

Area & Volume

Aidan Ryan

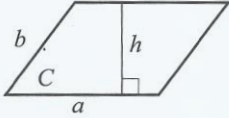
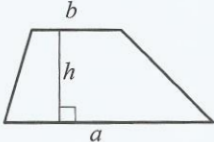
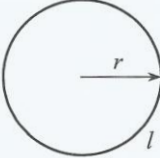
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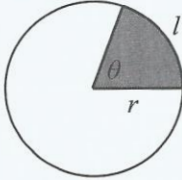
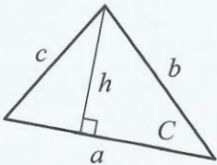
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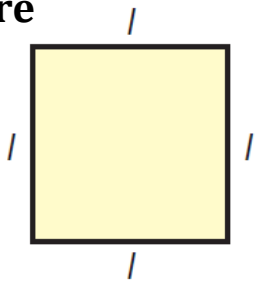
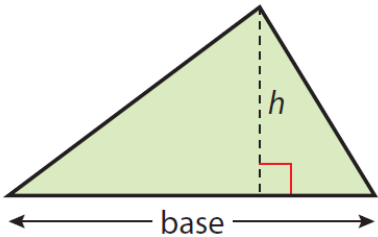
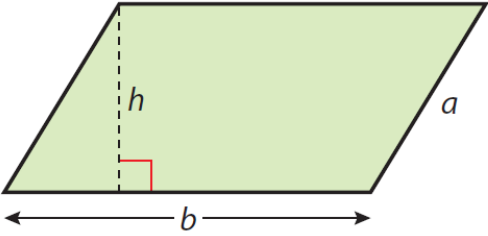
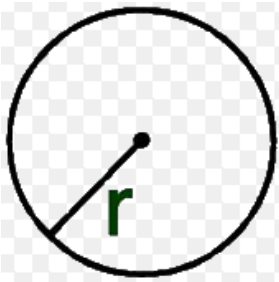
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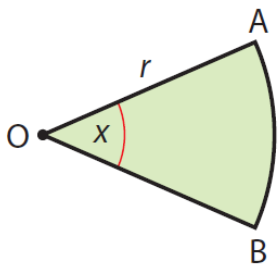
Area and perimeter formulae

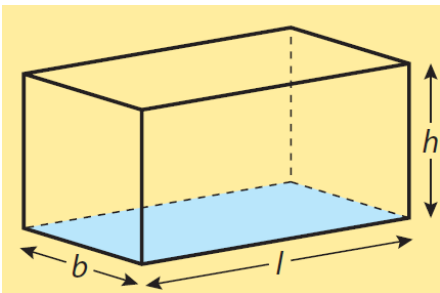
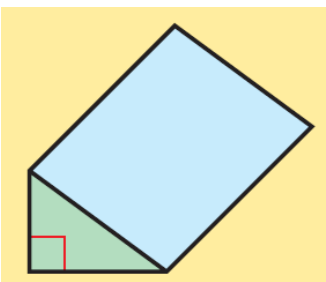
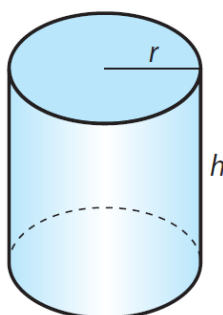
The following formulae are given in The Formulae & Tables Booklet:

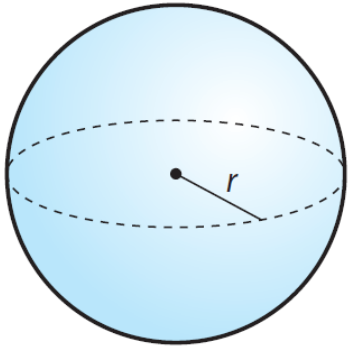
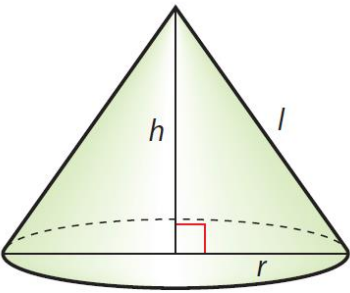
Fad agus achar	Length and area	
Seasann A iontu seo a leanas d'achar na fíorach atá i gceist.	In the following, A represents the area of the shape in question.	
Comhthreomharán		$A = ah$ $= ab \sin C$
Traipéisiam		$A = \left(\frac{a+b}{2}\right)h$
Ciorcal / Diosca fad l (imlíne l)		$l = 2\pi r$ $A = \pi r^2$
		Circle / Disc length l (circumference l)

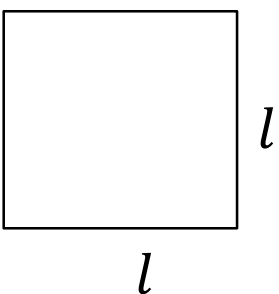

Stua / Teascóg		Arc / Sector
<i>nuair is ina raidiain atá θ</i>	$l = r\theta$	$A = \frac{1}{2}r^2\theta$ <i>when θ is in radians</i>
<i>nuair is ina chéimeanna atá θ</i>	$l = 2\pi r \left(\frac{\theta}{360^\circ}\right)$	$A = \pi r^2 \left(\frac{\theta}{360^\circ}\right)$ <i>when θ is in degrees</i>
Triantán		Triangle
áit a bhfuil $s = \frac{a+b+c}{2}$	$A = \frac{1}{2}ah$ $= \frac{1}{2}ab \sin C$ $= \sqrt{s(s-a)(s-b)(s-c)}$	taking $s = \frac{a+b+c}{2}$

Shape	Area	Perimeter
<p>Rectangle</p> 	$L \times W$	$2(L + W)$
<p>Square</p> 	$L \times L$	$4 \times L$
<p>Triangle</p> 	$\frac{1}{2} \text{base} \times \text{perpendicular height}$ $\frac{1}{2}bh$	<p>No formula.</p> <p>Just add length of 3 sides together!</p>
<p>Parallelogram</p> 	$\text{base} \times \text{perpendicular height}$ bh	<p>No formula.</p> <p>Just add length of 4 sides together!</p>
<p>Circle</p> 	πr^2	$2\pi r$

<p>Sector of a circle</p> 	$\text{Area of OAB} = \frac{x}{360} \times \pi r^2$	<p><i>Length of arc AB</i></p> $= \frac{x}{360} \times 2\pi r$
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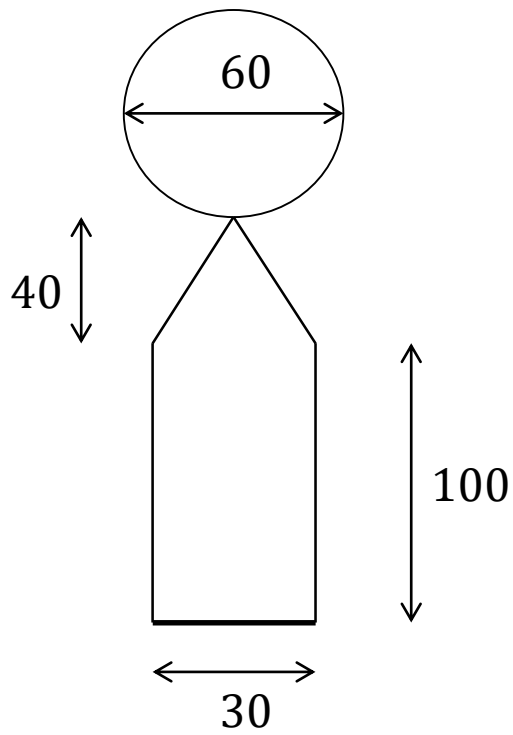
Shape	Volume	Surface Area
<p>Rectangular Solid</p> 	$l \times b \times h$	$2lb + 2bh + 2lh$
<p>Prism</p> 	$\text{Area of Face} \times \text{Length}$	<p><i>Varrys depending on the shape of the face of the prism</i></p>
<p>The cylinder</p> 	$\text{Area of Face} \times \text{Height}$ $\pi r^2 h$	$\text{Curved SA} = 2\pi r h$ $\text{Total SA} = 2\pi r h + \pi r^2$

<p style="text-align: center;">Sphere</p> 	$\frac{4}{3}\pi r^3$ <p style="text-align: center;">Hemisphere = $\frac{2}{3}\pi r^3$</p>	$4\pi r^2$ <p style="text-align: center;">Hemisphere = $2\pi r^2 + 2\pi r^2$</p>
<p style="text-align: center;">Cone</p> 	$\frac{1}{3}\pi r^2 h$	<p style="text-align: center;">Curved SA = $\pi r l$</p> <p style="text-align: center;">Total SA = $\pi r l + \pi r^2$</p>

<p style="text-align: center;">Square</p>  <p style="text-align: center;">l</p> <p style="text-align: center;">l</p> <p>Area = l^2</p> <p>Perimeter = $4l$</p>	<p style="text-align: center;">Rectangle</p>  <p style="text-align: center;">l</p> <p style="text-align: center;">b</p> <p>Area = lb</p> <p>Perimeter = $2l + 2b = 2(l + b)$</p>
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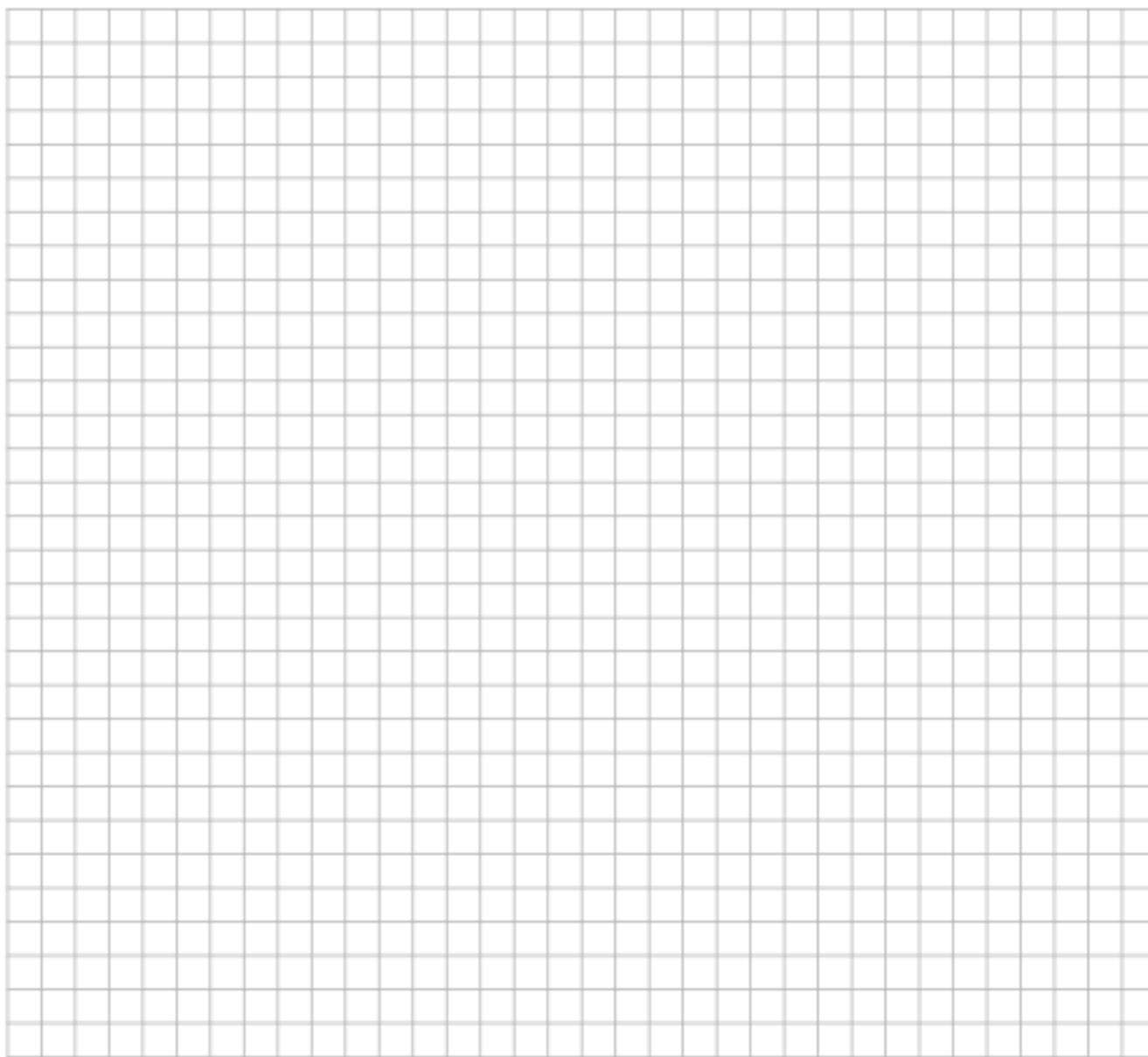
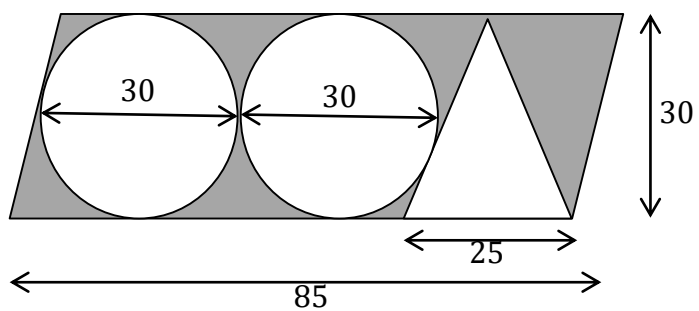
eg1. Find the area of the following shape

(all units in cm, assume $\pi = \frac{22}{7}$)



eg2. Find the area of the shaded region in figure below

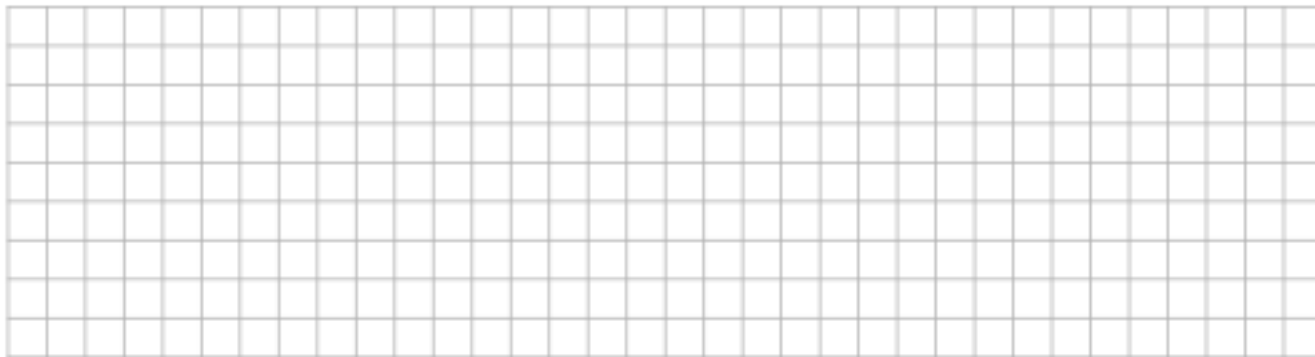
(all units in cm, assume $\pi = \frac{22}{7}$)



Finding missing lengths when given area or perimeter

In some questions we are given the area or the perimeter of shapes and we must work backwards to find their original lengths.

eg1. If the circumference of a circle is 80cm. Find its area (assume $\pi = \frac{22}{7}$).

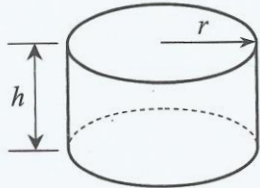
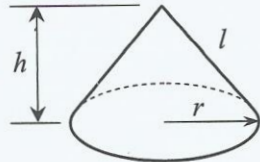
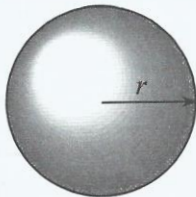


eg2. The perimeter of a rectangle is 180cm. If the ratio of its length to breadth is 5:4 find the area of the rectangle.

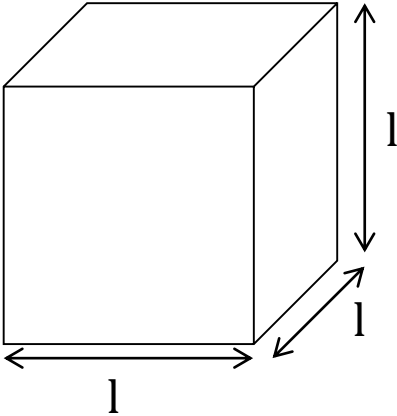
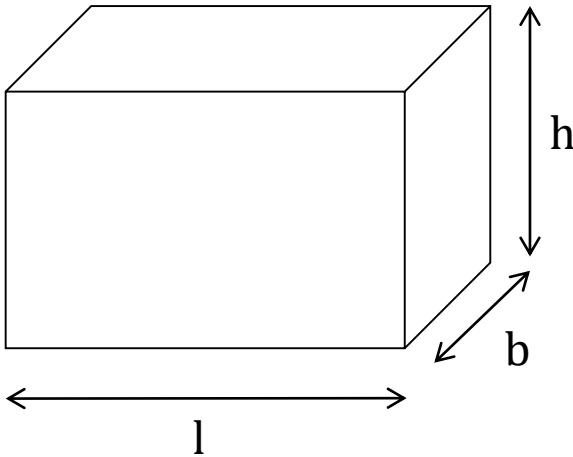


Volume and surface area formulae

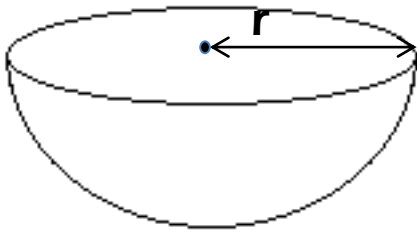
The following formulae are given in The Formulae & Tables Booklet:

Achar dromchla agus toirt		Surface area and volume	
Seasann A iontu seo d'achar cuar an dromchla agus seasann V do thoirt an tsolaid atá i gceist.		In the following, A represents the curved surface area and V represents the volume of the solid in question.	
Sorcóir		$A = 2\pi rh$ $V = \pi r^2 h$	Cylinder
Cón		$A = \pi rl$ $V = \frac{1}{3}\pi r^2 h$	Cone
Sféar		$A = 4\pi r^2$ $V = \frac{4}{3}\pi r^3$	Sphere

The following formulae are not provided in The Formulae & Tables Booklet but you still need to know them:

<p>Cube</p>  <p>Volume = l^3 Surface Area = $6l^2$</p>	<p>Rectangular solid</p>  <p>Volume = lbh Surface Area = $2lb + 2lh + 2bh$</p>
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Hemisphere



$$\text{Volume} = \frac{2}{3}\pi r^3$$

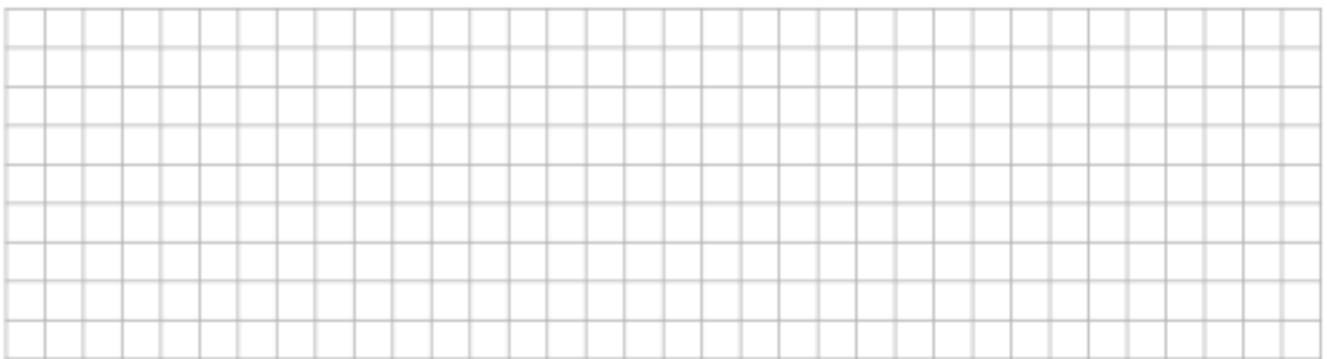
$$\text{Curved surface area} = 2\pi r^2$$

$$\text{Total Surface Area} = 3\pi r^2$$

eg1. Find the surface area and volume of a rectangular box with dimensions: 10cm, 7cm and 8cm.



eg2. Calculate the volume and total surface area of a cylinder with a height of 10cm and a radius of 2cm.



eg3. A sphere with a diameter of 10cm fits exactly into a cylindrical container. Find the volume of the empty space inside the container when the sphere is placed inside it.



