\text{EDGE LENGTH} = \sqrt[3]{10.652...} \text{ (m)}$$

$$= 2.2002... \text{ (m)}$$

$$\text{SURFACE AREA} = 6 \times 2.2002...^2 \text{ (m)}$$

$$= 29.047$$

$$= \underline{\underline{29 \text{ cm}^2}} \text{ (A)}$$

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

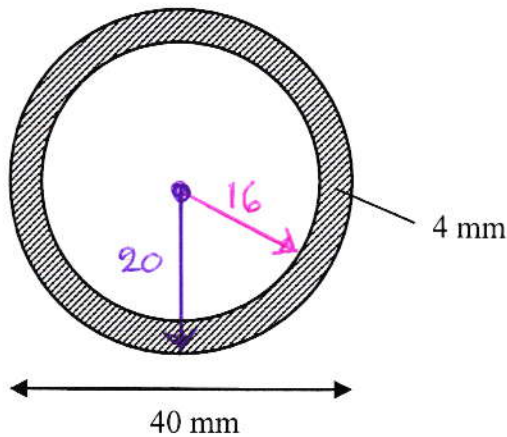


Diagram NOT
accurately drawn

The mass of the ball ^{is} 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.

$$\text{VOLUME} = \frac{4}{3}\pi \times 2^3 - \frac{4}{3}\pi \times 1.6^3 \quad \text{(M1) [EQUATION]}$$

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

(B1) [FOR CORRECT
INNER RADIUS]

(M1) [FOR VOLUME
IN cm³]

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

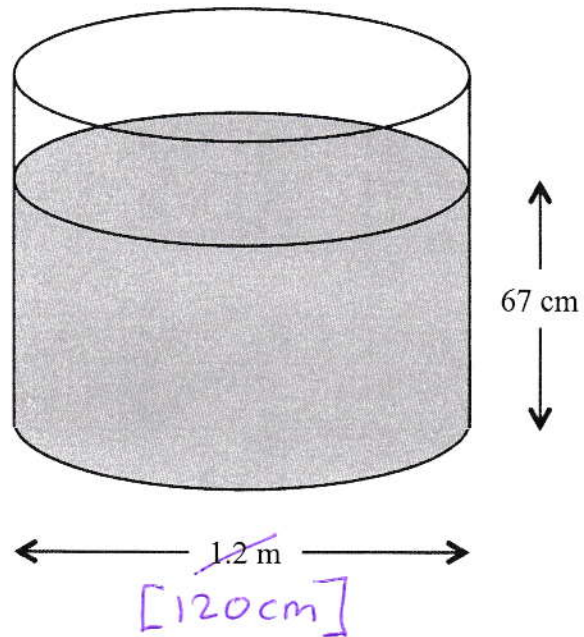
$$= \frac{24}{16.353...} \quad \text{(M1)}$$

$$= 1.4676... \quad \text{(A1) [ROUNDING IS NOT
REQUIRED IN THIS
QUESTION]}$$

$$= \underline{\underline{1.47}} \text{ g/cm}^3$$

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

Diagram NOT
accurately drawn



The kettle has a diameter of 1.2 m.

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.

$$\begin{aligned} \text{VOLUME OF SOUP} &= \pi \times 60^2 \times 67 \quad (\text{m}) \\ &= \underline{\underline{757,752}} \text{ cm}^3 \quad (\text{m}) \end{aligned}$$

$$\begin{aligned} \text{MASS OF SOUP} &= 1.15 \times 757,752 \\ &= \underline{\underline{871,414.97}} \text{ g} \quad (\text{m}) \end{aligned}$$

$$\begin{aligned} \text{NO. OF TINS} &= \frac{871,414.97}{400} \quad (\text{m}) \end{aligned}$$

$$= 2178.53 \dots$$

$$= \underline{\underline{2178}} \quad (\text{A})$$