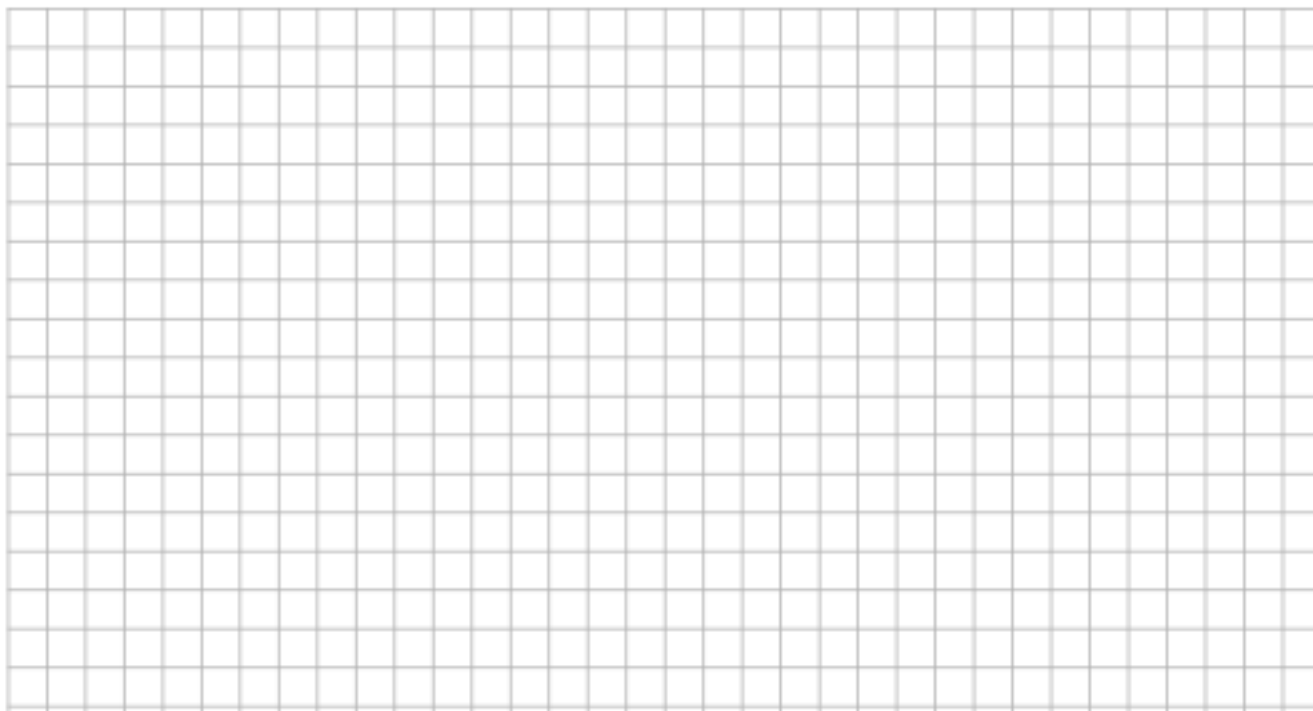
eg4. Find the volume and total surface area of a cone with a height of 8cm and a radius of 4cm. (assume $\pi = 3.14$).



Finding missing lengths when given volume or surface area

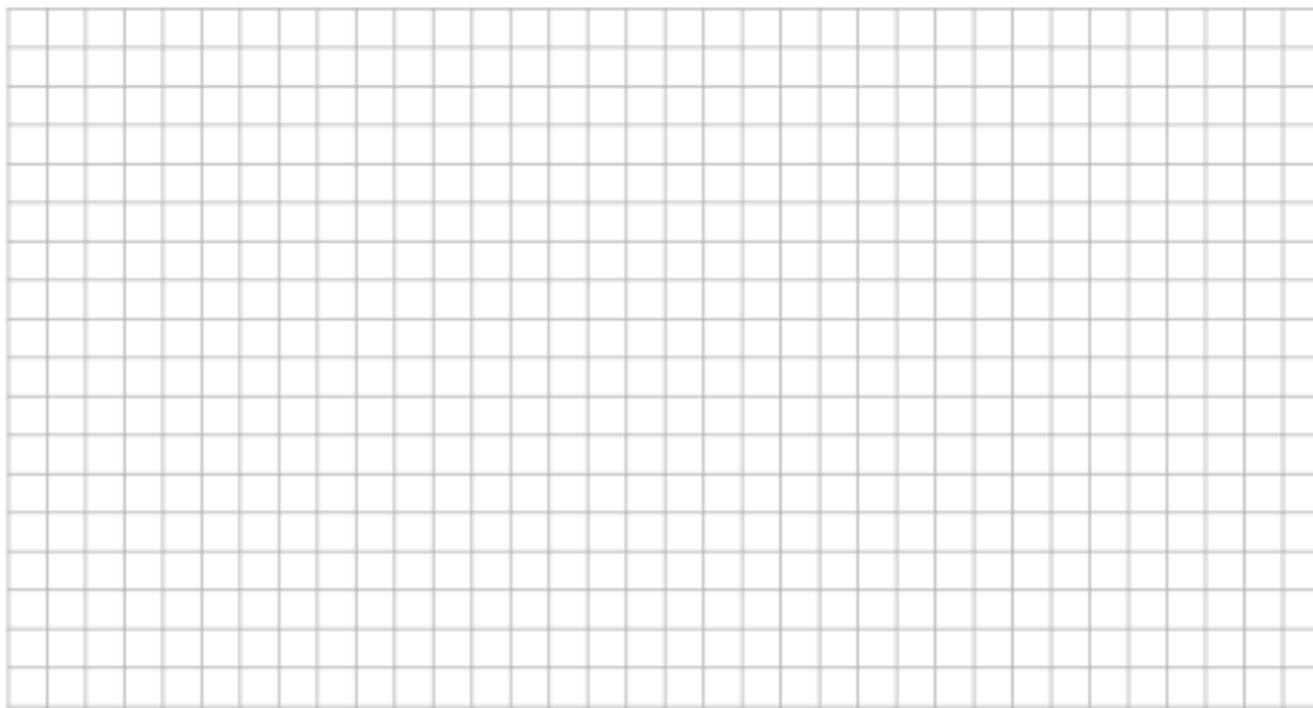
These are just like the questions in Section 2. All you have to do is work your way backwards through the formulas to find the original lengths.

eg1. The volume of a cone is 400cm^3 , if the base is 7cm , find the height of the of the cone.



eg2. The curved surface area of a cone is $70\pi\text{cm}^2$. If the radius of the cone 7cm ,

Find (i) its slant height, (ii) its volume, in terms of π .



Equal volumes

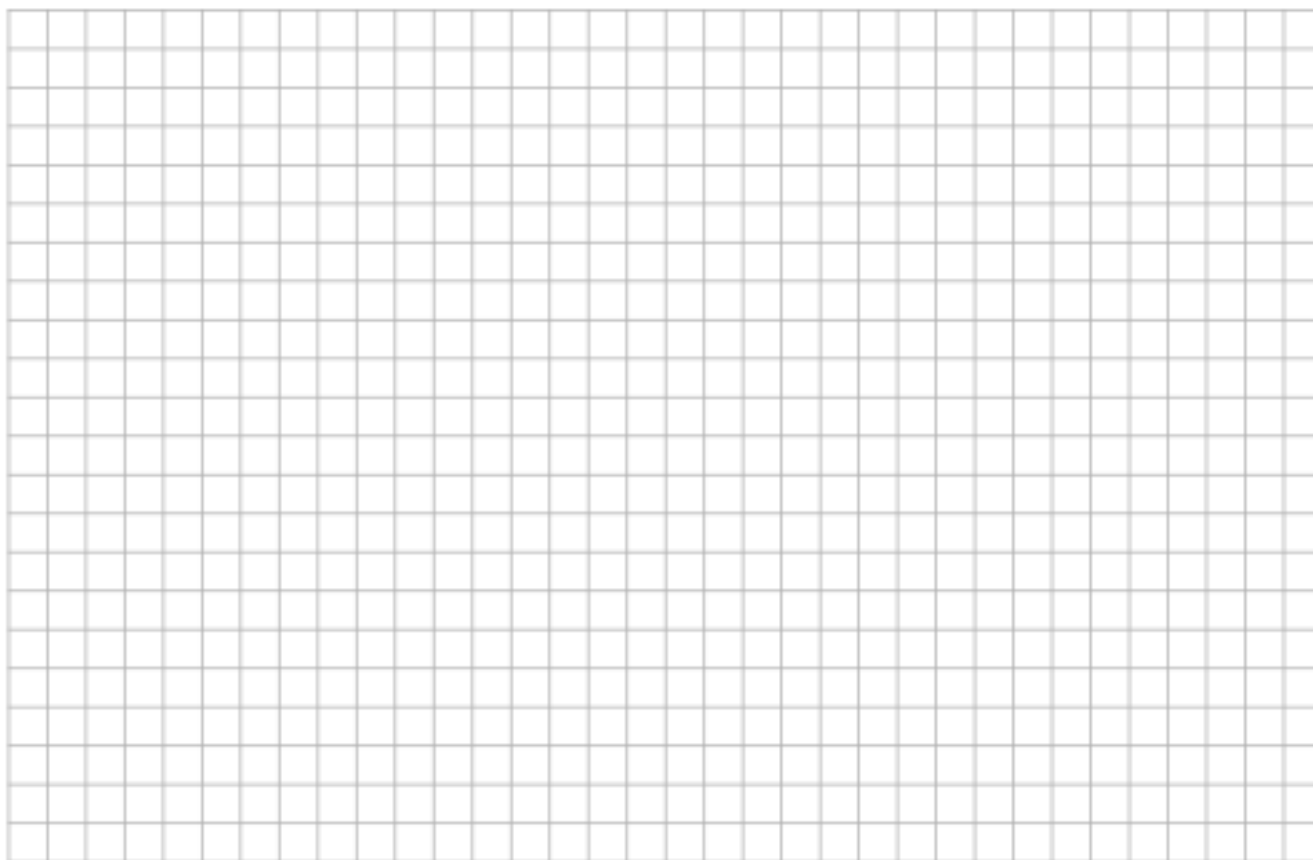
There are 3 different types of these questions:

1. Moving liquids
2. Melting down shapes and recasting them
3. Displacing liquids

1. Moving Liquids

- In these questions, liquid is moved from one container to another container with different dimensions or shape and you are asked to find the dimension of the new container.

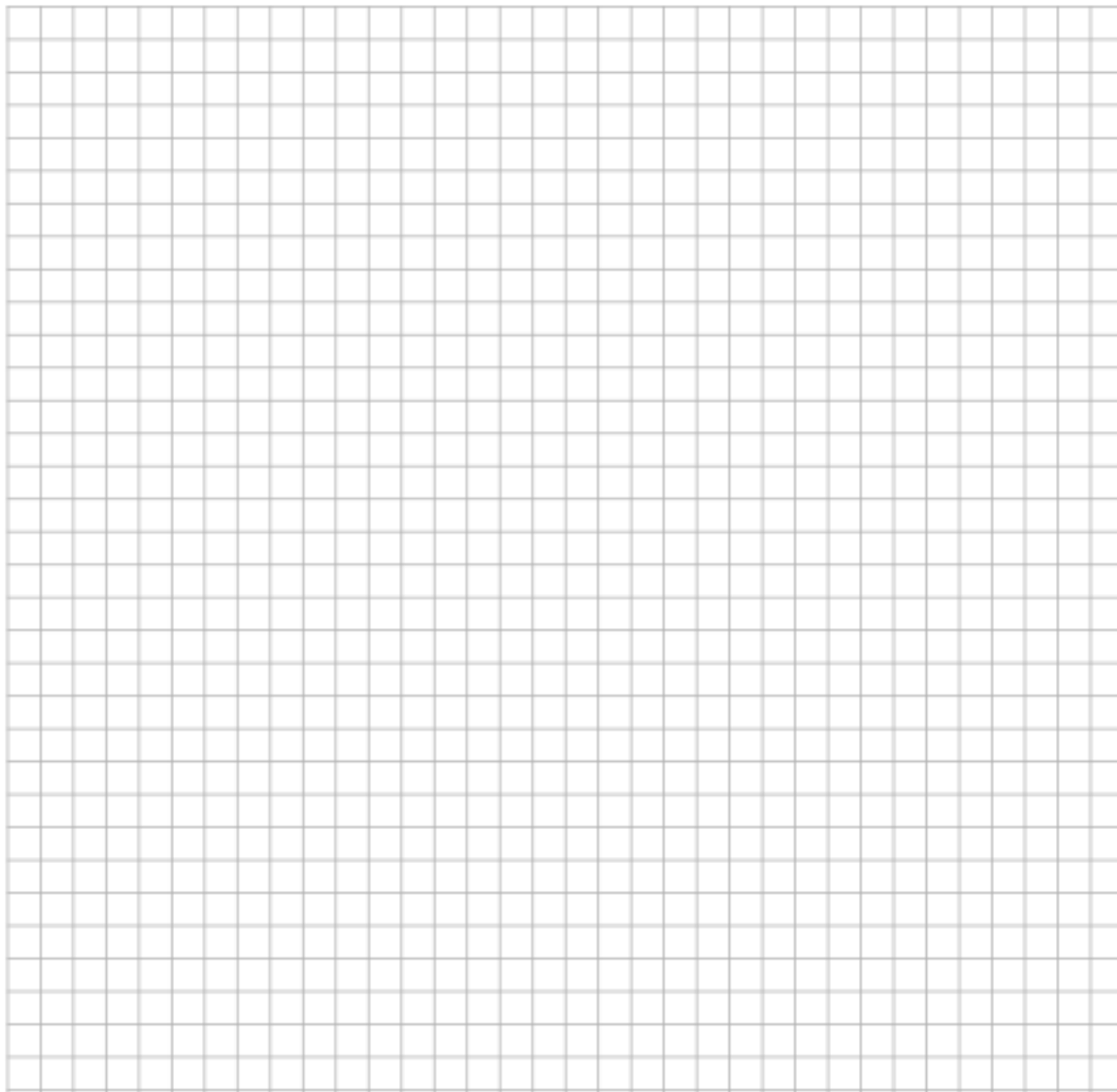
eg1. Water is poured from a cylindrical container with a height of 5cm and a radius of 3cm into another cylindrical container with a radius of 2cm, find the height of the water in the new container.



2. Melting down shapes and recasting them

- In these questions shapes are melted down and recast into different shapes and you are asked to find the dimensions of the new shapes.
- NOTE: THE VOLUME OF THE TWO SHAPES ARE EQUAL

eg1. A sphere of radius 10cm is made of lead. The sphere is then melted down and some of it is used to make to make a solid cone of radius 7cm and of height 18cm, the rest of the lead is used to make a cylinder of height 17cm. Find the radius of the cylinder.



3. Rising or falling liquids

- In these questions liquid rises or falls by putting in or removing solid objects.
- NOTE: THE VOLUME OF THE DISPLACED LIQUID IS EQUAL TO THE VOLUME OF THE OBJECT THAT IS PUT IN OR REMOVED.
- NOTE 2: In these questions don't put a value in for π as the π 's usually end up cancelling.

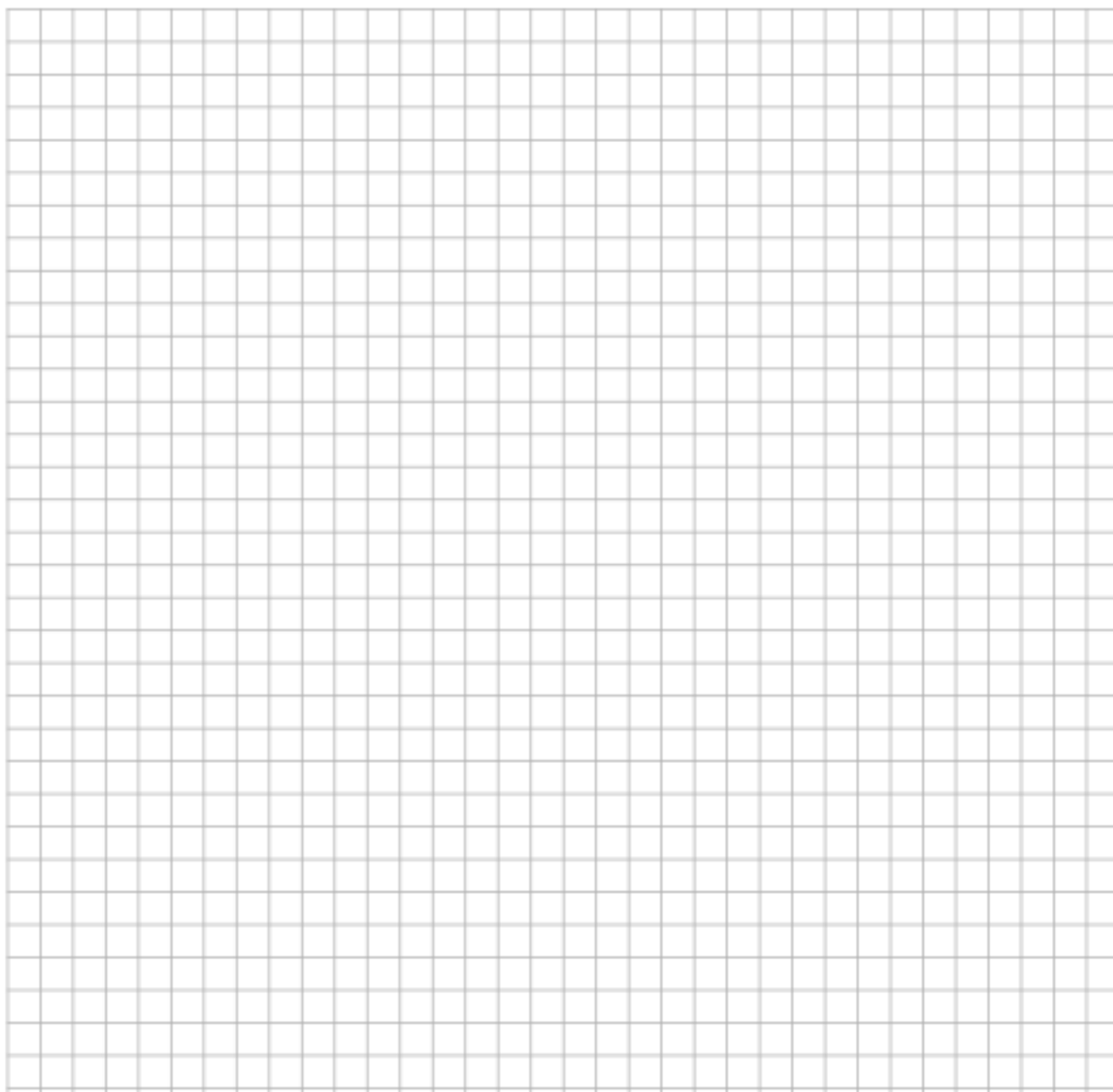
eg1. A solid cone has a height of 20cm and a radius at its base of 10cm. The cone is submerged in a cylinder filled with water with a diameter of 25cm. The cone is then removed from the cylinder. Calculate the drop in the level of the water when the cone is removed.



Algebraic substitution

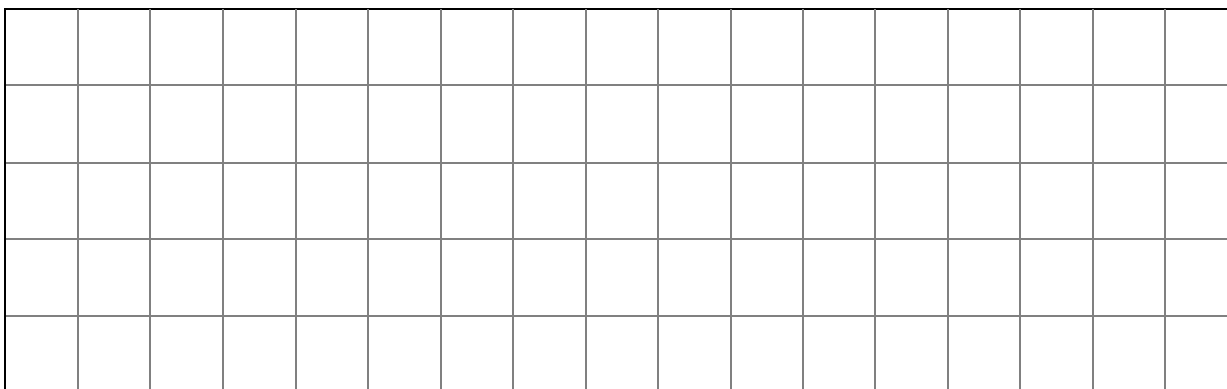
- Some of these area and volume questions require you to use a thing called algebraic substitution to solve them.

eg1. A cylinder and a cone have the same radius and the height of the cone is twice the height of the cylinder. Find the ratio of the volume of the cone to the volume of the cylinder.



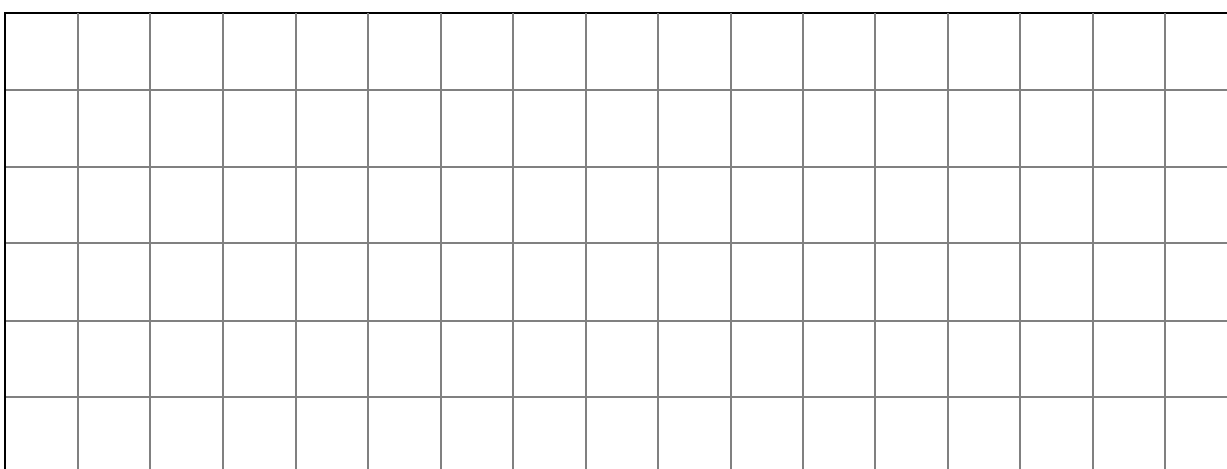
(iii) Find the total perimeter of Shape 2.

[5]



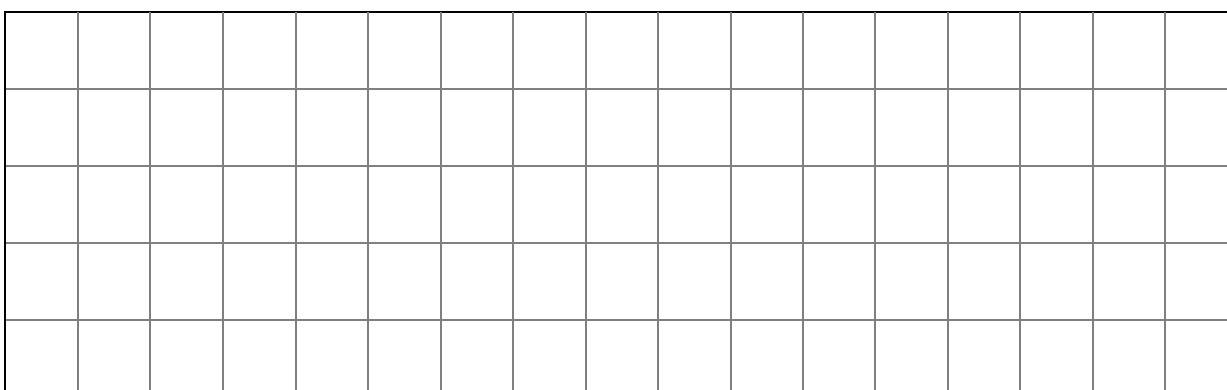
(iv) Find the total area of Shape 2.

[10]



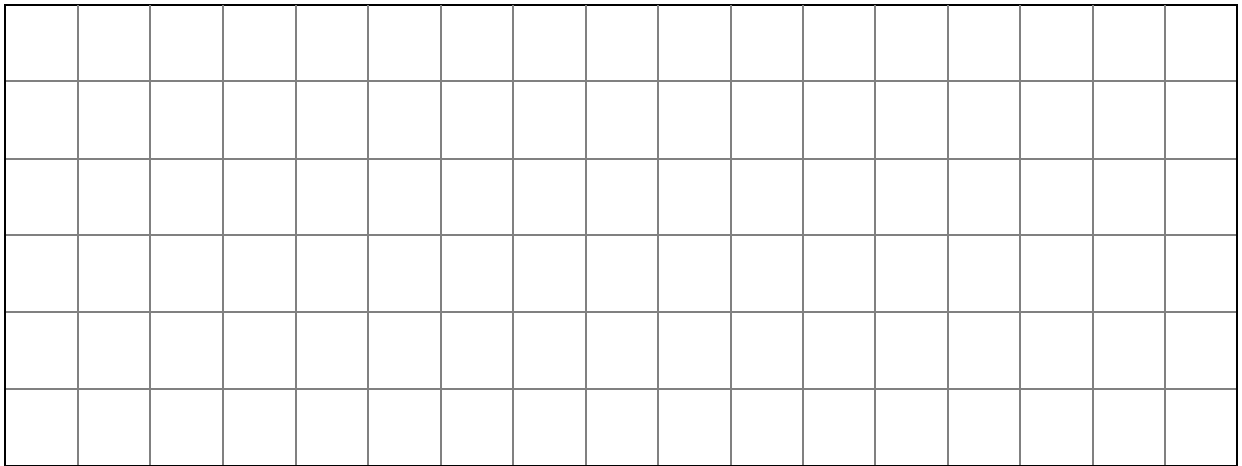
(v) Find the total perimeter of Shape 3.

[5]



(vi) Find the total area of Shape 3.

[10]



Question 2

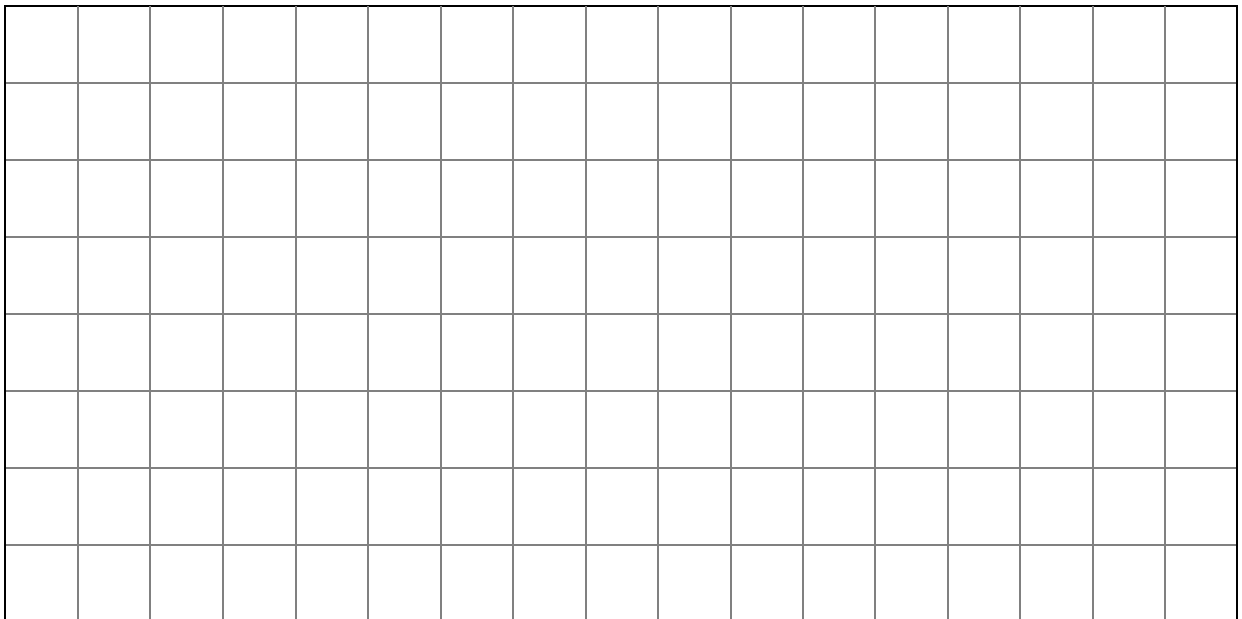
A school hall is in the shape of a rectangle 45m long and 36m wide.

The floor of the hall is going to be covered in new tiles.

Each tile is in the shape of a square with sides of length 30cm.

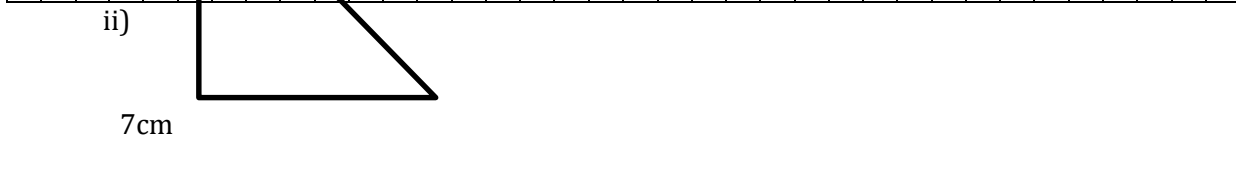
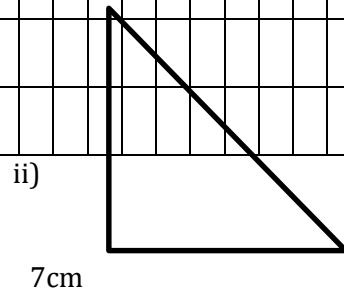
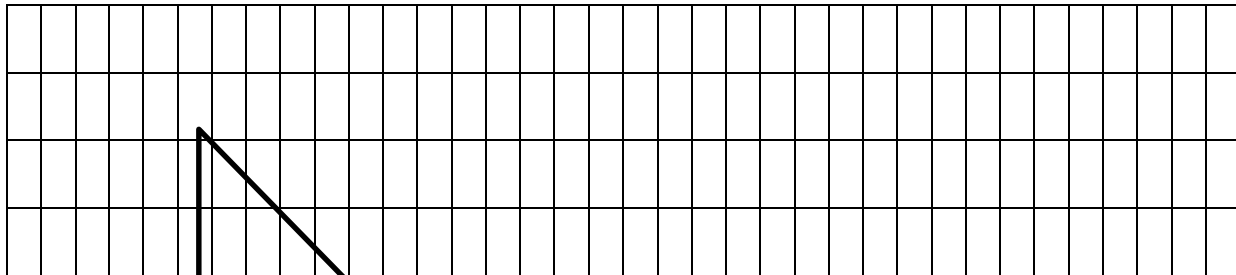
(i) How many tiles will be needed to cover the floor?

[15]

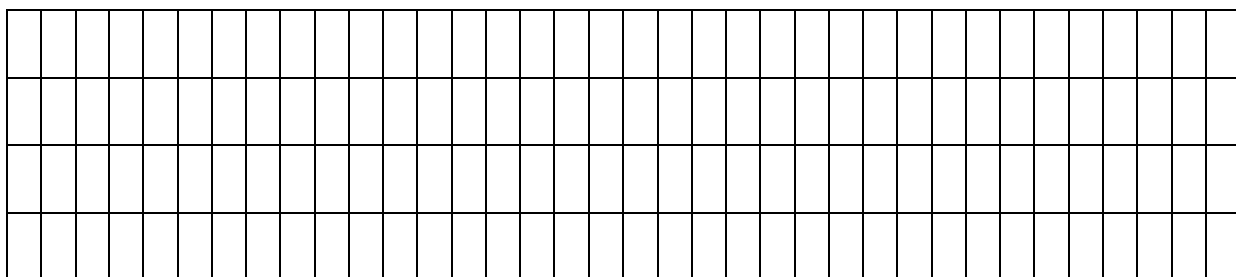
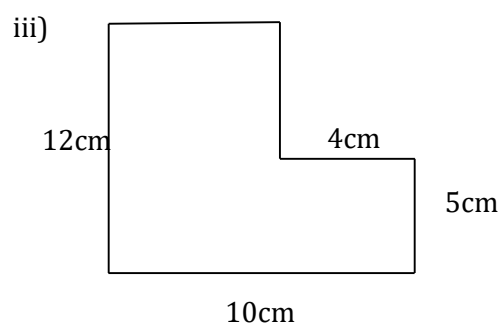
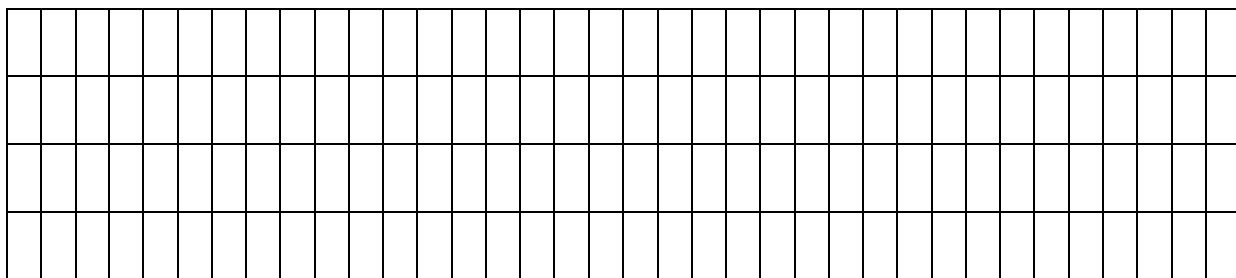


Homework 2

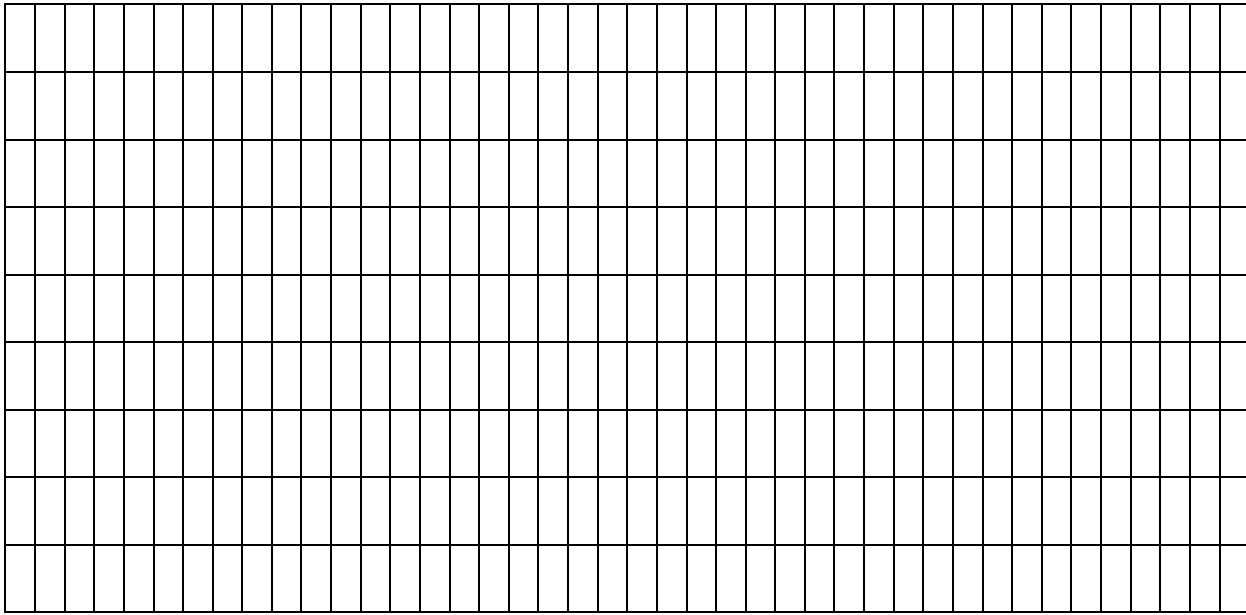
1. Find the area and perimeter of each of the following shapes:



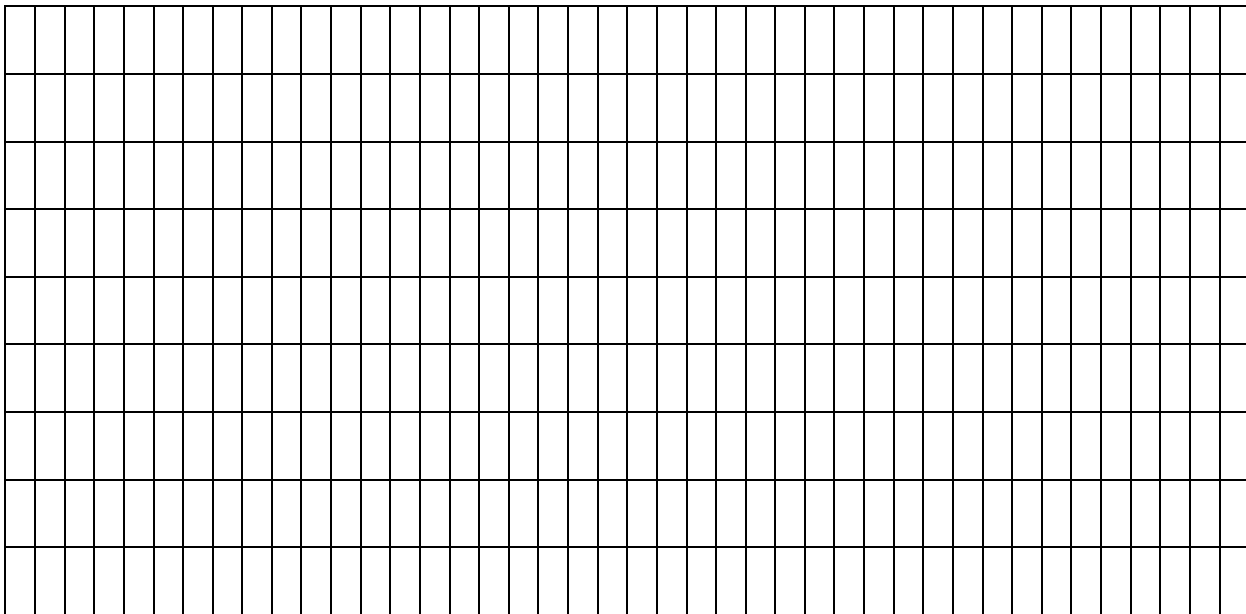
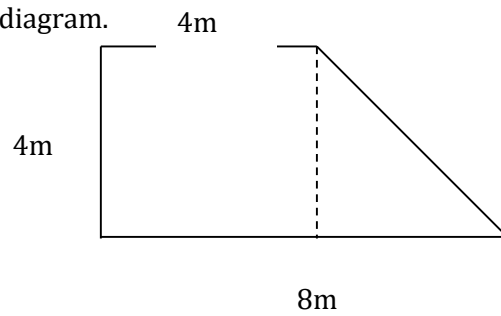
6cm



- iii) Ball-bearings of a different size are also produced.
 One steel rod makes 225 000 of these new ball-bearings.
 Find the radius of the new ball-bearings.



4. a) Calculate the area of the figure in the diagram.



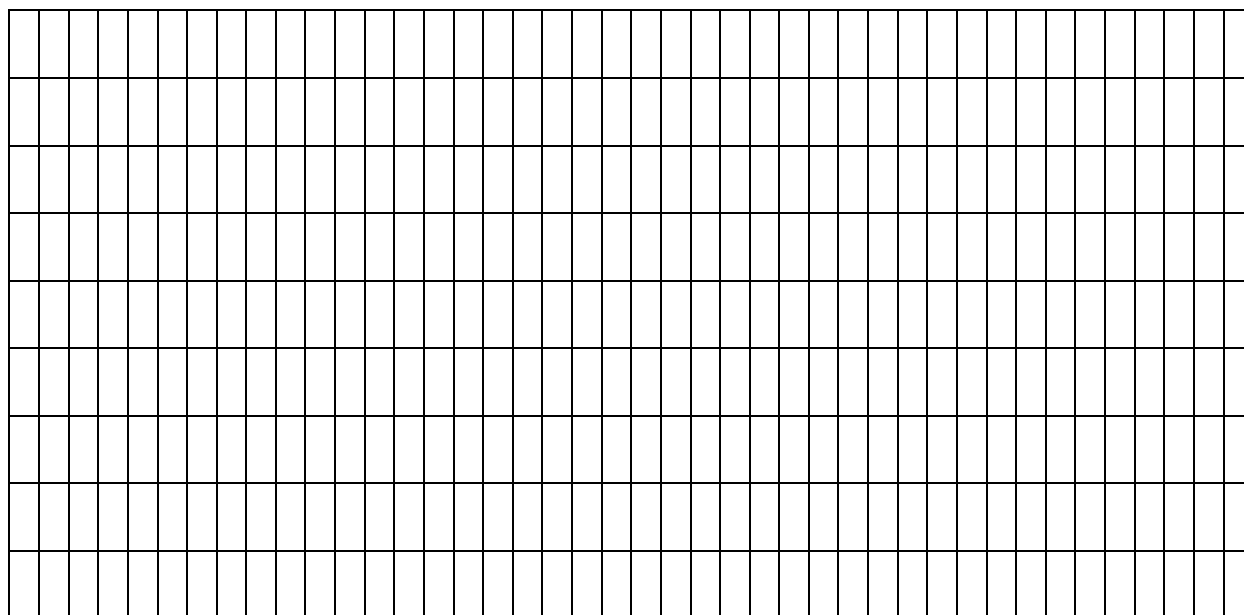
b) The diagram show a rectangle of length 42cm.

The area of the rectangle is 966 cm^2 .

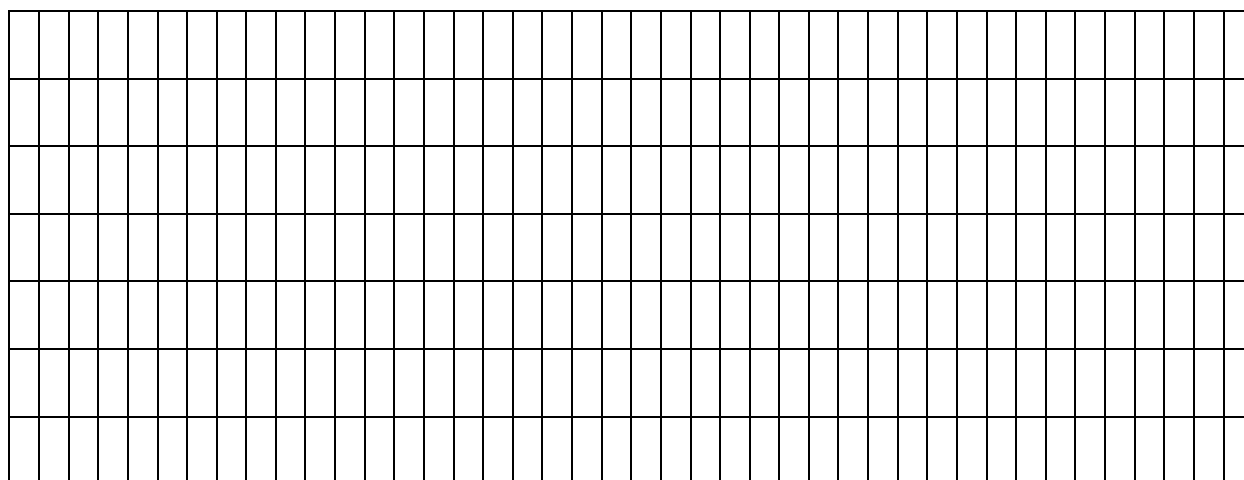


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i) Find the height of the rectangle.

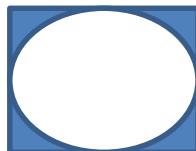


ii) Find the area of the shaded triangle.



Homework 4

1. a) The diagram shows a circle inscribed in a square.



The area of the square is 16m^2 .

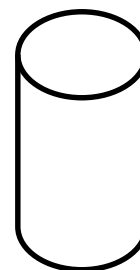
- ii) Find the area of the shaded region, in cm^2 , correct to one decimal place.

- b) A solid wax candle is in the shape of a cylinder with a cone on top as shown in the diagram.

The diameter of the base of the cylinder is 3cm and the height of the cylinder is 8cm .

The volume of wax in the cone is $21\pi \text{ cm}^3$.

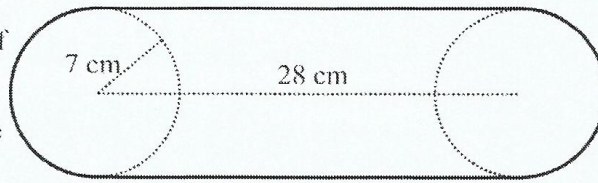
- i) Find the height of the candle.



Old Syllabus Exam Questions

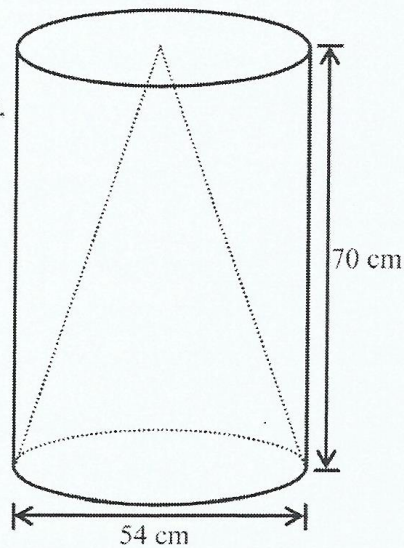
Q1.

- (a) The diagram shows two pulley wheels of equal size, connected by a drive belt. The radius of each wheel is 7 cm and the distance between the centres is 28 cm.



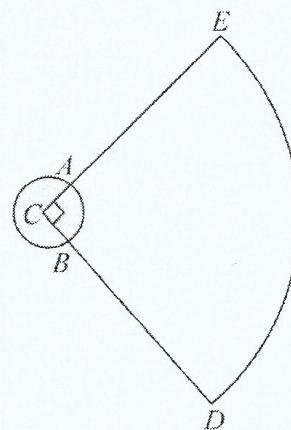
- ✍ Calculate the length of the belt.
Give your answer correct to the nearest whole number.

- (b) The diagram shows a solid cylinder of diameter 54 cm and of height 70 cm. A cone, of the same diameter and height as the cylinder, is cut from inside the cylinder.



- (i) ✍ Calculate the volume of the cylinder.
Give your answer in terms of π .
- (ii) ✍ Calculate the volume of the cone.
Give your answer in terms of π .
- (iii) ✍ What fraction of the cylinder remains after the cone is removed?

- (c) The diagram, not to scale, represents a shot-put zone in an athletics stadium. The area of CDE is a quarter of the area of a disc of centre C and of radius 100 m.



- (i) ✍ Calculate the area of CDE , correct to two decimal places.

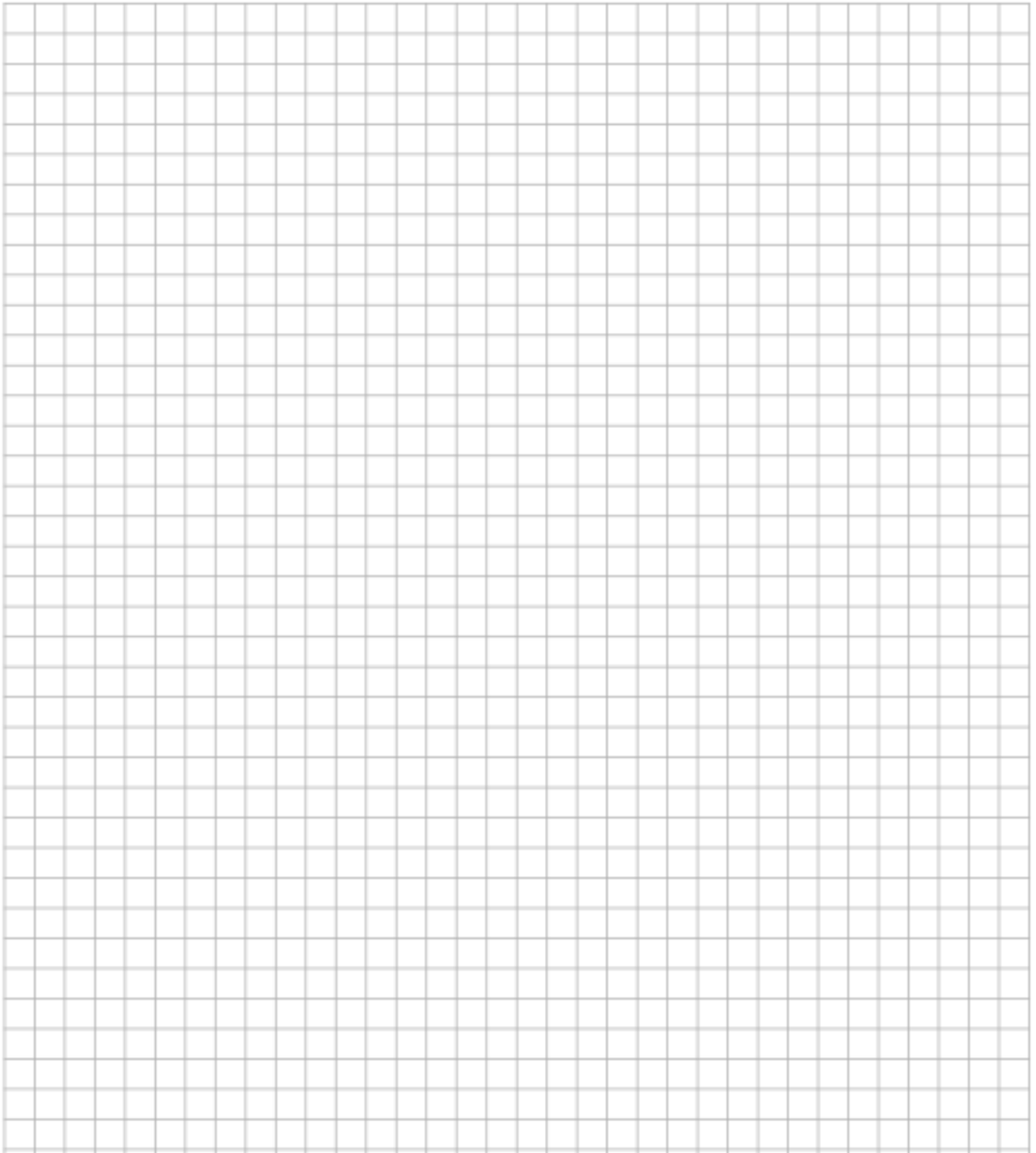
The shot-put zone consists of a throwing zone and a landing zone.

The throwing zone (shaded) is a disc of centre C and of radius 1 m.

- (ii) ✍ Calculate the area of the throwing zone, correct to two decimal places.

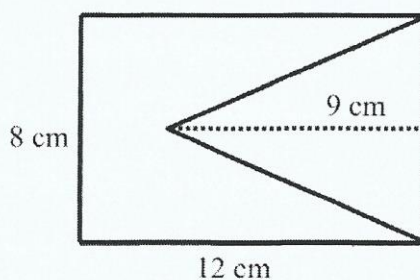
The landing zone is the unshaded area $ABDE$, which is part of CDE .

- (iii) ✍ Calculate the total area of the shot-put zone, correct to two decimal places.



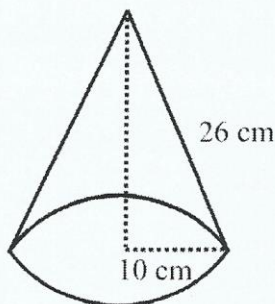
Q2.

- (a) The diagram shows a rectangular piece of cardboard with a triangular section cut out.



✍ Calculate the area of the cardboard.

- (b) A cone has a slant height of 26 cm and a radius of 10 cm.

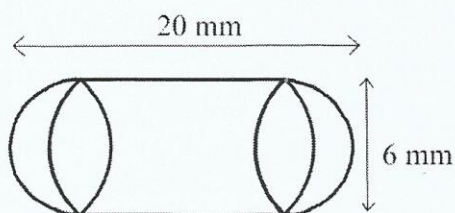


- (i) ✍ Find the curved surface area of the cone, in terms of π .

The curved surface area of the cone is doubled, while the slant height remains the same.

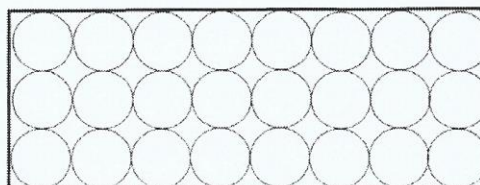
- (ii) ✍ Find the radius and hence the vertical height of this cone, correct to the nearest cm.
- (iii) ✍ Show that the volume of this cone is more than double the volume of the cone part (i).

- (c) A vitamin capsule is in the shape of a cylinder with hemispherical ends. The length of the capsule is 20 mm and the diameter is 6 mm.

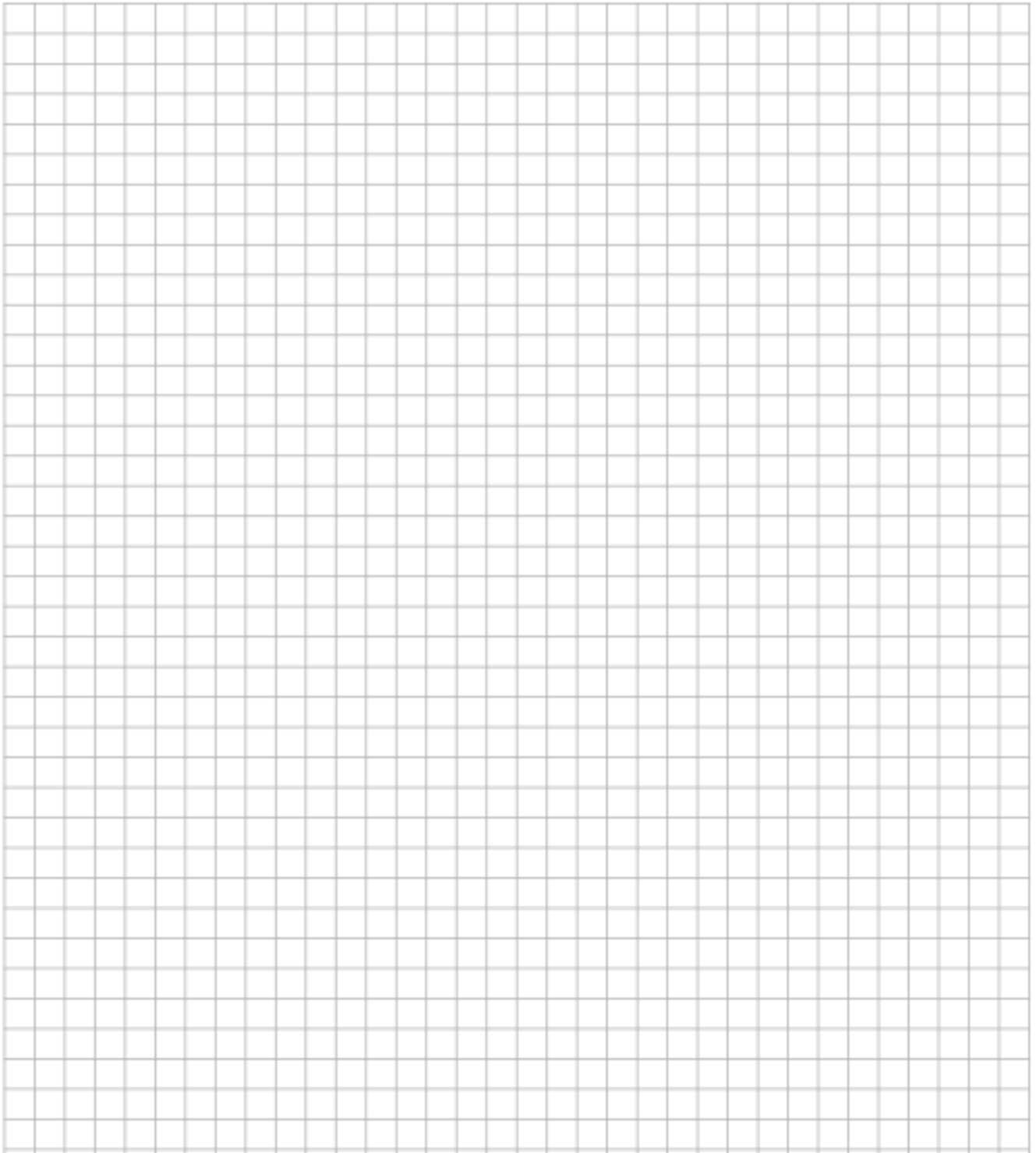


- (i) ✍ Calculate the volume of the capsule, giving your answer correct to the nearest mm^3 .

A course of these vitamins consists of 24 capsules. The capsules are stacked in three rows of eight in a box as shown in the diagram.



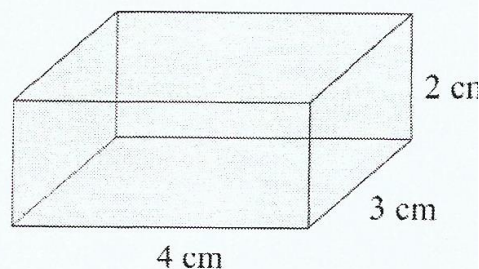
- (ii) ✍ How much of the internal volume of the box is not occupied by the capsules.



Q3.

- (a) ✍ Find the total surface area of a solid hemisphere of diameter 14 cm.
Give your answer correct to the nearest whole number.

- (b) A jeweller buys a rectangular block of gold of length 4 cm, width 3 cm and height 2 cm.
1 cm³ of gold costs €400.



- (i) ✍ Calculate the cost of the block of gold.

The jeweller needs 250 mm³ of gold to make a gold ring.

- (ii) ✍ How many rings can be made from the block?

Each ring is sold for €120.

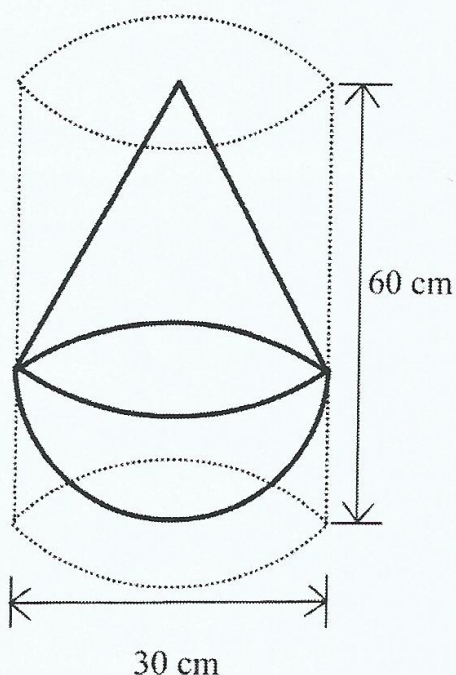
- (iii) ✍ Calculate the amount of profit the jeweller makes on each ring.

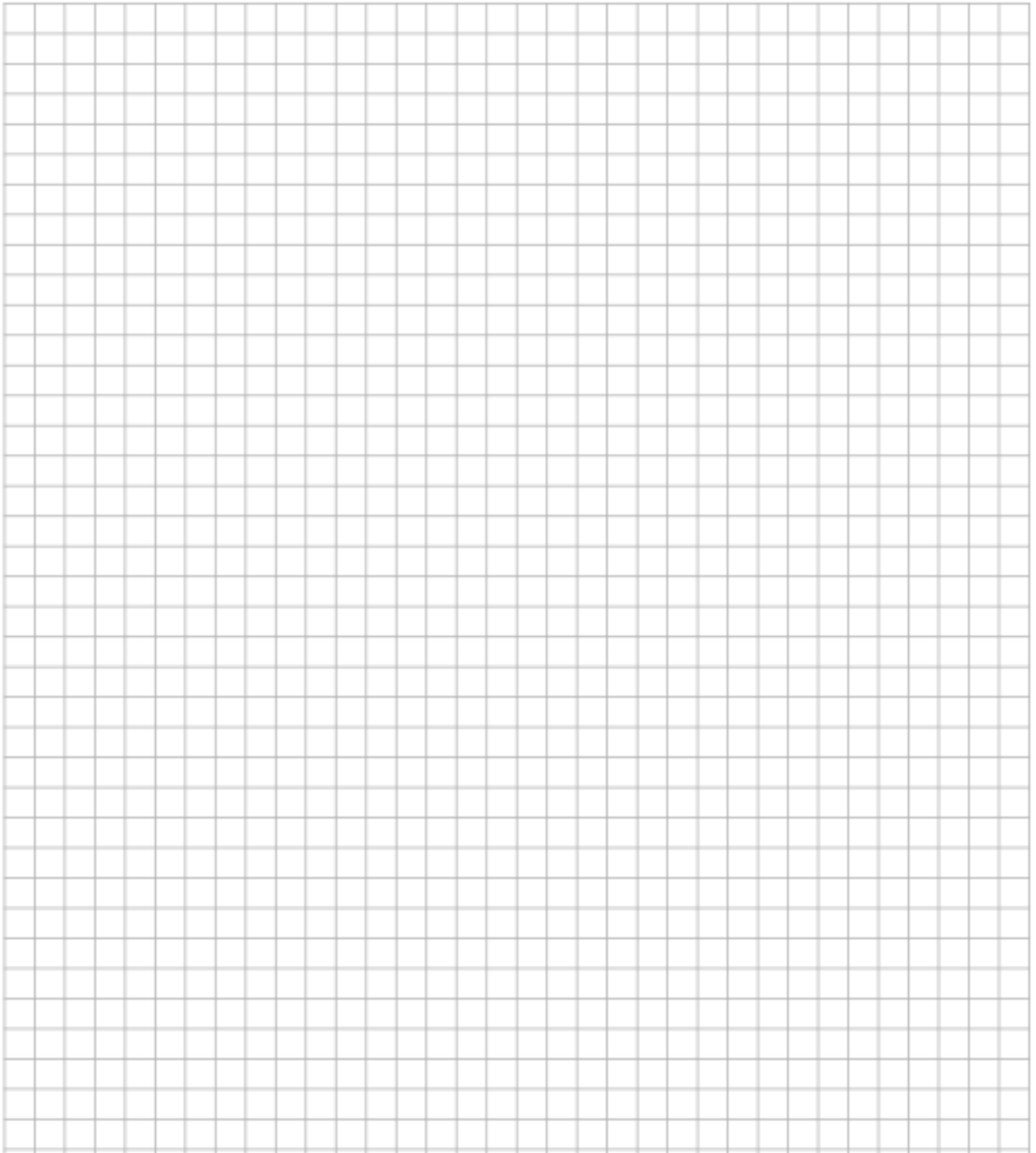
- (c) A float in the shape of a cone on top of a hemisphere is made from solid rubber.
The diameter of the hemisphere is 30 cm and the height of the float is 60 cm.

- (i) ✍ Find the volume of the float in terms of π .

The float is cut from a solid rubber cylinder of diameter 30 cm and height 60 cm.


- (ii) ✍ Express the volume of rubber used in the float as a percentage of the volume of the cylinder.
Give your answer correct to the nearest whole number.



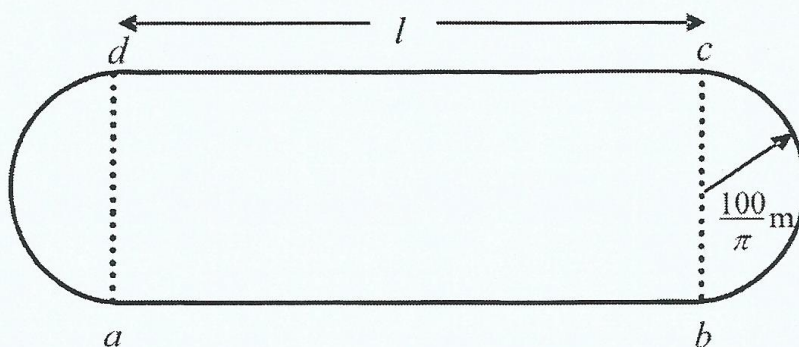



Q4.

(a) The height and the diameter of a solid cylinder are both 8 cm in length.


 Find the curved surface area of the cylinder correct to the nearest whole number.

(b) The diagram shows the perimeter of a running track, consisting of two straight sections of length l , and two semi-circular sections, at each end, of radius $\frac{100}{\pi}$ m, as shown.




(i)  Given that the perimeter of the track measures 400 m, find l .

(ii) A 1500 m race starts at the point a and goes in the direction $abcd$.

 At what point does the race finish?


(iii) An athlete completes this distance in 3 mins 26 sec.

 Find his average speed in m/s, correct to one decimal place.


(c) A spherical golf ball has a diameter of 4 cm.

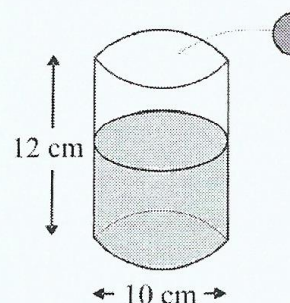
(i)  Find the volume of the golf ball in terms of π .

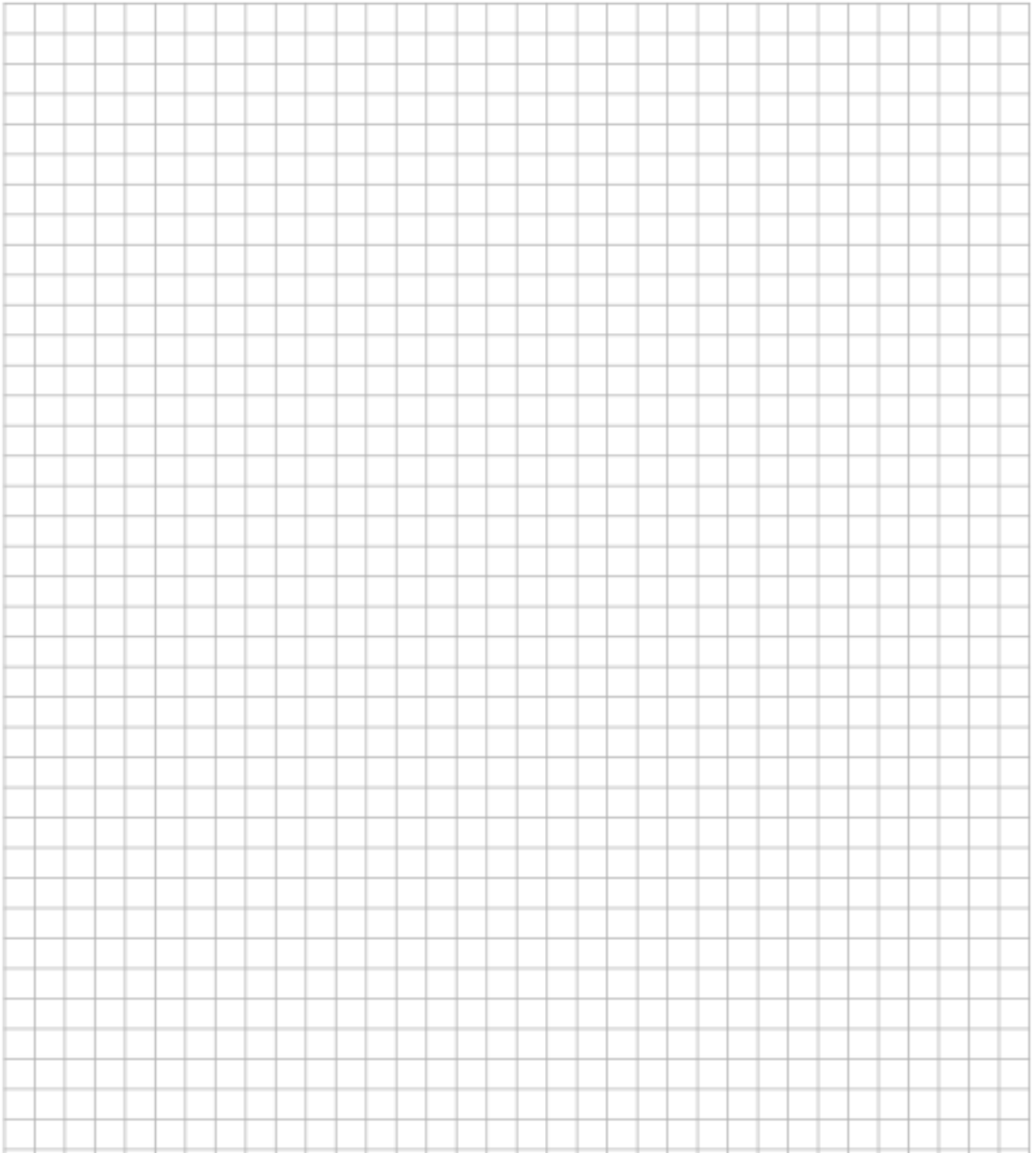
A cylindrical hole on a golf course is 10 cm in diameter and 12 cm deep. The hole is half full of water.

(ii)  Calculate the volume of water in the hole, in terms of π .

The golf ball is dropped into the hole.

(iii)  Find the rise in the level of the water, correct to two decimal places.

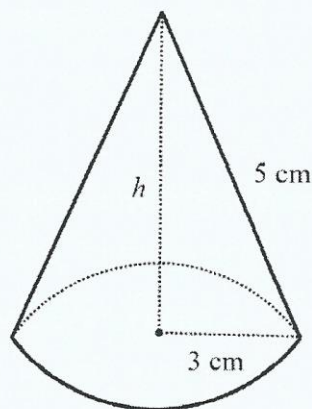




Q5.

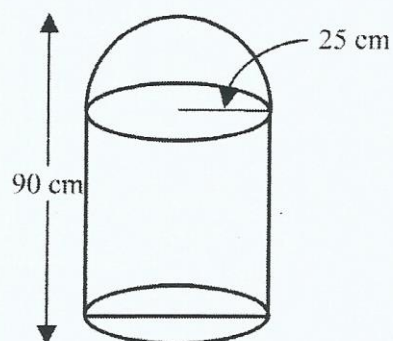
(a) A cone has a base radius of 3 cm and a slant height of 5 cm.

- (i) ✎ Find h , the perpendicular height of the cone.
- (ii) ✎ Find the volume of the cone in terms of π .

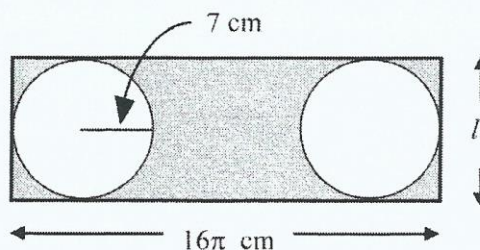


(b) A hot water container is in the shape of a hemisphere on top of a cylinder as shown. The hemisphere has a radius of 25 cm and the container has a height of 90 cm.

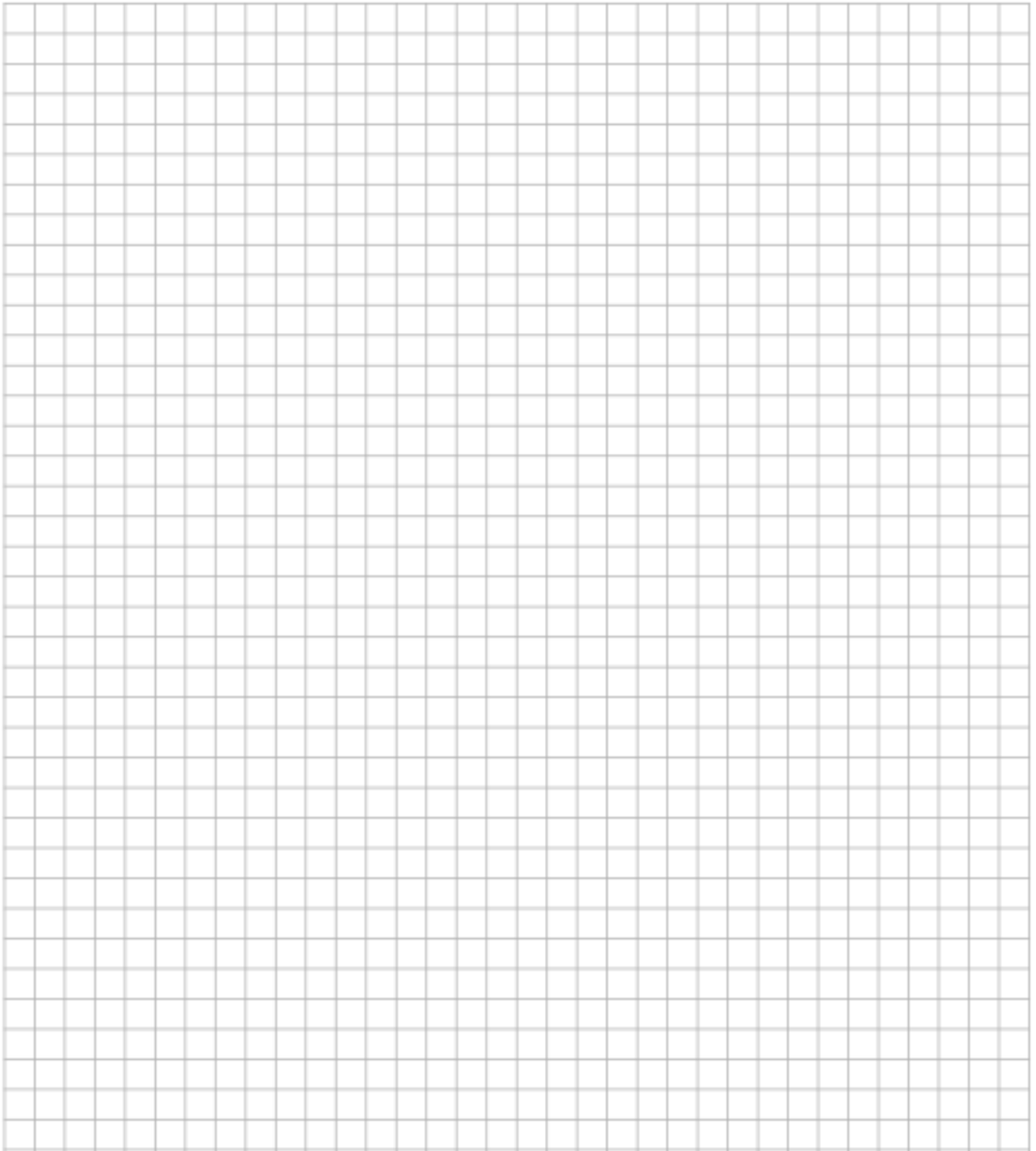
- ✎ Find the internal volume of the container in litres, giving your answer correct to the nearest litre.



(c) A rectangular piece of metal has a width of 16π cm. Two circular pieces, each of radius 7 cm, are cut from the rectangular piece, as shown.



- (i) Find the length, l , of the rectangular piece of metal.
- (ii) ✎ Calculate the area of the metal not used (i.e. the shaded section), giving your answer in terms of π .
- (iii) ✎ Express the area of the metal not used as a percentage of the total area.




Q6.


(a) The height and the diameter of a solid cylinder are both 9 cm in length.

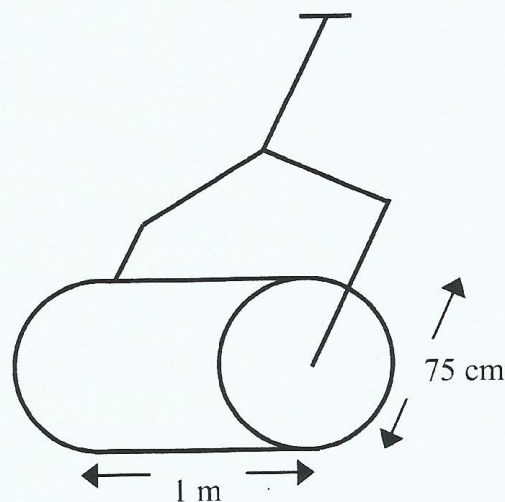
 Find the volume of the cylinder correct to one decimal place.


(b) (i) The perimeter of a square lawn is 96 m.

 Find the area of the lawn in m^2 .


(ii) A garden roller, in the shape of a cylinder, has a diameter of 75 cm and is 1 m wide as shown in the diagram.


 Calculate the curved surface area of the roller in m^2 , correct to one decimal place.

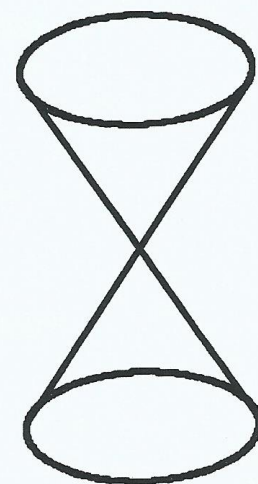


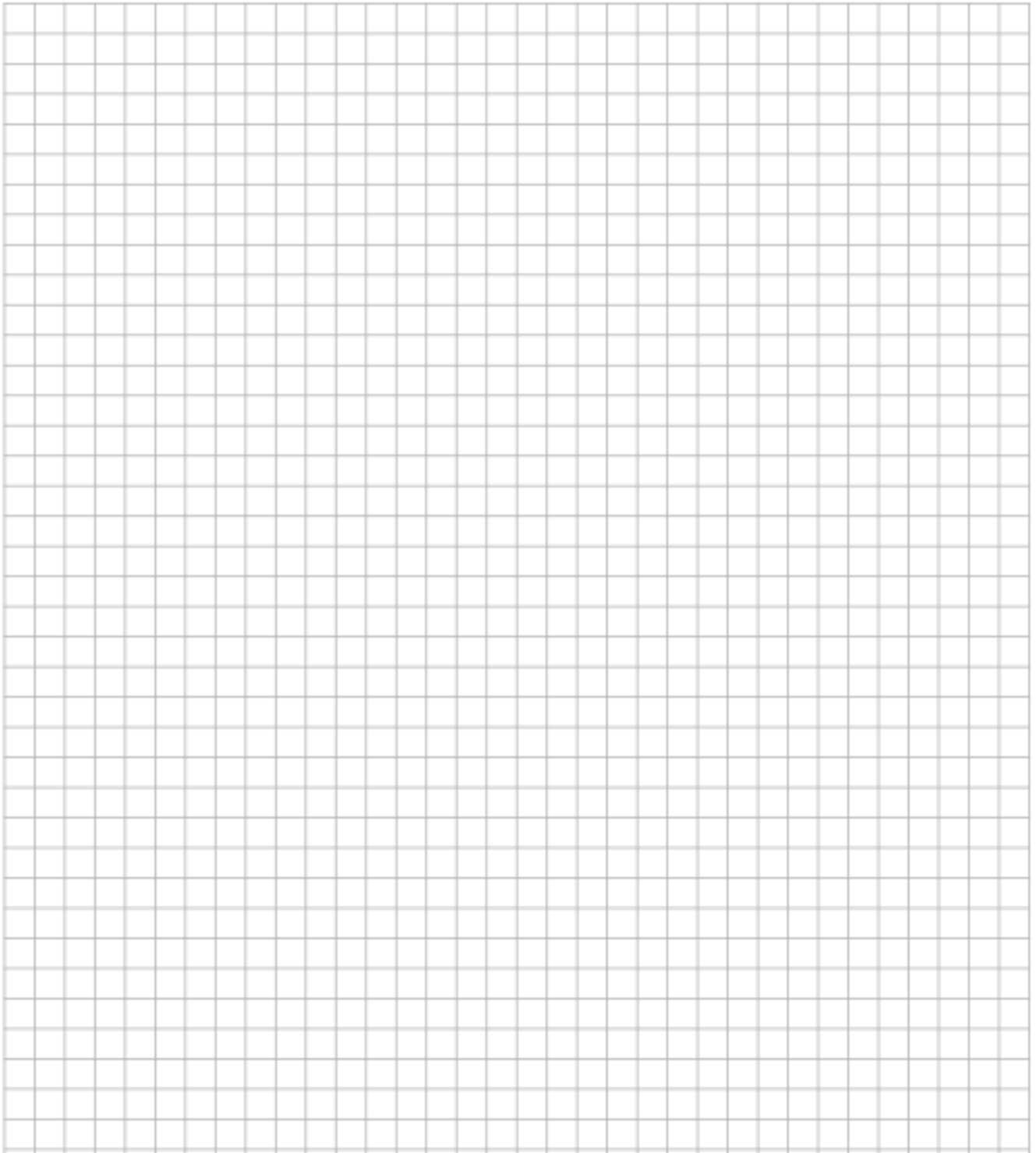
(iii)  What percentage of the lawn will be rolled when the roller has completed 9 revolutions?

(c) An egg-timer consists of two identical cones of height 6 cm and base radius 4 cm. Sand occupies half the volume of one cone and flows from one to the other at a rate of $\frac{4\pi}{45} \text{ cm}^3$ per second.

(i)  Calculate the volume of each cone in terms of π .

(ii)  Calculate the length of time it takes for the sand to flow from one cone into the other.

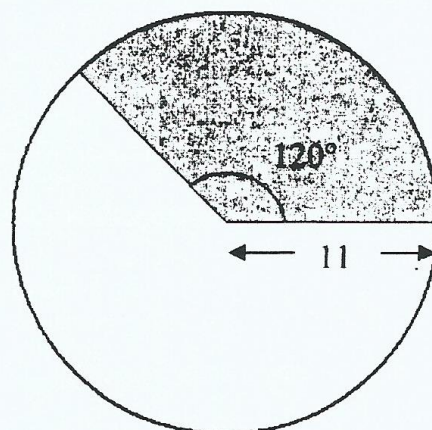




Q7.

- (a) (i) ✍ Find, correct to the nearest cm^2 ,
the area of a disc of radius 11 cm.

- (ii) ✍ Find, correct to the nearest cm^2 ,
the area of the shaded region in
the diagram.

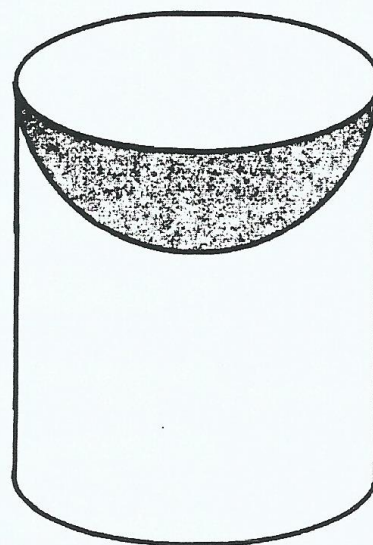


- (b) (i) A solid metal cylinder has height 20 cm
and diameter 14 cm.

- ✍ Find its curved surface area in
terms of π .

- (ii) A hemisphere with diameter 14 cm is
removed from the top of this cylinder, as
shown.

- ✍ Find the total surface area of the
remaining solid in terms of π .

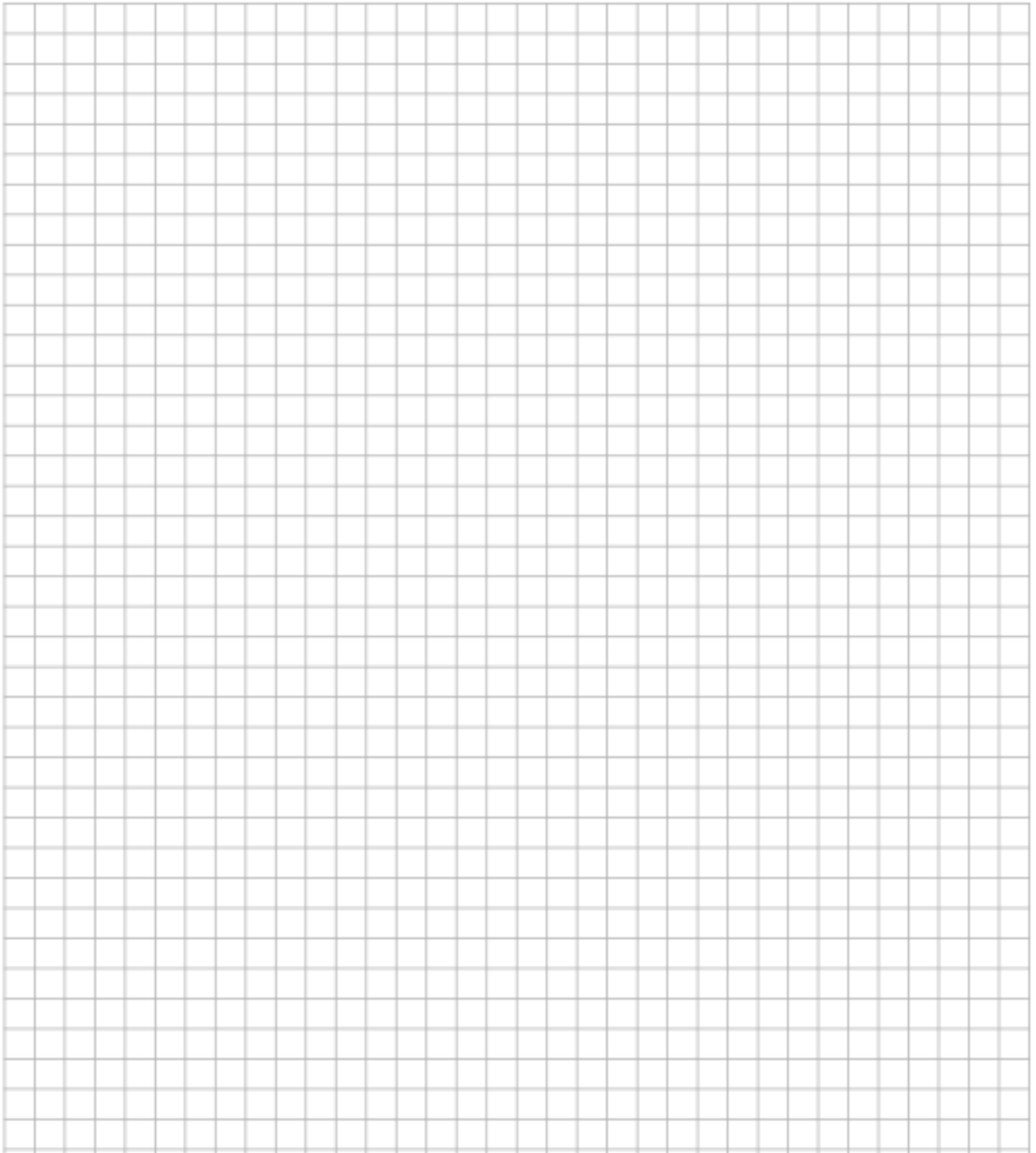


- (c) (i) A cone has radius x and height $3x$.

- ✍ Find its volume in term of π and x .

- (ii) A second cone has twice the radius and half the height of the first cone.

- ✍ Find the ratio of the volume of the second cone to the
volume of the first.



Q8.

(a) ✍ The perimeter of a rectangle is 200 cm. If the length : breadth = 3 : 2, find the area of the rectangle.

(b) A solid cone has a vertical height 6 cm. The slant height is 7.5 cm.

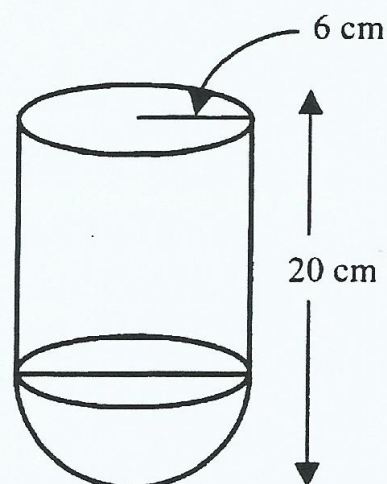
(i) ✍ Find the radius of its base.

(ii) ✍ Find the total surface area in cm^2 .

Give your answer correct to three significant figures.

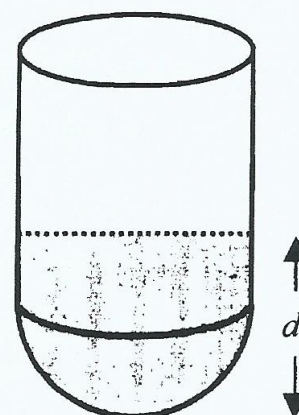
(c) (i) A container is in the shape of a cylinder on top of a hemisphere as shown. The cylinder has a radius of 6 cm and the container has a height of 20 cm.

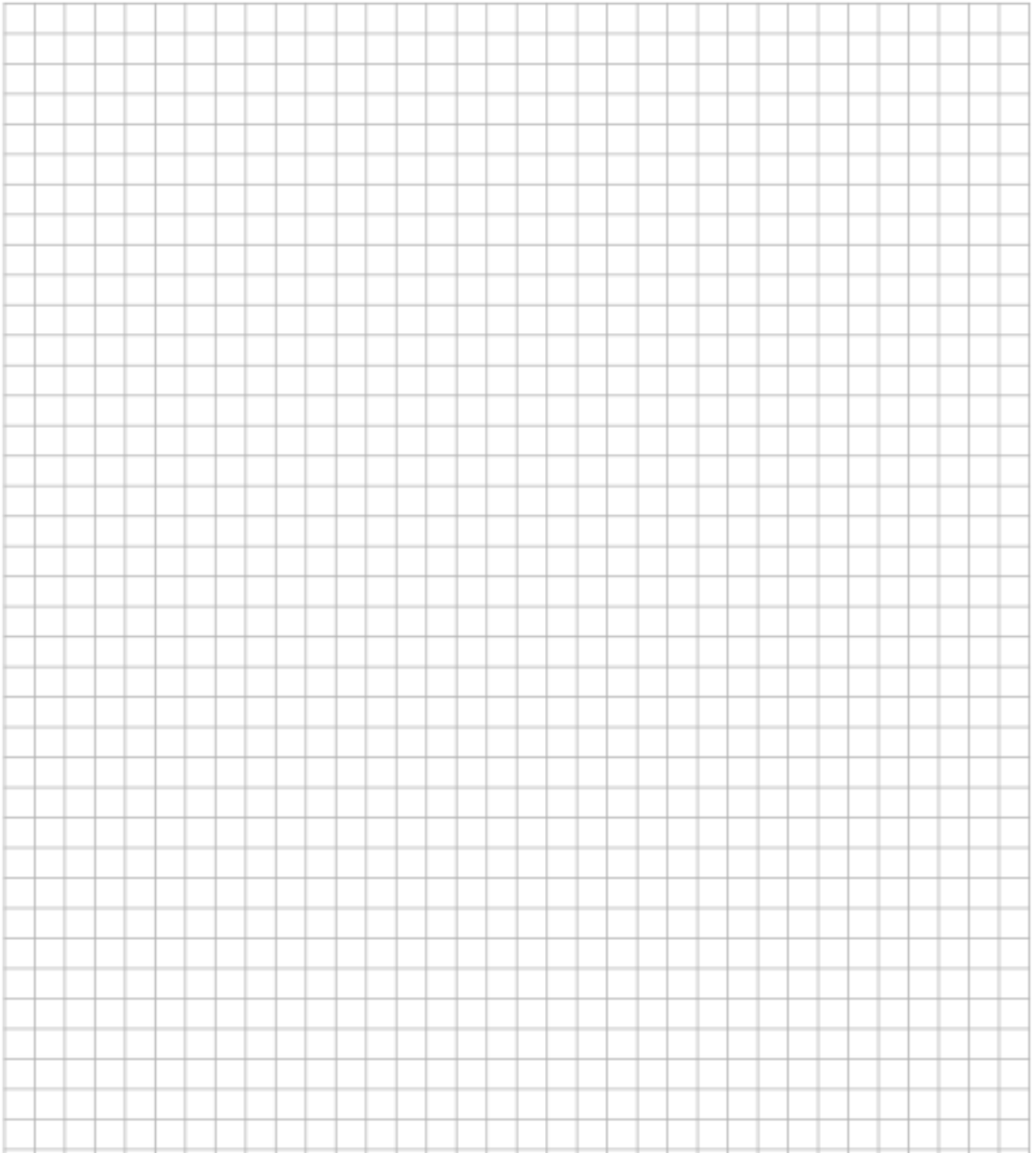
✍ Calculate the volume of the container in terms of π .




(ii) One third of the volume of the container is filled with water.

✍ Calculate, d , the depth of the water in the container.







Q9.

(a)  A solid cone has vertical height 4 cm. The radius of its base is 3 cm. Find, in terms of π , the volume of the cone.

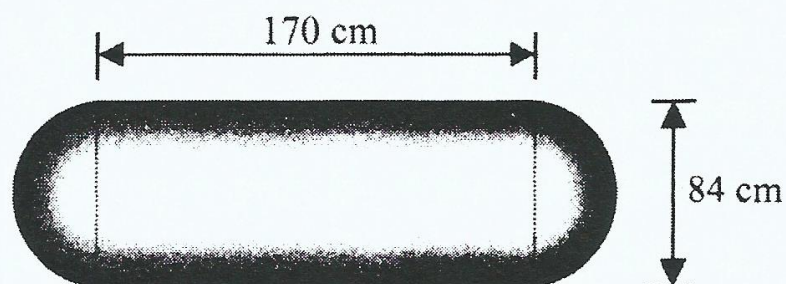
(b) A solid rectangular metal block has length 12 cm and width 5 cm. The volume of the block is 90 cm^3 .

(i)  Find the height of the block in cm.


(ii)  Find the total surface area of the block in cm^2 .


(iii)  Each cm^3 of the metal has mass 8.4 g. The total mass of a number of these metal blocks is 113.4 kg. How many blocks are there?

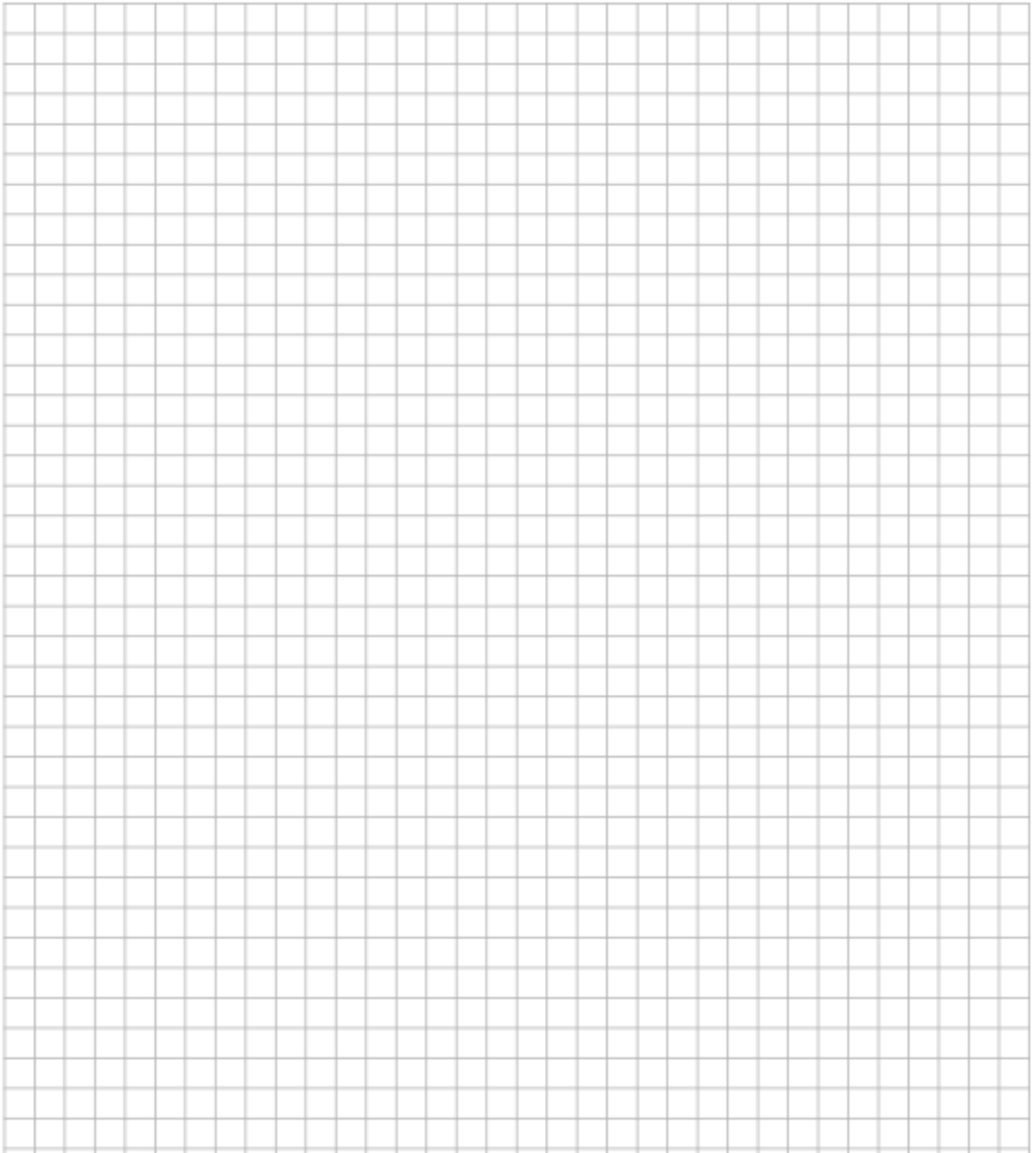
(c)



A capsule is made up of a cylindrical section and two hemispherical ends. The length of the cylindrical section is 170 cm and the diameter is 84 cm.

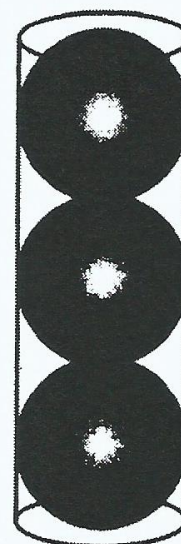
(i)  Find the surface area of the capsule in cm^2 . Give your answer correct to two significant figures.

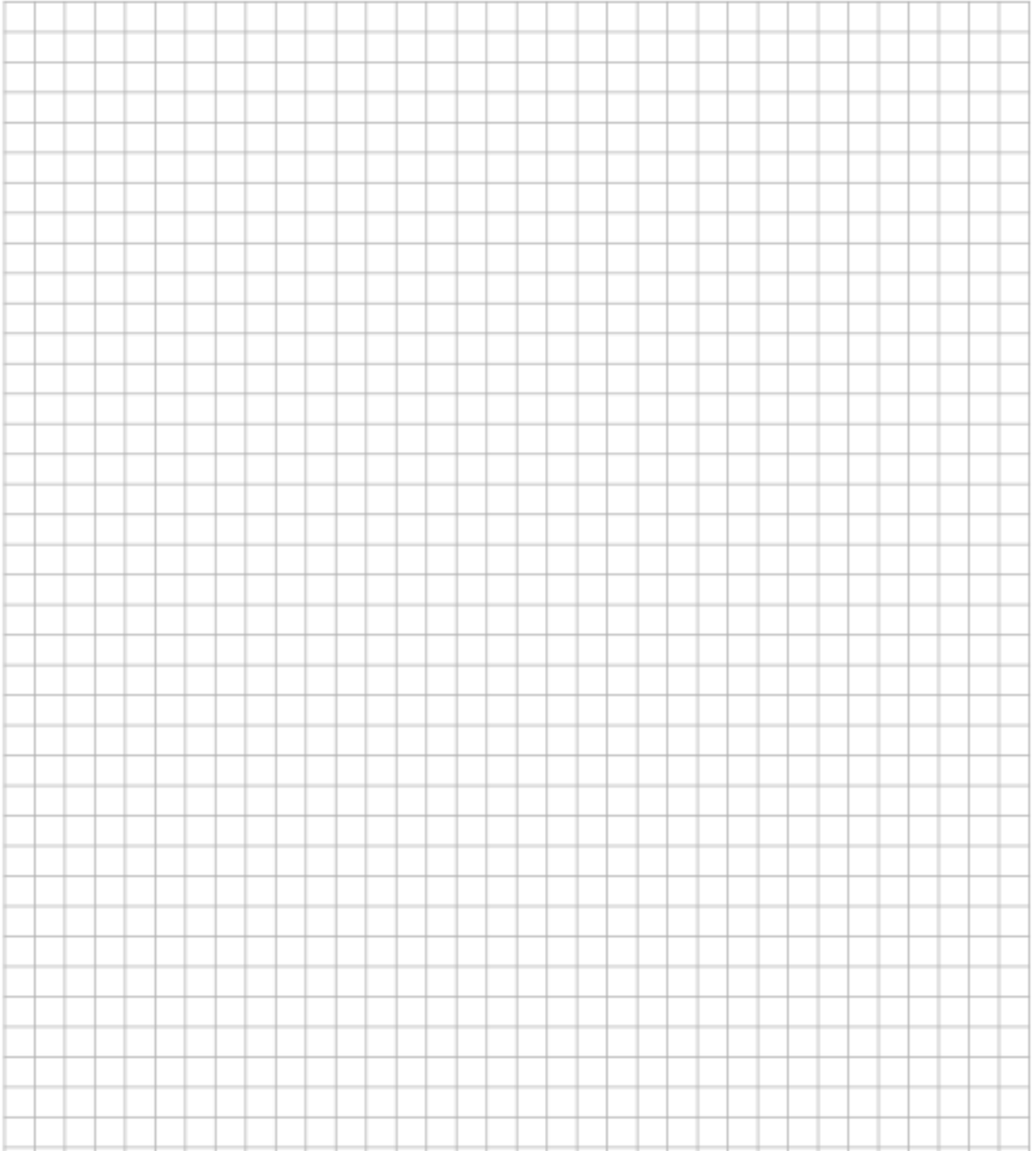
(ii)  Find the volume of the capsule in m^3 . Give your answer correct to two decimal places.



Q10.

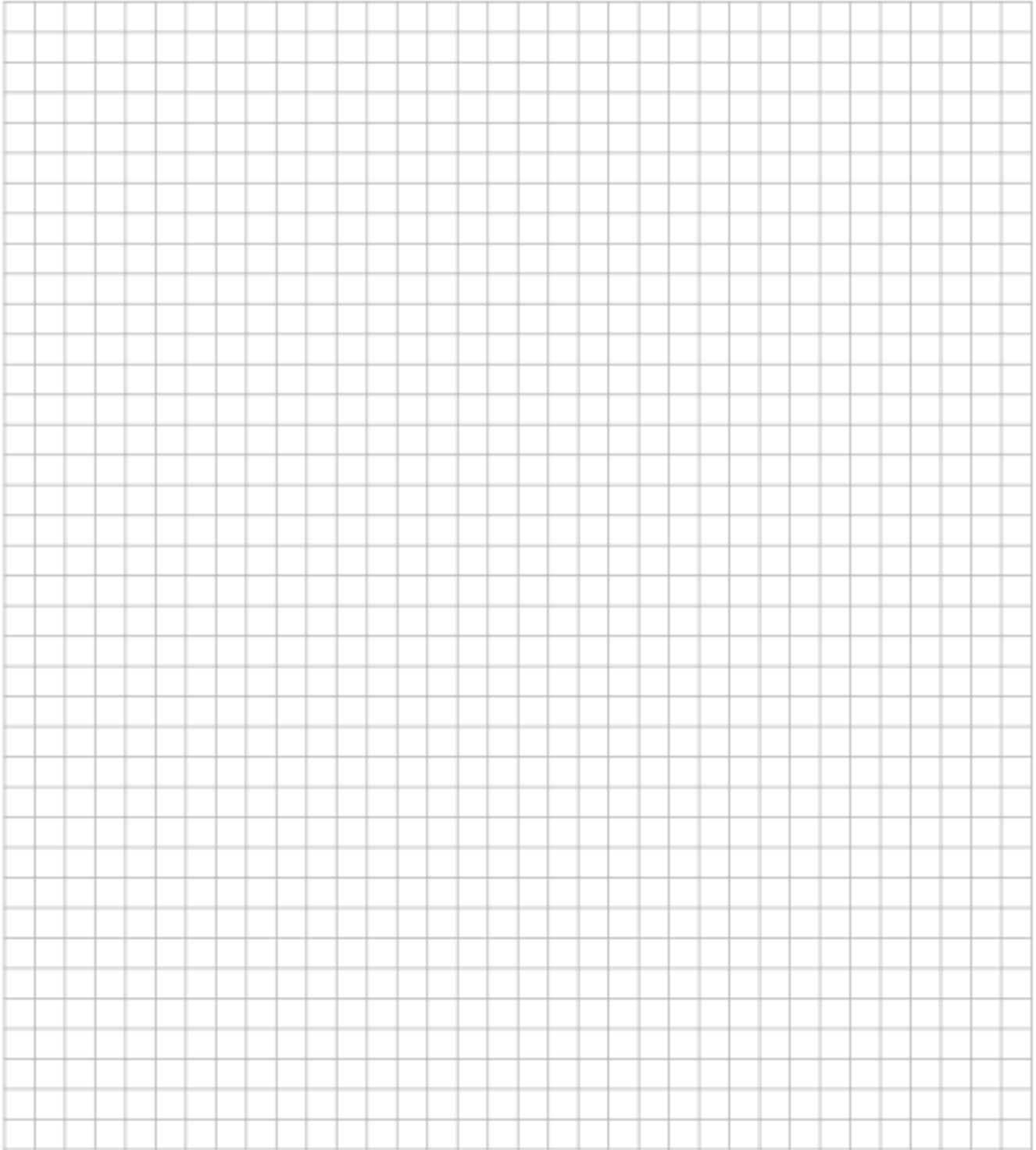
- (a) ✍ The area of a square is 49 cm^2 . Find the length of the perimeter in millimetres.
- (b) A solid cone has vertical height 6 cm. The radius of its base is 2.5 cm.
- (i) ✍ Find the slant height.
- (ii) ✍ Find the total surface area in cm^2 , correct to two decimal places.
- (c) (i) ✍ Find, in terms of π , the volume of a sphere of radius 6 cm.
- (ii) ✍ Three such spheres, placed one on top of the other, fit exactly into a cylindrical tube. Find the internal volume of the tube.
- (iii) ✍ What fraction of the internal volume of the tube is not occupied by the spheres?





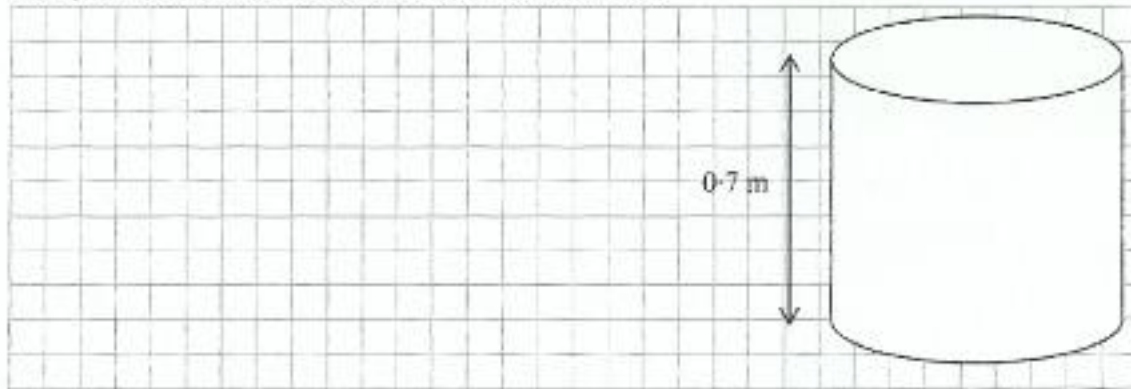
Q11.

A tissue measures $300\text{ mm} \times 260\text{ mm}$. There are 100 tissues in a box.
Find the total area of tissue in the box in m^2 .



Q12.

- (a) A container in the shape of a cylinder has a capacity of 50 litres. The height of the cylinder is 0.7 m. Find the length of the diameter of the cylinder.
Give your answer correct to the nearest whole number.



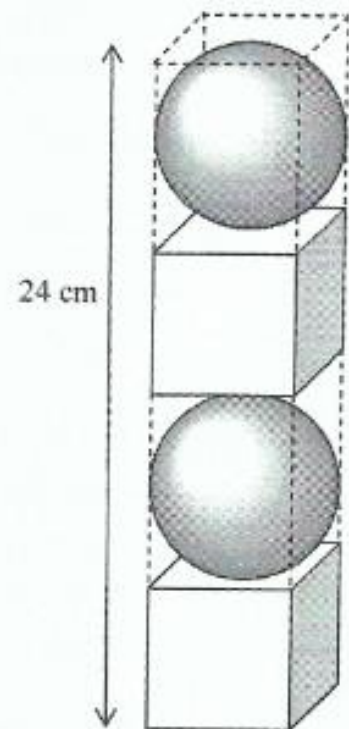
- (b) A rectangular tank has a length of 0.6 m, a width of 0.35 m and its height measures 15 cm. Find the capacity of the rectangular tank.



- (c) The rectangular tank is full of water. This water is then poured into the cylindrical container in (a) above. Find the depth of water in the cylinder.
Give your answer correct to one decimal place.

Q13.

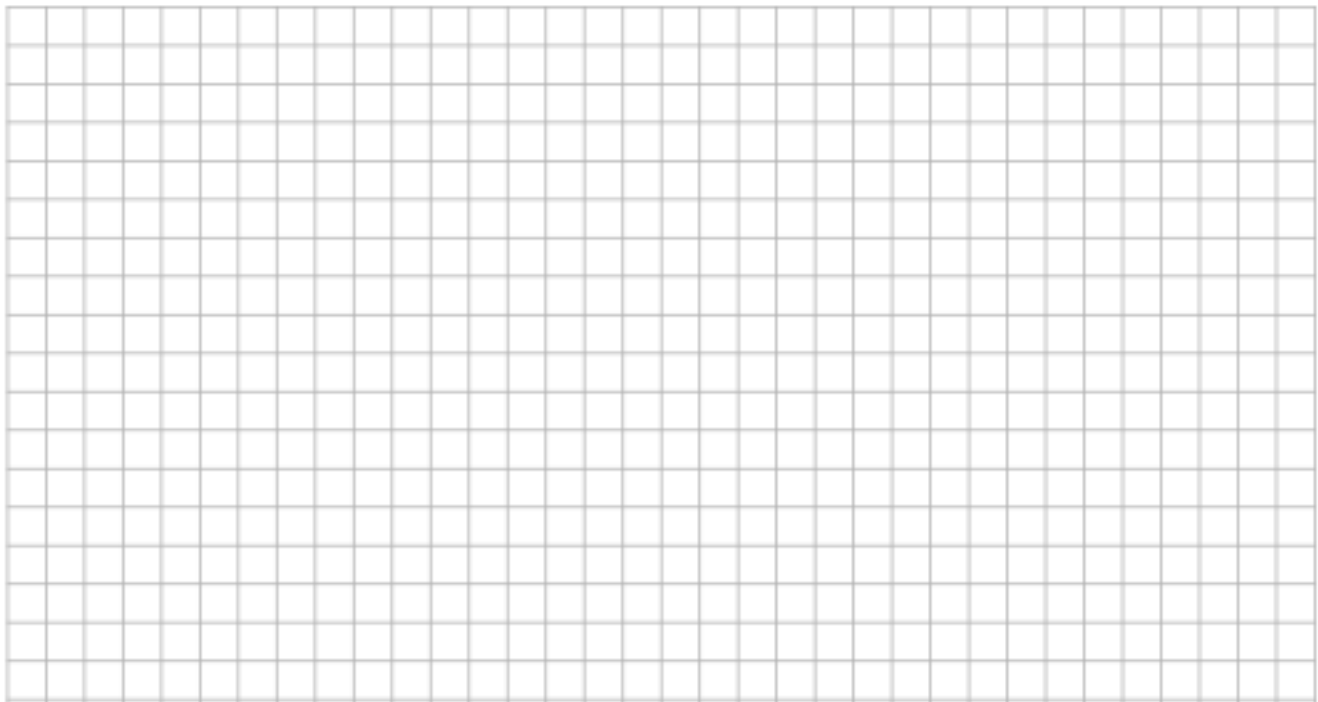
An ornament is carved from a rectangular block of wood which has a square base and a height of 24 cm. The ornament consists of two identical spheres and two identical cubes as illustrated in the diagram. The diameter of each sphere is equal to the length of the side of each cube. The ornament has the same width as the original block.



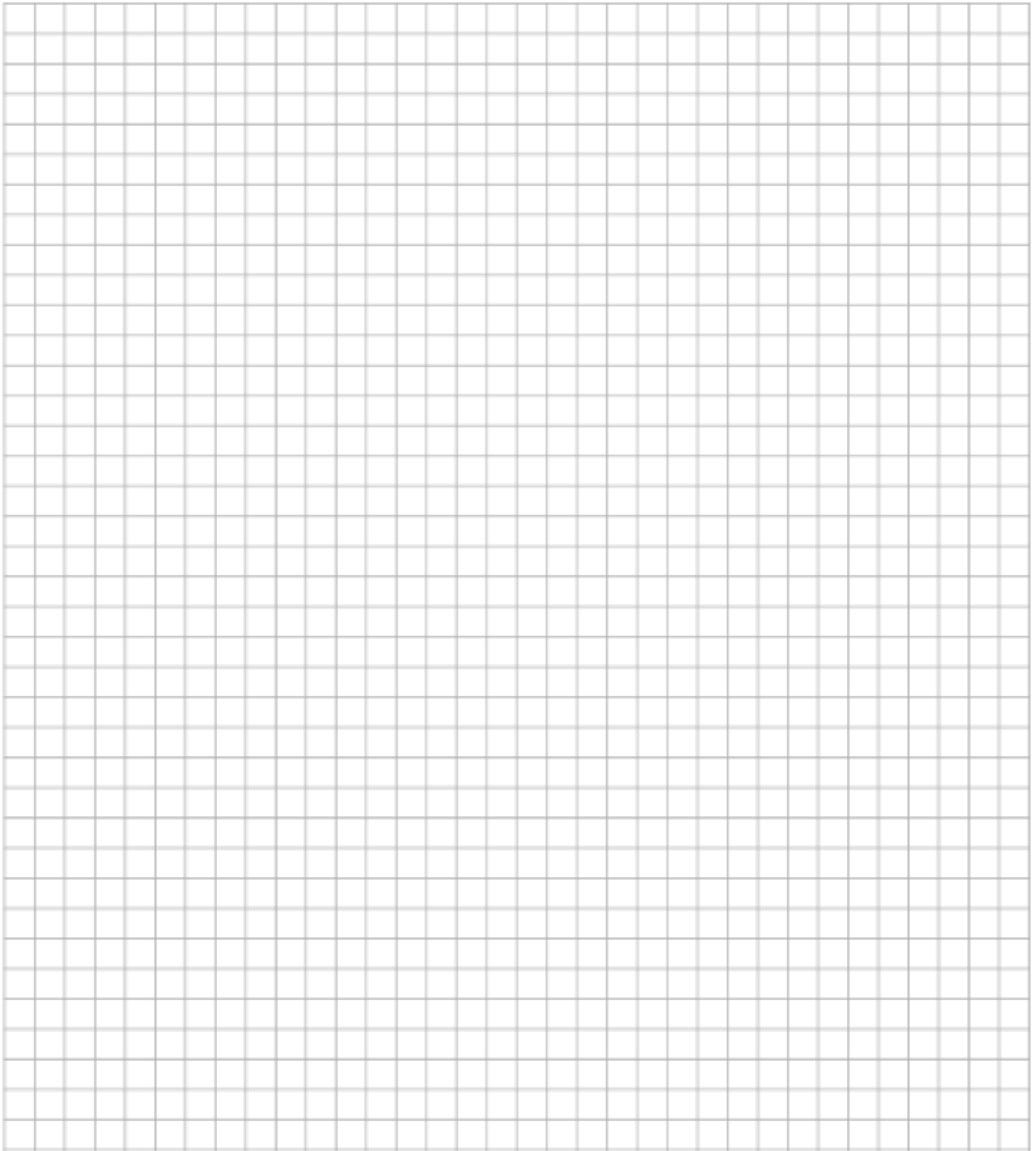
(a) Find the length of a side of one of the cubes.

(b) Find the volume of the ornament.

(c) In making the ornament, what percentage of the original block of wood is carved away?



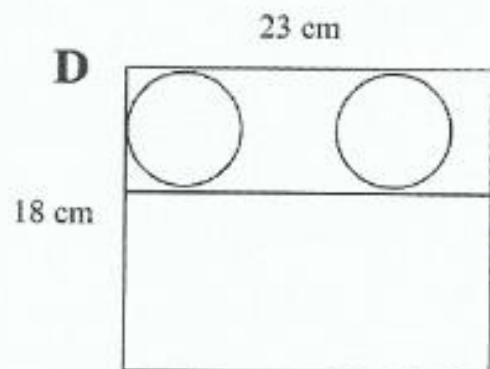
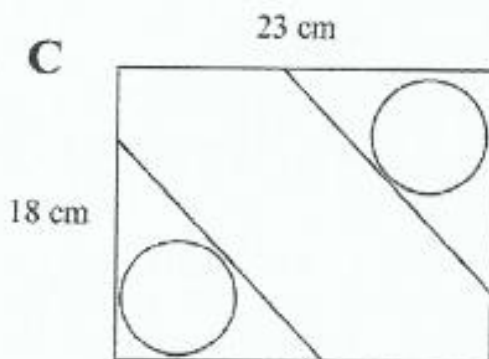
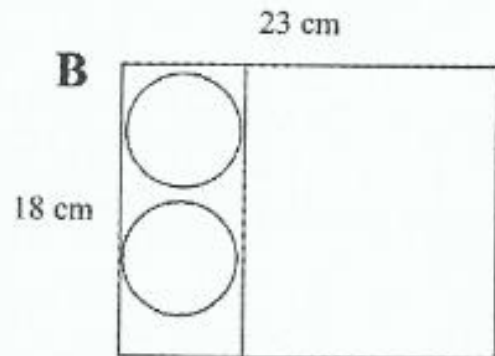
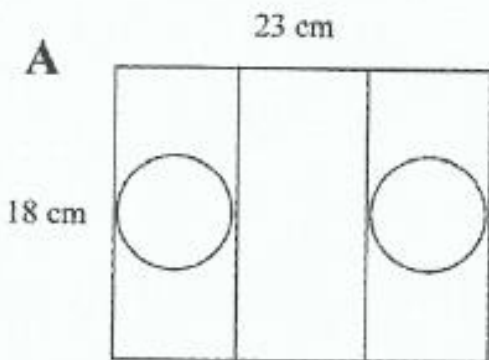
Note: There is space for your solution on the next page.



Q14.

A soup tin in the form of a cylinder has a diameter of 7 cm and a height of 10 cm. The cylinder is constructed from pieces of metal cut from a thin sheet measuring 23 cm by 18 cm.

- (a) Which one of the four diagrams A, B, C or D could represent the sheet of metal from which the cylinder has been cut?

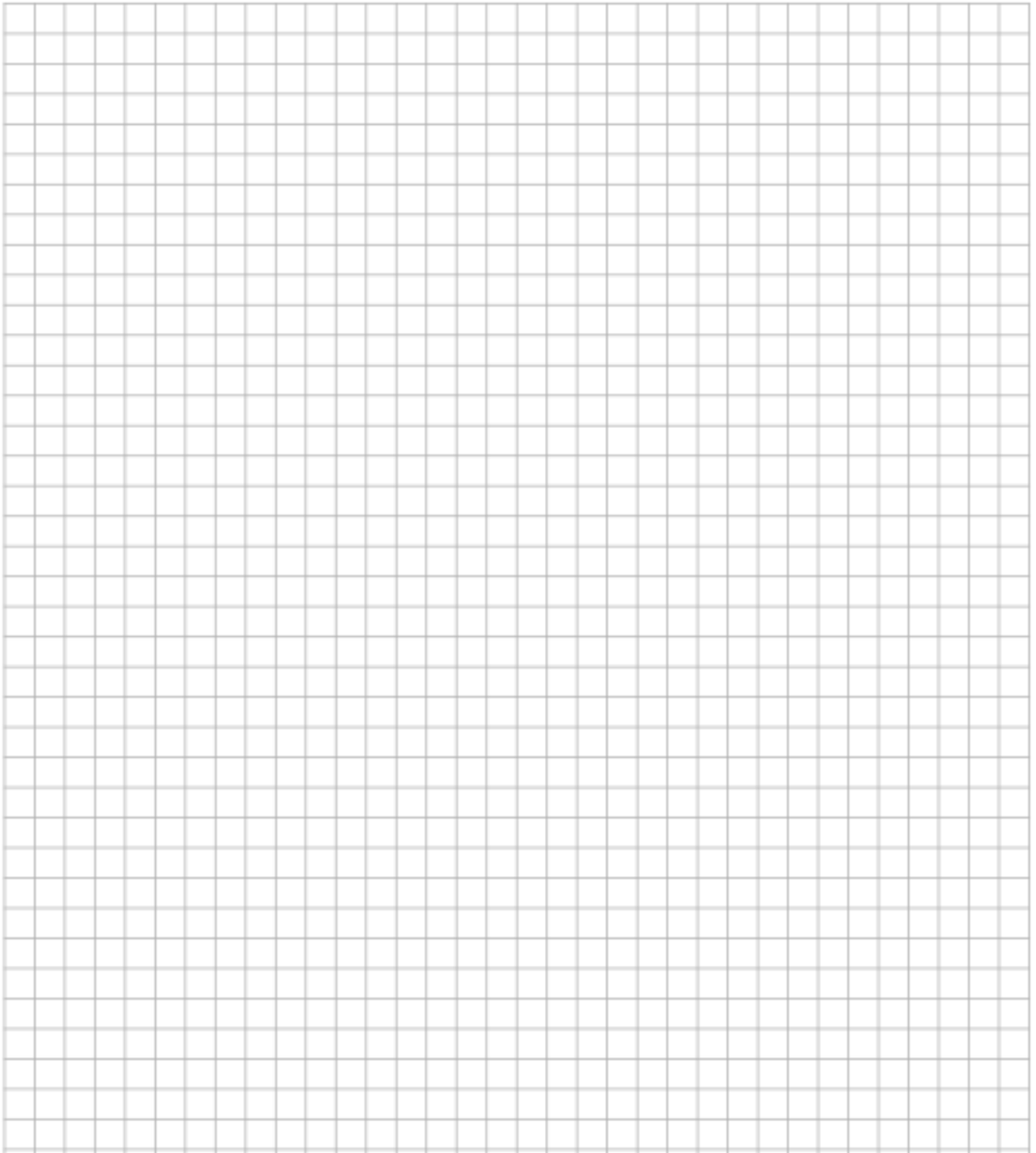


Answer = Diagram _____. Give a reason for your choice.

- (b) Find the area of metal which remains after the pieces have been cut out.
 (c) Find the capacity of the soup tin.



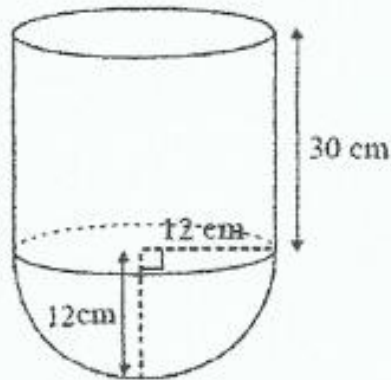
Note: There is space for your solution on the next page.



Q15.

A container has a **hemispherical** base of radius 12cm as shown in the diagram.

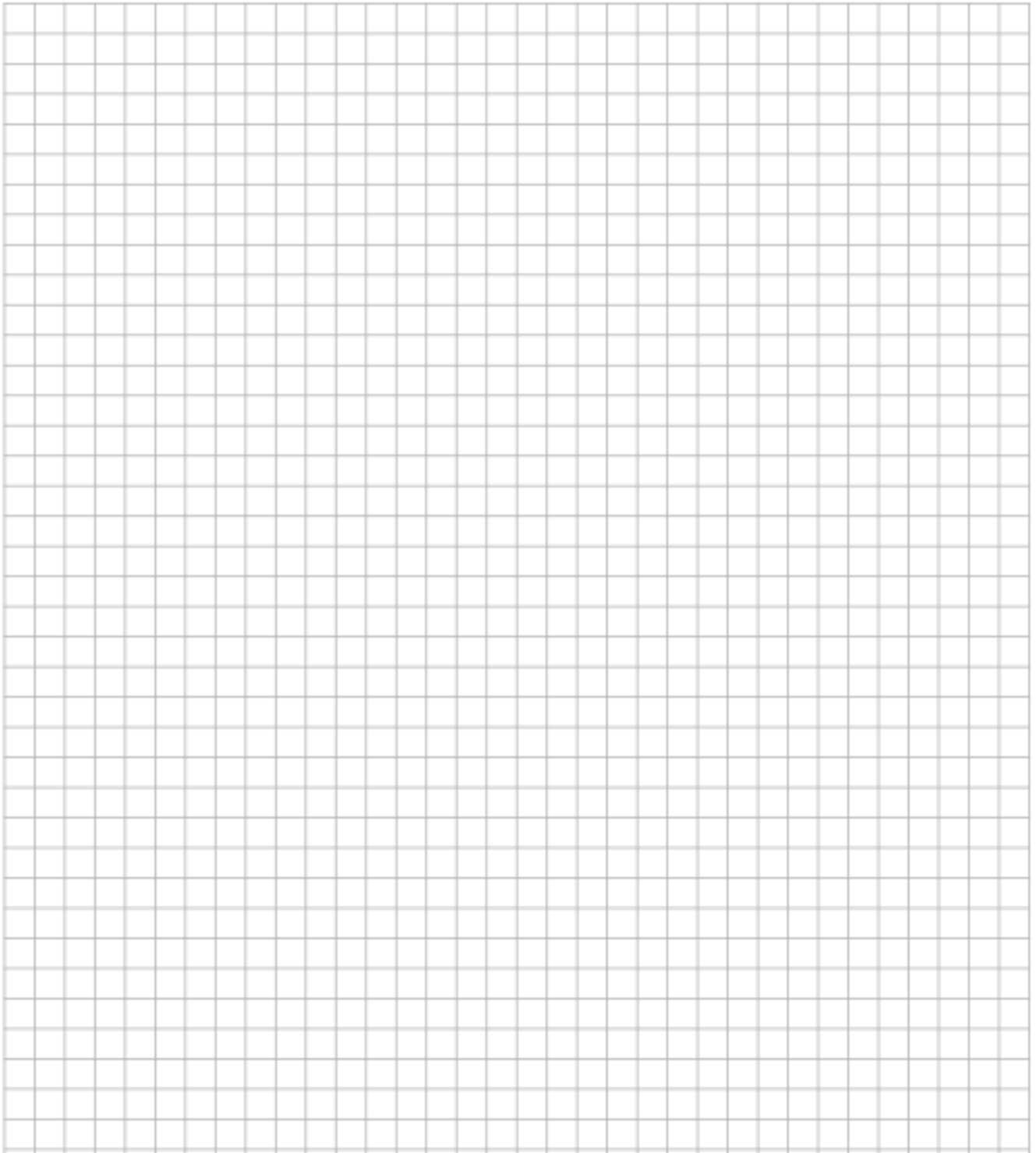
(a) Calculate the volume of water needed to fill the container.



(b) Tap A can fill the container at a rate of 100 ml per sec, whilst tap B will fill it at a rate of 12 per sec.

How long will it take to fill the container with *both* taps running?

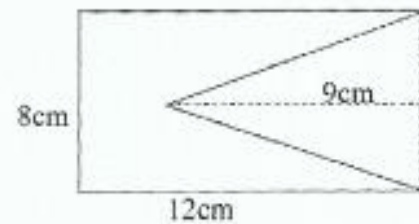
(c) A label goes around the complete cylindrical part of the container. Draw a sketch of the label showing and mark its dimensions.



Q16.

- (a) The diagram shows a rectangular piece of cardboard with a triangular section cut out.

✍ Calculate the area of the cardboard.



- (b) A cone has a slant height of 26 cm and a radius of 10 cm.

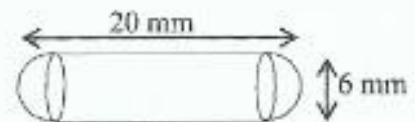
- (i) *✍* Find the curved surface area of the cone, in terms of π .



The curved surface area of the cone is doubled, while the slant height remains the same.

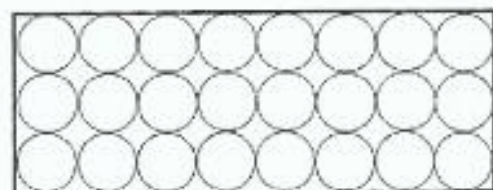
- (ii) *✍* Find the radius and hence the vertical height of this cone, correct to the nearest cm.
- (iii) *✍* Show that the volume of this cone is more than double the volume of the cone in part (i).

- (c) A vitamin capsule is in the shape of a cylinder with hemispherical ends. The length of the capsule is 20 mm and the diameter is 6 mm.

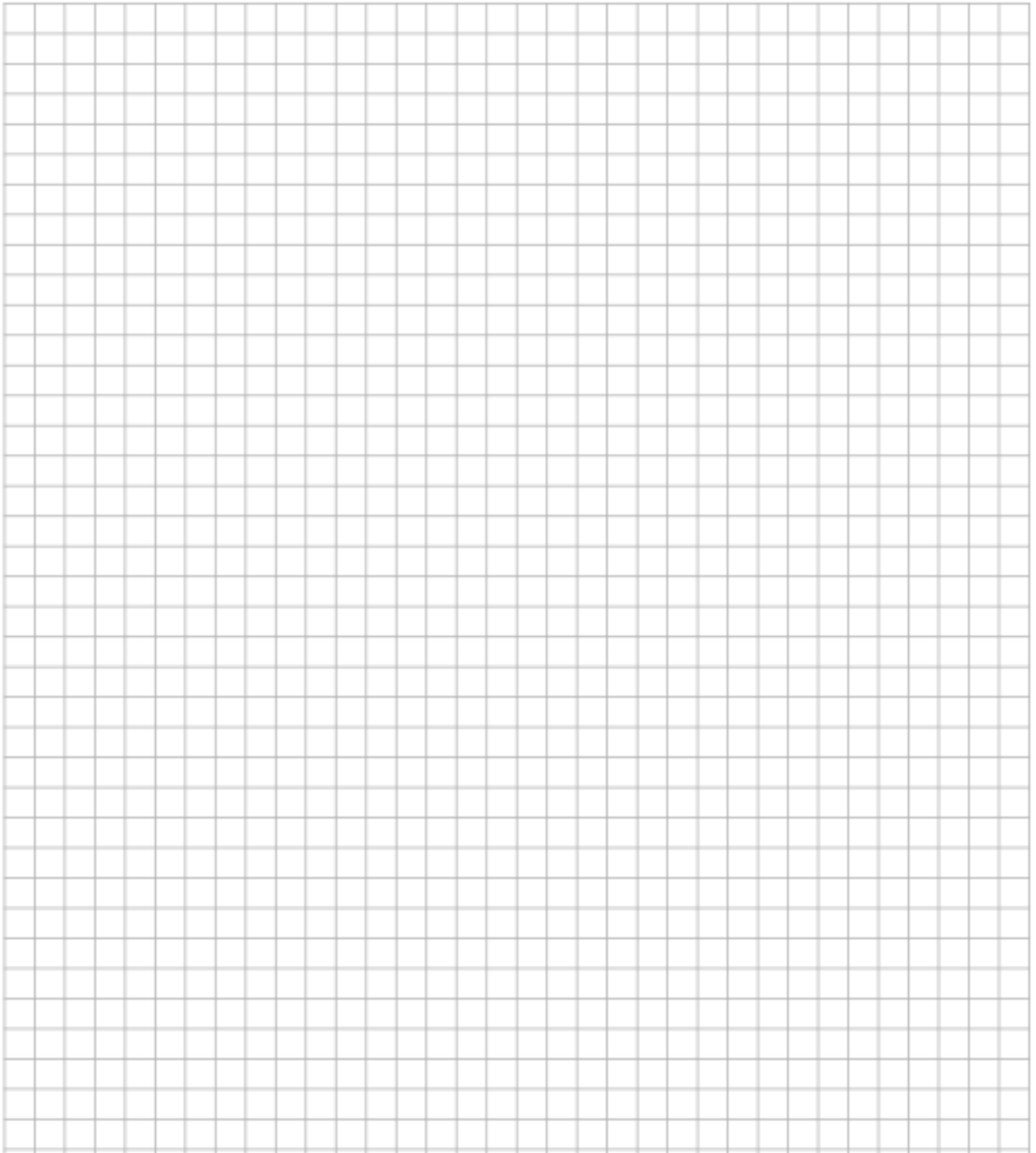


- (i) *✍* Calculate the volume of the capsule, giving your answer correct to the nearest mm^3 .

A course of these vitamins consists of 24 capsules. The capsules are stacked in three rows of eight in a box, as shown in the diagram.



- (ii) *✍* How much of the internal volume of the box is not occupied by the capsules.



JC HL Project Maths Exam Questions